Analysis of an Integrated Combined Power Cycle Plant in Egypt

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ABSTRACT

This study examines the investment in the proposed combined power cycle plant in Egypt. Due to rise in population, Egypt is facing a challenge supply of the electricity to the end users. As a result, the demand of electricity in Egypt is very high and it is potentially attractive to invest in the power sector. In order to meet the growing demand for electricity, the Egyptian government is considering to introduce the various projects, which are efficient in terms of cost, as well as, they have a positive impact on the economy. Out of these projects, from the cost and benefit perspective the El Kureimat Combined Power Cycle Plant is a good choice. Furthermore, the proposed plant technology is an alternative to the existing fuel technology plants which are not so fuel efficient, thus, the cost of generating electricity per unit decreases.

The proposed plant is powered by natural gas and uses 6^{th} gas and steam turbines. It has a capacity of 750MW electricity. The Gas turbines generate 500MW and the steam one produces 250MW.

Different kinds of analyses such as economic, financial and stakeholder analyses are conducted under this research in order to check the impacts of the proposed plant on the economy. Financially and economically this project is viable but it has some issues regarding the repayment of the loan.

There are some factors that impose risks to the financial variability of the project caused by such factors as change in interest rate, electricity tariffs, inflation, the rate of inflation, the degree of subsidization of the natural gas and demand tariff on

financial viability that have an adverse impact of the proposed project. Possible measures need to be considered in order to decrease the identified risk exposure, as well as to make this project more attractive in future.

Keywords: Investment appraisal, financial analysis, economic analysis, stakeholder analysis, risk analysis, power plant, Egypt

ÖZ

Bu çalışma, Mısır'da önerilen kombine enerji santrali fabrikasına yapılan yatırımın incelenmesi ile ilgilidir. Nüfusun artması nedeniyle Mısır elektriği son kullanıcılara sunmak için bir sorunla karşıkarşıyadır.Sonuç olarak, Mısır'da elektrik talebi çok yüksek ve bu yüzden elektrik sektörüne yatırım yapma potansiyeli bulunuyor.Artan elektrik talebini karşılamak için Mısır hükümeti,maliyet bakımından verimli olan ve ekonomi üzerinde olumlu bir etkisi olan çeşitli projeleri sunmayı düşünüyor. Bu projelerden,maliyet ve fayda perspektifinden El Kureimat Kombine Çevrim Santrali iyi bir seçimdir.Ayrıca,önerilen tesis teknolojiye mevcut yakıt teknoloji sitesislerinin alternatifi olup yakıt verimliliği düşüktür, çünkü bu etki birim başına elektrik üretme maliyetini düşürür.

Birleştirilmiş enerji santrali,ElKureimat enerji santralinin mevcut binalarında kuruldu. Önerilen tesis doğal gaz ile güçlendirilmiş ve 6.gaz ve buhar türbinleri kullanıyor.750MW elektrik kapasitesine sahiptir.Gaz türbinleri 500MW,buhar birimi 250MW üretmektedir.

Önerilen tesisin ekonomi üzerindeki etkilerini control etmek için bu araştırma kapsamında ekonomik,finansal ve paydaş analizleri gibi farklı analizler yapılmıştır.Mali ve ekonomik açıdan bu proje uygulanabilir ancak kredinin geri ödemesiyle ilgili bazı konular bulunmaktadır.

Önerilen projede faiz oranındaki değişim,elektrik tarifeleri,enflasyon,enflasyon oranı ve doğalgazın sübvanse olma derecesi ve mali canlılık üzerindeki talep tarife gibi faktörlerin neden olduğu projenin finansal değişkenliğine risk getiren bazı faktörler vardır.Belirlenmiş riski azaltmak ve gelecekte projeyi daha çekici kılmak için olası önlemlerin değerlendirilmesi gerekmektedir.

Anahtar Kelimeler: Yatırım değerlemesi,finansalanaliz, ekonomikanaliz, paydaş analizi, risk analizi, santral, Mısır ve buhar türbinleri

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I dedicate this thesis to God, and my parent, who taught me that there is dignity in learning.

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LIST OF ABBREVIATIONS

EIRR	Economic Internal Rate of Return
EOCK	Economic cost of capital
EOCL	Economic cost of labor
FEP	Foreign exchange premium
FIRR	Financial internal rate of return
GDP	Gross domestic product
HRSG	Heat Recovery Steam Generator
HV	High voltage
NPV	Net present value
O&M	Operation and maintenance
SMEs	Small and Medium Size Enterprises
UPS	Unified Power System
RFS	Resource Flow Statement
SCF	Special Conversion Factor

Chapter 1

INTRODUCTION

1.1 Study Background

Egypt is located in the north-eastern part of Africa and it occupies 995,450 square kilometers of land, around 6000 square kilometers of water, which makes it the 30th largest country on the globe. It is a Mediterranean Country which has an attached north border with Israel and the Gaza Strip, on the other side, the Red Sea is located in its eastern part and the southern side is connected with Sudan, whereas its west border is linked with Libya. According to the 2012 worldometers info, the population of Egypt was82,040,994, the population density in Egypt is 84 people per square kilometer, which entails that Egypt is the third most populous country in Africa (after Nigeria and Ethiopia).Based on the latest report of the United Nations, the current population of Egypt is 94,010,653 which makes it the 15th populated nation of the Globe. (http://en.wikipedia.org/wiki/Egypt)

The population of Egypt increases steadily at about 1.5 million per year, which has imposed huge pressure on the economic, social, and environmental dimensions of sustainable development in the economy. As a result of the increase in the population growth of the 80 million people and the huge demand of energy for industry, Egypt needs a large power supply in order to deal with the growth and the upcoming demand for electricity. The Vision of the Egyptian Government is to provide sufficient energy to the different economic sectors at minimum cost for their efficient operations and to sustain the growth of the economy. Furthermore, it is also

responsible for giving a constant supply of energy to the households in order to bring an ease in their lives, as well as to give the better living conditions to the society. In order to achieve these goals, the Egyptian Government is encouraging the private sector to participate in the energy sector to meet the upcoming demand. With regards to this, three projects were signed with the support of foreign investors under the BOOT financing act. On the Other hand, as a result of the low tariffs, the Egyptian Government successfully managed the demand of electricity with sufficient generation in the last decade. This was achieved due to the improvement in the existing system capacity. In regards to the planning perspective, the government conducted a research to analyze the various generation opportunities like, thermal power, hydro energy, solar-energy and energy that is imported from the bordering countries. According to the details, the possible hydro-energy sites available for exploration has no future and no nuclear energy resources as well, furthermore, the method of generating the energy through solar and wind was discovered to be non-competitive in comparison with the traditional method or purchasing it through bordering countries. Therefore, the energy generation by the improvement in the existing capacity of thermal plant was found be an appropriate opportunity for meeting the upcoming demand of the UPS.

The Ministry of Energy and petroleum accepted 19 different new power stations projects which have aggregated installed capacity of around 13,009 MW, for the period of 2004-2012. Thus, the proposed Combined Cycle Power Plant project is a plant that has a convenient location in regard to the grid and it has access to the prevailing system of gas distribution, besides, it is near to the supply of cooling water.

1.2Aim of the Research

Analyzing the feasibility study of a thermal power plant that will be constructed in the prevailing El Kureimat Power Station is the main concern of the following study. In this research the financial viability of the thermal power plant is calculated by using the integrated appraisal approach that examines the project into various aspects. Therefore, the project is monitored by project holder' and bankers' perspective. The following questions, mentioned below, must be answered at the end of the study.

1- Is a combined cycle power plant in Egypt financially and economically viable? And what is their stakeholders' impact?

2- What is the major risk/risky variables and their magnitude associated with the combined cycle power plants in Egypt?

1.3Research Method Used for Evaluation of the Proposed Plant

1.3.1 Collection of the Data Resource

The data for this research is collected from the project owners and their prefeasibility study. This study is accomplished through literature review which is collected from various sources, books, articles, lectures slides, library and internet sources. For assumptions, various kinds of stuff and information are received from the government and other organizations.

All the necessary data was gathered or linked with the same sort of projects, along with the same component, which is done by the World Bank, the African Development Bank and the Power Ministry of Egypt.

1.3.2 Study Approach

For estimating the viability of the project, the integrated financial appraisal analysis method is used. By the researched dataset, this study will help to determine the project financial worth. This information is compiled in the spread sheet, after some necessary adjustments; the project generated cash flow are calculated by utilizing the excel functions. Eventually, the NPV and IRR are calculated by the proposed project obtained NCFs; both indicators are used to determine the feasibility of the project.

Chapter 2

ENERGY SECTOR

2.1 Energy Sector in the World

Electricity is used in various significant fields around the world. For a time being, if we imagine our lives without electricity, there will be a total collapse for a while. Electricity is a vital input almost for everything. The electricity is used for households in different aspects such as heating, lighting, and other purposes as cooking or cleaning, which are done mainly by electric machineries that require power to process. Moreover, the private sector, which consists of industries, small scale setups, institutions and other service providers, likewise needs power for various operations that is relevant to their activities. Energy is also a vital demand of the public sector for various functions such as cooling, heating or lightening schools, libraries, banks, other government departments and also for traffic lights.

According to report from 2008, the power consumption throughout the world was around 474 Exajoules(474×1018J) and 80 to 90% are generated through the combustion of fossil fuels, which equals to an average annual power consumption rate of 15 terawatts (15.04×1012W). The demand of energy consumption has been increasing along with the growth of world population, therefore more energy resources are required to satisfy rising human needs and maintain welfare. Two things, an improvement of living standards and prolongation of human life, absolutely depend on the average energy consumption per person. Furthermore, the demand for energy resources increases globally as more developing countries are

gradually becoming industrialized. The existing energy sources are: crude oil 37%, coal 25%, natural gas23%, nuclear 6%, biomass 4%, hydropower 3%, new and renewable energy mostly winds and solar 1.3%, as well as other minor sources as agricultural and animal residues which are used in remote countryside areas.

"Nowadays, the biggest challenges that are faced by the power sector is meeting the upcoming power demand and at the same time minimizing the emissions of greenhouse gases. To resolve the climate change issue, it must be responded on urgent basis. Therefore, we need to figure out the new options that can be used to help reduce the greenhouse gases influence as well as to focus on the change of the climate." (Bohannon, 2007)

The consumption demand of the energy varies from family to family, as well as from country to country. It totally depends on different resources such as income levels, climate, and need and according to the natural reserves existing in their territories. Normally, two ways for generating electricity are considered, either by utilization of renewable resources or non renewable ones.

1: Renewable resources:

- The power can be generated by utilization of such resources: Hydro, Biomass, Solar and Wind.

2: Non-Renewable resources:

- The energy can be produced by coal-power, fossil fuel power plant, petroleum, natural gas and by nuclear resources.

2.1.1 Production Demand and Energy Trends

The demand and the production of electricity are dependent on the economic development, as well as on an increase in population. This demand and production process further have an impact on other components of the society, such as the society needs of better education and institutions like health and financial service providers that require electricity in order to run the operations smoothly. The development in various sectors has to be considered as economic growth. In modern economies, the income rate is high, due to this the consumption rate is high too, so it will be a cause for more consumption of various products such as the agricultural goods, the luxuries villas and other expensive technological items demands is increased. All the items up to some extent are connected with electricity. It is not wrong if we say economic and population growth will move parallel with the energy demand. The Energy Information Administration (2006),states in a report that China and India are rapid developing economies and in the future, they will be the world biggest energy consumers. Figure 1 is about historical spending, as well as the prediction for the coming 50 years.

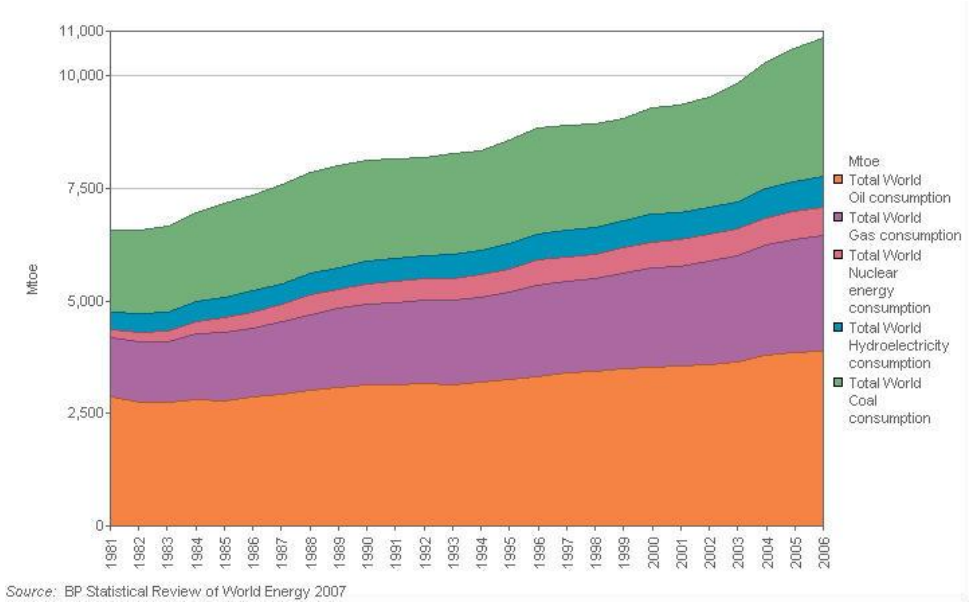

Figure1:Energy Consumption

In this graph, it is stated that Global energy consumption patterns reveal that the world remains highly dependent on fossil fuels. Over the last 50 years, while energy consumption grew substantially, the world undertook a transition in its usage of fossil fuels, from solids coal, to liquids oil to natural gas.

2.1.2 Why Combined Cycle Power Plant

The CCPP is an alternate of the old technology plant because, this technology is the substitute of fossil fuels, coal and oil, as well as it has less impact on the environment in comparison to the old time technology. This is the reason the demand of such plant has been increased in the market due to its benefits. Currently, it is the most reliable method which is used to generate electricity in those areas where the natural gas reserve is in excessive quantity. There are different reasons why CCPP is more desirable than other plant.

- It requires low capital cost as compared to conventional fossil power plants.
- It will consume less construction time in comparison to other nonrenewable resource power plants.
- The cost of fuel is cheap due to higher cycle efficiency (lower cost per kilowatt) than convention fossil power plants.
- Due to higher cycle efficiency it has less impact on environment.
- The energy efficiency which is generated through CCPP is almost in the range of 50 – 62%.
- Easy and simple to maintain and operate.

2.2 Energy Sector of Egypt

The energy sector of Egypt has been divided into two ministries, the first is the MOP, and the second is the MEE. The MOP is responsible for activities like exploring the natural gas reserves, production processes, refining the explored reserves, oil and gas marketing and transportation, whereas The Ministry of Electricity of Energy (MEE) deals with the power generation, transmission and distribution procedures. Three central organizations are supported by these ministries for decision making. The main forum for their coordination in this sector is the Cabinet of Ministers, which works in a shape of proposed committees and these regulating committees set the electricity and petroleum price.

Recently a research was conducted in the United States which indicated that the energy industry supports many more jobs than it generates directly. The constant supply of energy is a fundamental requirement for economic development. After the 2011 revolution, The Egyptian economy is seriously disturbed and it has been facing frequent electricity blackouts and severe shortages in energy supplies. As a result, the Government took an action against this issue by reducing the subsidy for heavy

industries use. Furthermore, a smart card system has been introduced that entails a certain quota of fuel for each registered car per month. It seemed to the public that Egyptian government was perusing to adopt an energy conservation policy to ration energy consumption and trying to manage the deficit in energy supplies. Although energy is an important input for many economic activities, it has a concern that a reduction in energy consumption may cause to demand the growth potentials of the Egyptian economy.

2.3 Combined Cycle Power Plant

It is also identified by CCGT shortcut, is essentially an electrical power plant in which a gas turbine and a steam turbine are used in combination to achieve greater efficiency than would be possible independently. The gas turbine drives an electrical generator. The gas turbine exhaust is then used to produce steam in a heat exchanger (steam generator) to supply a steam turbine whose output provides the means to generate more electricity. However, the Steam Turbine is not necessarily, in that case, the plant produce electricity and industrial steam which can be used for heating or industrial purpose.

In other words, the proposed plant generates the electricity through gas and steam turbine which is actually 50% more than the existing conventional simple cycle plants. Additional energy is generated through the waste heat from the gas turbine after putting it in the steam turbine.

2.3.1 How does a Combined Cycle Power Plant Work?

Here is the mechanism how combined cycle power plant generates power and collects waste heat from the gas turbine in order to improve the efficiency and increase output.

1. Fuel is burnt in Gas turbine
    I. In the Gas turbine air is compressed and mixed with fuel which is heated on a very high temperature. The mixture of fuel and hot air move through the blades of gas turbines which makes them spin.
    II. The generator is driven by the fast spinning turbine which converts a portion of the spinning energy into electricity.

2. Heat collection system.
    I. The exhaust heat from the gas turbine is captured by the Heat Recovery Steam Generator (HRSG), otherwise it would escape through the exhaust stack.

    II. Through HRSG method steam is generated from the gas turbine exhaust heat and transferred to the steam turbine.

3. Steam turbine offers extra electricity
    I. From generator drive shaft will convert it into extra electricity.

Chapter 3

METHODOLOGY

3.1Review of the Cost and Benefit Technique

The main responsibility of the government is to improve the living standards of its nation by utilizing the public funds in an efficient way. Regarding this, several kinds of projects have been focused on. In order to select the best project, few things should be considered: whether it has a harmony with the basic policies for bringing a positive change in the society or it is helpful to maximize the economic resources that are limited or not. Furthermore, in terms of the society's point of view, through analysis it has to be figured out that the prescribed project is beneficial for the society or not.

The primary aim and objectives of the study are discussed under this part, as well as it explains which approach is considered under the prescribed project. The most common technique which is currently in practice for such kind of projects; is the cost and benefits approach and it is found to be highly effective. Thus, this approach has been selected for the current project. The concept of that technique was introduced by Jenkins and Harberger in 2002 (Jenkins, Harberger and Kuo 2013). Under the cost and benefit approach, the proposed plant is evaluated through different analyses, such as economic impact analysis, financial viability analysis, risk analysis and stakeholders impact analysis over its period of operations.

Financial viability and sustainability of the proposed project is properly observed under this appraisal work. The economic analysis would not be spared because it

would assess the project economic impact. Moreover, the risk and the stakeholder analysis are conducted in order to check how the project can affect through risky variables and how it is beneficial for the society.

3.2 Following Elements Should be Considered While Analyzing the Project

According to Jenkins, Harberger and Kuo (2013), while observing the different sort of projects, the objectives of the projects are treated as separate elements and they are assigned as components or modules. Out of various modules the demand, technical, financial and the economic modules are considered for the proposed project. While making an appraisal for the proposed project these modules help to provide the feasible analysis.

The demand module works into the following perspectives; either the output of the project is used domestically or sold internationally for others consumption. It is considered that the available resources balance the demand. In regards to the nominal and real case, from the beginning to the end of the proposed project, the market prices are considered; furthermore, the primary data source is used in demand modules for effective results.

Various investments and operational phases of the project are dealt under the technical modules. The technical layout deals with the complete details of input, quantity, cost and investment, whereas the operational phase is relevant to the manpower and labor wage. The possible technical certainties should be identified in the technical modules.

The sources of funds for the proposed project are discussed under the financial module. It also explains whether the source of fund is supplied by debt or equity, if by debt or equity then what is the ratio of supplying the fund. In a case where the fund is supplied by debt, two things should be considered, the first is the mode of repayment and the second is the number of years to pay it back. Further, this module determines the financial stability, as well the viability of the proposed project.

On the following criteria a model is built and evaluated:

In this model, a parameter table is built which contains significant information and important variables that would be utilized for several analyses, it further helps to evaluate the project, as well as it will give an assistance in order to conduct the economic, financial and sensitivity analysis. To calculate the quantity of the benefits and cost against the domestic price for both financial and economic appraisals, the used method is called the integrated investment analysis method, as well as it is also useful to measure the stakeholder impact. Over a period of years, the costs and revenues of the proposed project expanded, if an event occurs or not, it should be entertained first at the time of conducting the financial analysis. Then, the same procedure has to follow for economic analysis. In the following, we present an overview of how the proposed project is judged with the help of an integrated evaluation approach which consists of different analysis such as economic, financial, risk and stakeholder analysis.

3.3 Financial Appraisal

(Harberger et al 2003) state that for all sorts of capital investments, the most important component is the financial analysis, which helps to determine the feasibility of the project. For financial evaluation, the first step is to be gathered the

relative financial data that gives information about sale and production volume from the financial analysis.

On the base of some specific case assumptions, a financial model is created, which includes the proposed project input, output price and quantities, as well as some other parameters are shown in the table of parameter. In this built model, the inflow and outflow of the domestic currency are considered in nominal terms; later on they are transformed into real values. Changes in the real price of a commodity would have an impact on demand side, as well as supply side, for both domestic and foreign market. The projected cash flows are used to measure the change in the real prices of input and output commodities in future, throughout the life of the project.

The information about the expenditure and receipt, which is collected through financial analysis, is isolated between domestic and international according to its nature. In order to calculate the economic analysis, the foreign exchange impact is measured efficiently through this process. Further, this information helps to determine the financial feasibility of the project, as well as it explains the debt to equity structure and the measurement of the interest rate. By utilizing this significant information, income tax liability and availability of cash flow, in order to meet the debt obligations can be calculated.

According to bankers' perspective, the proposed project financial cash flow statement must be more then each year debt obligations. That statement begins with net cash flow before setting the debt for financing and finalizes it by dividing the price index to figure out the real cash statement of the entire investment. The statement is used as a foundation for undertaking the project economic analysis.

Through financing activities, inflows are added and the deduction is done in outflow for such operations (Interest + principle) to the net cash flow from banker view will generate cash flow statement from owner perspective.

The next move that should be taken is to figure out the cash flow of each year price level and to deflate the cash flows with a general price index. The own rate of return is expected to be received of the project owner through the life of the whole project. By using the investor required rate of return the cash flows are to be discounted. If the results are negative, then the project is not feasible for investment. The discount rate should consider the risks which are linked with the project. For the evaluation of project financial viability, different criteria are considered but the most reliable one which is commonly used around the world is Net Present Value. The project owners need to earn their own RRR, in evaluation that rate is considered. When the NPV more than zero, it means the proposed project is attractive for investment but if it is less than 0 or negative, it means the project cost is higher then return and it is not feasible for investment.

From the banker's view, LLCR and ADSCR are the standards which help to determine that the project has the capacity to provide a sufficient fund for its debt obligations. The ADSCR is considered to be both (principle and interest), which are divided with net cash flows after tax. The LLCR is known as the PV of interest and principle during loan repayment period with the help of discount rate over the present value of net cash flow after tax. Below are given the ADSCR and LLCR formulas for calculation.

Annual Net Cash Flow in Year t

ADSCR(t) = Year (t) Annual Debt Repayment

From the Year 0 to Year (t) = PV (NCF)

LLCR(t) = from year 0 to year (t)PV (Debt Repayment)

3.4 An Investigation of the Possible Risk

Until now, the financial analysis and results are based on the deterministic values of the project variables which do not include any certainty and how this certainty affects it. The certainty of all the project values like variation in inflation rate, exchange rate, quantities and prices of the proposed project output, as well as input cannot be approached subjectively. As a consequence, the NPV of the proposed project is unable to measure the certainty and the risk. Uncertainty is an important component while preparing the project risk analysis evaluation. The first step is to highlight the risky and sensitive variables in order to conduct the risk analysis of the proposed project. How sensitive these variables are, is checked under the sensitivity analysis.

3.5 Economic Appraisal

The Economic appraisal is used to determine the impact that the proposed project has on the whole economy. From the economic perspective, the project analysis empowers us to observe, the future benefits on an incremental basis, for the society, as an economic unit. To conduct these analyses effectively, it is important to determine the values of benefits and costs on real terms basis and if they are directly incorporated with the project participants or other people in Egypt, so in this case, the impact of the government shouldn't be excluded (Jenkins, Harberger, &Kuo, 2013).

In most cases, economic costs and benefits are not much different from the financial cost and benefits. Maybe some distortions affect the economy as a whole and create some differences such as import tariff, value added tax, corporate taxes, personal income taxes and others. In the economic analysis, the goods are categorized into two forms, the first one is Tradable, and the second one is Non-tradable. A tradable good, can be an input or an output for the project. The Input fulfills the project outcome by buying more from other countries; therefore the imports are higher than the exports of the country. In regards to the tradable output, the exports are more than imports. Whereas for goods and services which are non-tradable, the domestic price is higher than the export price this is less than CIF (freight and cost of insurance) import.

3.5.1Non-Tradable and Tradable Goods (Economic Evaluation)

It is compulsory to make a difference between the nature of goods and services, in order to figure out an effective value of economic benefits and cost. Furthermore, an investigation about the price of a commodity is set through the demand force of the domestic or international market. When the production of tradable output goods and services is increased, it means, the exports are more than imports, if they are an alternative of the import goods and services.

However, the cost insurance and freight price is less than the price of non-tradable good or service, but it is more than the freight on board price, in result it is to discourage whether to import or exports the good and service.

3.5.2 How to Build Up an Economic Model

The next step that should be taken after observing the proposed project economic values of input and output is to change the receipt and expenditure values, which

were used for financial evaluation. In order to assess the economic values conversion factor is used. Each conversion factor value is multiplied by the financial price for assessing the economic values. Eventually, to observe how economically feasible the project would be, the Net present value is calculated by using the EOCK as a discount rate. Any project which contains a positive net present value should be undertaken because the benefits are higher than its costs.

3.6 Stakeholder Impacts

In order to determine the impact of the proposed project on stakeholder point of view, the stakeholder analysis is conducted. It observes the impact of the project against the different interested parties as well as it assists to determine the magnitudes of profit or losses of stakeholders. In case of differences between economic and financial values, it means that some externalities exist, like: tariff, subsidies on taxes, producer surplus or consumer surplus etc.

EOCK is used in order to calculate the net present values of externalities. Furthermore, it is used as a discount rate for financial and economic figures of the whole proposed project cycle. In order to boost the quality of the integrated appraisal approach, the both statements are adjusted with the distributional impact. It indicates that, externalities impact creates a difference between economic and financial NPV. The both statements are the same in case of addition in the externalities. The formula given below is used to determine the externalities:

$$NPV\ (ECON)\ @\ EOCK = NPV\ (FIN)\ @\ EOCK + \sum PV\ (EXT)\ @\ EOCK$$

Here NPV (ECON) @ EOCK describes the NPV of economic benefits

NPV (FIN) @ EOCK describes the NPV of FNCF.

$\sum$ PV (EXT) @ EOCK that is total sum of the PV of externalities which collect through project and all of them are discounted by EOCK (Jenkins et a., 2013).

Chapter 4

FINANCIAL ANALYSIS

4.1Parameters and Assumptions of the Project

The Combined Cycle Power Plant financial model is constructed on a set of assumptions and parameters. In the table of parameters all the deterministic outcome like debt coverage ratio, internal rate of return, net present value are calculated on the bases of the following key assumptions.

4.1.1 Timing of the Project

This project began to generate electricity in 2008 and its operation life has been projected to last for about 40 years, thus it is assumed to work efficiently until 2048.

4.1.2 Investment Cost

The total investment cost for the combined cycle power plant is € 264.1. This amount includes the physical contingency, customs, taxes and 72.9% of the foreign cost. Another analysis was conducted to figure out the cost of the natural gas, in which the price was constant in 2005 and it included the liquidation value for the gas turbine. This plant capacity is 750 MW; the factor of availability is 80% and the rate of annual plant utilization has reduced by 0.50%, which started in 2010. The net capacity generation of this plant is 691 Mega Watt after reducing5%, 3% ISO factor and auxiliary consumption respectively. An assumption is assumed for the replacement of the gas turbines after 25 operational years. The cost is adjusted due to changes in the budgeted amount, so during the estimation of the cost for actual investment cost, the

investment cost over-run is considered in the financial analysis and it is to be fixed in the beginning as 0%.

Table 1: Investment Cost

Investment Cost	**Unit**	**Cost**	**%**
Use			
Civil Work	EGP	726.00	15%
Generator Set and auxiliaries	EGP	3915.6	85%
Total	**EGP**	**4642**	**100%**
Funds			
Equity			25%
Debt			75%
			100%
Investment Cost overrun	**0%**		

4.1.3 Project Financing

The EEHC project investment cost is financed by debt and equity. One third of the total investment cost is gotten through loan whereas the rest of the amount is provided through equity. The ADBF bank finances this project and provides € 173.6 million with a floating interest rate of 2.45% p.a. The repayment schedule is considered to be twenty years, which includes five years of exemption. Thus, the nominal interest rate is exceeded from 2.451% to 4.5% p.a. The commitment fee is charged 0.25% on the undisbursed amount.

Table 2: Project Financing

PROJECT FINANCING			
Loan repayment profile	choice	Equal Principal Repayment	
Choice		1	
Loan disbursement	Date		2007
Loan tenor	Year		20
Grace period	Year		5
Real interest rate	%		4.5%
Risk premium	%		0%
Loan repayment start date	Date		2011
Loan repayment end date	Date		2025

4.1.4 Operating Cost

The calculation of the fuel cost is estimated on the base of the net plant heat rate per year, which is 6,190 Btu/kilo Watt per hour and the consumption rate of the natural gas is 0.16081m3/kilo watt per hour (with built in degeneration factor) at EGP 0.141/m3. To start the turbines, diesel fuel is used which equals to 4 percent of the generation time and the rate of consumption is 163,27grams/kilo watt per hour at the price of 182 EGP/ton. For fixed generation the operating and maintenance cost is estimated about $15.8 million per annum and the variable of operating and maintenance at 1.57 US$/ Mega Watt per hour. The cost of Labor is a component of the fixed generation operating and maintenance and extra 350 employees are expected to be hired.

The maintenance of the gas turbine is done after every five years and its estimation is 10% cost of the gas turbine. With regards to the incremental working capital the account payable should stand for at least six weeks of the fuel. Whereas,the labor, variable cost, cash balance should be sustained for a minimum of five weeks based on the fuel cost. The diesel fuel stock should be around 83000 tons against labor and variable cost.

4.1.5 Electricity Price

It is necessary to obtain the information in regards to the proposed plant in terms of the cost efficiency whether it can be generated at reasonable cost or not. The estimated electricity cost of the proposed plant is US& 1.71 cent/kilo watt per hour, a figure is selected on an international standards.

4.1.6 Life of the Assets

The Tax depreciation for civil works is for a period of 40 years, in regards to the generator and set auxiliary equipment the tax depreciation is 25 years.

4.1.7 Depreciation

The straight line method is considered for estimating the depreciation in this project.

4.1.8 Inflation Rate

In this project the inflation assumed for Egypt is 3.5%, whereas for the USA it is 2.5%.

4.1.9 Taxation

The project sale tax is 10%. 5% is charged on the imported goods and 20% is income tax personal rate.

4.2 Financial Analysis Results

There are two different ways to judge the project under financial analysis. In the first method, the project is keenly observed by investment and bankers' perspective. Whereas, the second method is about the equity holder perspective in which the project is observed whether this proposed project is beneficial for the shareholders or not.

4.2.1 Total Investment Perspective

From the investment perspective, the nominal cash flow statement takes all the benefits that are treated as an inflow in the project and the all types of costs are considered to be outflows. In order to obtain the real cash flow statement from the investment perspective, the inflation index is divided by the nominal cash flow statement. The debt capacity is measured by the cash flow statement while considering the two ratios which helps to determine the ability of the project over debt obligation.

1) ADSCR (Annual Debt Service Coverage Ratio) =

$$\frac{\text{Annual Net Cash Flow (Real)}}{\text{Annual Debt Repayment (Real)}}$$

This ratio raises awareness about the proposed project ability against its debt while assessing the yearly cash flows. Jenkins et al 2004, states that the ADSCR ratio is taken from the real ANCF of the real ADR. This ratio is calculated on yearly basis which continues from beginning to the final installment of the borrowed loan amount. This ratio criterion for assessment is the ADSCR value which shouldn't be less than zero. According to the ratio results, in the first couple of years, the proposed project has weak ratio, which indicates that the project has some difficulties in order to meet the debt obligations. To make this project attractive, there are some considerable ways that can be adopted, such as reprofiling or the loan repayment which is deferred until the project generates enough cash flow which can fulfill the required debt obligations. The proposed project results are given below which we estimated through financial analysis.

Table 3: ADSCR Results from Financial Analysis

Years	ANCF (Real)	ADR (Real)	ADSCR
1	6122	5907	1.04
2	6660	5786	1.15
3	6806	5663	1.20
4	6954	5536	1.26
5	7101	5407	1.31
6	7250	5274	1.37
7	7398	5138	1.44
8	7547	5000	1.51
9	7695	4858	1.58
10	7843	4712	1.66
11	7990	4564	1.75
12	8137	4412	1.84
13	8282	4257	1.95

It is clear from the table above that in the first few years the project faced some problems with regards to debt repayment. In order to make this project feasible, the government should participate and give a guarantee or take the responsibility to give the amount when the project cannot fulfill the debt requirements. From the 8th year onwards the project cash flows generate enough cash which fulfills the requirements of the debt, which is above the criterion value of 1.50 and this progress of generating enough cash for debt obligations will increase in the following years. From year 1 to year 7, the project ADSCR ratio show signs of weakness. So, the modification is required in order to improve this ratio in first face. It is because this set condition is not favorable for an appropriate ADSCR ratio in terms of the loan repayment. Thus, to attain the high ADSCR ratio, some methods can be employed to uplift this ratio. The first option is that, the government takes a responsibility as a backup or gives guarantee in such years. The ratio can be attractive if we adopt such opportunities as: restructuring policy in debt repayments or to get an extension in the payment of the debt. Such opportunities help to enhance the ADSCR ratio, as well as the increase the chances for repayment of the debt obligations. Thus maybe, there is flexibility in regards of repayment of the debt that the project pays for when it generates enough positive cash flows. Another possibility can be an extension in the duration of the loan repayment which helps to reduce the annual burden of the debt commitments. These changes help to minimize the debt burden, as well as they support to attain the flexibility in the debt repayments. In case of a weak ADSCR, if such steps aren't considered, the proposed project has financial difficulties in terms of debt commitments which are not feasible for any lending authorities.

2) LLCR (LOAN LIFE COVERAGE RATIO) =

$$\frac{\text{PV (CFAF end year of debt)}}{\text{PV (ADR end year of debt)}}$$

This ratio guides bankers whether the proposed project can make enough cash for its debt obligations or not, if not then the available opportunity for the proposed project is the bridge financing for some period when it has fewer amounts of cash for its debt commitments. While paying off the loan commitments, the present value of the real interest rate is to be taken. The proposed project results are given below which we estimated through financial analysis.

Table 4: LLCR Results from Financial Analysis

Years	**PV(ANCF) Real**	**PV(ADR) Real**	**DSCR**
1	50526	36583	1.4
2	47162	32996	1.4
3	43459	29555	1.50
4	39715	26256	1.5
5	35931	23093	1.6
6	32106	260062	1.6
7	28250	17157	1.6
8	24332	14374	1.7
9	20382	11709	1.7
10	16391	9157	1.8
11	12357	6714	1.8
12	8281	4376	1.9
13	4162	2139	1.9

It is clear from the table above that, the proposed project cash flows are unable to generate enough cash, in order to meet the debt obligations during the first few years. In other words, the LLCR ratio indicates that, the project is sensitive at the initial stage in regards to the repayment of the debt. So, through bridge financing method or by increasing the number of installment period, the LLCR ratio of the project makes it stronger and attractive. After the 4^{th} year, the project ratios are constantly increasing until the last repayment of the debt, which states that the project cash

flows successfully generate sufficient funds for the debt obligations and the result values are more than the criterion values.

4.2.2 Total Owner's Point of View

The main investors of the proposed project are the project holders. The owners' cash flow statement assists them when they take decisions, as well as it also informs them about the situation of the proposed project whether the project is feasible or not. After paying all the expenses, the owners of the project receive the remaining cash. Jenkins et al. (2004) explains from the owners' perspective that this statement will comprise inflows, the loan receipts and outflows are the loan and interest repayments. In case of any grants or subsidies, the project receives, it should be included as receipts in the cash flow statement and in regards to payment of tax then it is considered as an outflow. Net present Value is calculated from the obtained net cash flows. The NPV is an algebraic sum, in which the PV is taken of all the expected incremental + VE and –VE NCF over the assumed life time of the project. Jenkins et al. (2004)

NPV year (0) = Sum of Net Cash flows in year (t) over (1 + rate) t

Rate= is treated as rate of discount and it is equal to cost of the capital. Furthermore, this rate is the rate of return that the project owners receive in return of their investment, which in our case is 8%. The NPV is the evaluation method which tells from the owners' point of view whether the project is suitable or not. If NPV value is more than zero, than the proposed project is considered to be feasible, in regards to the owners' perspective and it is accepted. If NPV is less than zero, then it is not financially feasible from the equity holders prospective and it should be rejected because it does not provide the desired return to the equity holders.

In another context, the owners' cash flow statement is evaluated by the IRR (Internal Rate of Return) method. In this method IRR is treated as discount rate which brings the NPV equal to zero. (Jenkins et al. 2004). This IRR rate is the discount rate that sets the NPV = 0.

$$\text{Sum of all cash flow for year (i)} / (1+p)I \; - \; I \; = 0$$

I= Initial Investment and it is used to figure out the P value that is consider as IRR. For evaluating, if the proposed project is financially feasible or not, there is another criterion. If p value is more than r value, then the project is viable. But in a situation where the p value is less than r value, then this project is not feasible.The Net present value of our proposed project is calculated by discounting all the incremental net cash flow, so Financial Model NPV is = EGP 880.3 million and IRR = 13.70%. These both ratios explain that this proposed project is financially acceptable from the shareholders' perspective. These figures details are given below in appendix a.

Chapter 5

ECONOMIC ANALYSIS

5.1 Introduction

5.1.1 National Parameters

While analyzing the combined cycle power plant, from the economic point of view, some economic parameters should be taken into consideration along with the existing deterministic assumptions which we used for the financial analysis.

1:The EOCK for the proposed plant is 12%

2:Foreign exchange premium and NTP (Non –tradable premium) is 9% and 1% respectively for the proposed plant.

5.1.2 Taxes and Import Duties

1. Sales Tax: In Egypt 10% general tax is on consumer goods, it includes the sale of electricity to consumers but natural gas transactions are excluded.

2. Custom duties are categorized into two parts.
    i. High duty imports
    ii. Low duty imports
    iii. High duty imports are those products which are domestically manufactured and an import duty is charged 30% on them.
    iv. Products that don’t have domestic equivalence are as low duty imports and 5% rate of tariff is charged on the CIF value.

Table 5: Income Tax Rate Criteria in Egypt

Salary	Range	Tax Rate
Below 10000	No Tax	Exempt
10000 to 13000	Tax	10%
13000 to 16000	Tax	15%
Above 16000	Tax	20%

A personal income tax is charged on monthly income basis.

5.2 Economic Value of the Project Components

The EVs of the proposed project inputs and output are presented under this section. Through these economic values conversion factors are calculated for the proposed project of various items which explains the difference between economic and financial values.

5.2.1 Economic Value of the Natural Gas

Egypt is rich in natural gas reserves but most of the reserves are underdeveloped. The aim of the Egyptian government is to provide the energy supplies around the entire economy on low cost. Thus, the international price of the natural gas is higher than the domestic price in Egypt. And in 2005, EGP 0.22 per cubic meter was settled for the industrial sector. Due to some agreements, the cost of the natural gas for the power sector is lower than the industrial sector, so the price for the proposed project is settled to 0.14 EGP/m3.The current production of natural gas fulfills the domestic requirements (industrial and residential), the remaining balance is exported as LNG (liquefied natural gas). The volume of the export of the natural gas in the previous year had been increasing and this pace will continue in the future, therefore, several contracts have been signed but due to some reasons, the contract price is unknown due to the confidentiality. Thus, the price of crude oil is considered to be the international price of natural gas. The gas exporters used a specific formula in order to calculate the LNG price in their contracts.

Liquefied Natural Gas Price (US/Gigajoule) = 0.1567* Crude Oil Price (US$/barrel) +0.79

Crude oil price is 30 US$ per bbl and it is estimated that the average price is the same in a long run, as compared to the LNG price, which is 5.49 US$/GJ. From source to the port, a shipping cost, a processing cost and a border cost are applied on the natural gas. In result, the proposed plant value of natural gas is 2.00 US$/ per cuf or in other words it is 0.0567 US$/m3. Eventually, by multiplying the foreign exchange rate with this rate, the final price of the natural gas for the project will be 0.3406 EGP/m3.

5.2.2 Economic Value of Natural Gas and Conversion Factor

In order to calculate the conversion factor, 9% foreign exchange premium has been further added to the natural gas price, so the new price is 0.3713 EGP/m3. The method to calculate the economic conversion factor is simply dividing the economic over financial value. So, it (0.3713/ 0.1410) indicates that the economic value is 2.633 of the financial value.

5.2.3 System Savings

In off-peak time, the proposed project will create two types of economic benefits, thus it enhances the economic valuation of the project. The first benefit is that, the natural gas is used instead of the fuel. In this way, the saved cost of the fuel is added to the economic cost of the natural gas. In order to calculate the operating and maintenance savings, the saved financial amount of operating and maintenance is multiplied with the conversion factor of operating and maintenance, which gives the economic value.

In order to estimate peak savings, the same approach is applied, which is used for off-peak savings too. A modification is required to calculate the EV of capital charges. During the peak time, two changes must be considered.

1: From the capital cost, taxes and import duties are removed from the installed gas turbine capacity, further, for tradable expenditures, the percentage amount of foreign exchange premium is added. 2: ECOK is the alternate of the finance return rate, so the economic value is 7.76 cent/ kilowatts per hour for capital charge.

5.3 Classification of Economic Goods

In any economy products are divided into parts whether they are tradable or non-tradable goods and services. Tradable goods are the goods which are not affected by any changes in the domestic demand and supply force but the prices are determined by the international market. Thus, the domestic consumption is not affected, if the demand and supply of the project is increased. Contrarily, a good is known to be non-tradable when its price is determined by the domestic market. So the domestic consumption is affected by the increase in the demand and supply of the project. Tradable goods can be further classified into importable and exportable commodities. An importable commodity contains imported goods which are the substitutes of domestically produced goods; whereas exportable products are the exported goods and they have no domestic substitutes. In this study, the categorization for importable and exportable commodities several inputs and outs are considered. The project inputs are segregated under importable and exportable inputs. The segregation is mentioned below:

Table 6: Classifications of Economic Goods

Tradable	Non-Tradable
Wood Products	Cement and other-non metallic products
Petroleum Products	Business and other services
Plastic Products	Labor
Ceramic Products and ceramic ware	
Treated and other fabricated metal products	
Electrical equipment and products	

5.4 Calculation of Commodity Conversion Factors (CCF)

Several inputs and outputs are considered for calculating the economic values in the proposed plant. Through the financial cash flow statement conversion factors are estimated for every single item.

5.4.1 Calculation of CCF – Importable Input

Table 7: Conversion Factor for Importable Input

		Financial Value	Cash Flow for NT Services	Value of Foreign Exchange Premium	Economic Value
Carriage Insurance & Freight		1000		90	1090
(+) Import duty	5%	50			
(+) Sales Tax	10%	105			
(+) Transport & Installation	10%	100	0.9		90
		1255			**1180**
Conversion Factor		**0.94**			

5.4.2 Conversion Factors for Working Capital

Account payables are attached with the group of cash out flow items under the head of variable costs and the conversion factor is designed accordingly, therefore, the

value of economic cost is linked with the conversion in case of any changes in the account payables. No distortion is considered in regards to cash balance, which kept it for the proposed project in order to facilitate the daily transactions. So conversion factor for working capital is assumed to be 1.

5.5 Labor

The idea of opportunity cost of labor (EOCL) must be considered while conducting the economic analysis of the proposed project. It is a fact, acknowledged by EOCL that the hired workers from the labor market for the proposed project avoid getting alternative employment opportunities as well as other non competitive marketing activities. EOCL is to be treated as the value of the economy of the set activities forgone by the employees that includes non-market costs and benefits linked with the changing employments (Jenkins, Harberger, &Kuo, 2013).

For evaluating the economic opportunity cost of labor the basic aim is to put an emphasis on the distortion and the better employment conditions that exist in the market of labor in case of the movement of labor from one place of work to another. EOCL is calculated by the value of marginal product of labor forgone approach and the supply price of labor approach. The supply price of labor approach is used for this study. The main purpose to carry on this method is simple and user friendly under specific conditions. Contrarily, the marginal product of labor forgone approach is a difficult one due to its complexity for quantifying crucial factors, like worker's cost of living difference and preference of region, regarding the worth of these factors particularly, in a condition when the information from them is scarce. The supply price of labor contains some significant factors, such as the preferences for work in respect to the desired place, flexible working conditions that can impact on

the interest of labor while working on the project. Further adjustment has to be done in distortion while estimating the EOCL, like subsidies, income tax and social security contributions(Walker, Bethell, & Reno, n.d).

For estimation of EOCL;

1: The project gross of tax supply price (Wsg) **minus**

2: The project workers paid income tax (Wsg T), Government gained the tax is (**Plus**)

3: The government lost the income taxes due to alternative employment opportunities of workers (**HdWaT**)

So the EOCL of the proposed project is as follows,

EOCL = Wsg – (Wsg T – HdwaT)

In this proposed project, an assumption is set that professional employees are hired to occupy senior management positions. The given table below shows the alternative wage, supply wage and the comparable EOCL and conversion factors.

The supply wage for managerial and operations are 7000 and 3200 per month respectively, which is not the same as the alternative wage. As a result, an annual supply wage for managerial and operation are the EGP 84000 and EGP 38400, as well as, the alternative wage for managerial and operation per year is 117600 and 58800. Meanwhile, the wage rate which is paid by the proposed plant is 20% or 30% higher than the alternative and the supply wage. So, the project offers a higher wage in order to attract the managerial posts. Personal income tax of 20% is charged on managerial income. Moreover, out of their net income tax the project employees participate in the social security contribution which result is that the effective tax rate is 8%. The above calculation of EOCL in the table is like that to subtract EOCL from the supply and it takes the difference between the income tax paid of the proposed project workers and the previous employment income tax lost.

5.6 Economic Feasibility of a Project

As illustrated earlier, from the banker's financial cash flow point of view, the economic resource flow statement is made for the proposed project. Each component of the financial cash flow statement is replaced in the economic values by using the SCFs. In the inflow section of the RF statement, revenue items are recorded and they are to be treated as the gross sales revenue for the proposed project which constitutes the domestic sale. In contrast, the investment cost and operating expense are acquired for operating the proposed plant and they are treated as economic outflows. Furthermore, in the resource flow statement, the changes in account payables and cash balance are considered as outflows. However, in the proposed project the taxes on inputs and outputs are treated as corporate taxes and the liability (VAT) which is paid

Table 8: Economic Opportunity Cost of Labor

	Project Wage	Alt Wage	Supply Wage	Income Tax Rate	Labor from alt sources	Supply wage net of tax	Tax earned	EOCL	CFS	Govt benefits	Total Benefit	Ext% to Labor	Ext% to Govt
	(Wp)	(Wa)	(Ws)		(Hd)	Ws*(1-T)	Hd*Wa*T			WP*t-(HdWaT)			
Managerial	10000	9800	7000	0.2	0.9	5600	1764	7364	0.74	236	2,636	0.91	0.09
Operations	5000	4900	3200	0.2	0.6	2560	588	3148	0.63	412	1,852	0.78	0.22

by the project is not entertained in the resource flow statement because the money is deducted from the project and transferred to the government. After deduction in economic inflows and outflows the net economic benefits are gathered. Later on, they are discounted throughout the operation life of the proposed project by the settled economic rate. EOCK is used to compute the economic PVs and the EIRR rate is considered for calculating the economic internal rate of return. These two rates help us to figure out that the proposed project is successful to enhance the economy value or it appropriately achieves the aim to transfer the resources to other beneficial activities in the economy which causes the welfare of the Egyptian economy. If the proposed project economic value is higher than 0, it means that the project successfully generates the large amount of net economy benefits for the entire economy. Besides, when the project economic NPV value is less than 0, it intimates that the project fails to generate large amount of net economy benefits for the entire society and the resources are not utilized properly, so it is better to invest somewhere else in the economy. In our project the NPV economic value is EGP 1740 million positive and Economic IRR is 17.9%, which indicates that the proposed project is favorable for the economy. The result is display in appendix b.

Chapter 6

STAKEHOLDER ANALYSIS

6.1 Stakeholder Impact

The consequences of the project implementation for various associated interest groups are estimated under the stakeholder analysis. Furthermore, the net beneficiaries and the net losers of the project are determined under this analysis. The data for estimating the stakeholder impact is collected through financial and economic analysis.

6.2 Identification of Externalities

The purpose for conducting the stakeholder analysis for the proposed project is to put a focus on different society segments and to highlight which ones are entertained more or less by the implementation of the plant. This kind of relationship is followed for any project under the stakeholder analysis.

$$Pe = Pf + (\sum_{I=1} Ei)$$

Where: P_e is related to the economic input and output value

P_f explains the FV of the related variable

$\sum E_i$ is about the total value of the considered externalities which represent the difference in values of financial and economic figures. That is, the financial value and the value of externalities like tariffs, consumer/producer surplus taxes after addition are considered to be the economic value for an item. The following relationship explained above is held, if a common discount rate is applied.

$$\mathbf{NPV_{ECON\ @\ EOCK} = NPV_{FIN\ @\ EOCK} + \sum PV_{EXT\ @\ EOCK}}$$

Where: NPV_e^{EOCK} Net Present Value of net economic benefits

EOCK

NPV_f Net Present Value of financial net cash flow and

$PV^{EOCK}(\sum Exti)$ Present value of all the externalities total sum that is caused by the proposed project.

Following are the net benefits that are generated by the proposed project. The first one is the financial net benefits that are directly related to the group which has financial interest in the project. The other is about externalities, which is related to the different segments of the society. These steps have to be taken under the stakeholder analysis.

First of all, the stakeholder impact of each item is determined for the proposed project, by deducting the economic statement of benefits and costs from the FCF statement. After that, the EOCK is used as the discount rate in order to figure out the PV of each line item of externalities. The next step is to transfer the present value of externalities in the economy according to the referred groups. .

The above table gives the information about the reconciliation that has been done among the financial, economic and the externalities statement; all the values of the mentioned statements are discounted by EOCK rate of 12% real. In case where the analysis is considered in a consistent manner, when ENPV is equal to the FNPV + the distributional impact PV by applying a common discount rate. The proposed project economic NPV is EGP 9079 million. Both economic and financial NPVs are discounted by the EOCK of 12% real and the difference between them is the present value of all externalities which is EGP 2676.2 million created by the project.

Table 9: Reconciliation Between Financial, Economic & Externalities Statement

Particulars	Financial @EOCK	Externalities @EOCK	Economic @EOCK
Benefits			
System off-peak cost savings			
Fuel cost savings	1016	4527.1	5543.1
Operating cost savings	2419	-144.6	2274.4
System peak cost savings			
Capital cost savings	1215.5	816.2	2031.7
Fuel cost savings	139.7	622.5	762.2
Operating cost savings	210.1	-12.6	197.5
Residual value	11.4	-1.4	10
Total Benefits	**5011.6**	**5807.4**	**10819**
Costs			
Investment Costs			
Civil Works	665.9	-101.6	564.3
Generator and Set aluxiery	3475.8	-371.6	3104.3
Operating Costs			
Gas expenditure (subsidized)	736.1	3280.2	4016.4
Fixed O&M	1125.5	-67.3	1058.2
Variable O&M	246.5	-14.7	231.7
Expenditure			
Managerial	16.6	-4.4	12.2
Operations	124.3	-46	78.2
Variation in A/P	-25.4	1.5	-23.8
Variation in C/B	38	0	38
Total Cost	**6403.3**	**2676.2**	**9079.5**

Table 10: Stakeholder Impacts (Labor)

Particulars	Externalities	Government Tax Subsidies	Labor Additional
Benefits			
System off-peak cost savings			
Fuel cost savings	4527.15	4527.15	0.00
Operating cost savings	-144.56	-144.56	0.00
System peak cost savings			
Capital cost savings	816.24	816.24	0.00
Fuel cost savings	622.53	622.53	0.00
Operating cost savings	-12.55	-12.55	0.00
Residual value	-1.38	-1.38	0.00
Total Benefits	**5807.42**	**5807.42**	**0**
Costs			
Investment Costs			
Civil Works	-101.57	-101.57	0.00
Generator and Set aluxiery	-371.57	-371.57	0.00
Operating Costs			
Gas expenditure (subsidized)	3280.22	3280.22	0.00
Fixed O&M	-67.26	-67.26	0.00
Variable O&M	-14.73	-14.73	0.00
Expenditure			
Managerial	-4.37	-0.39	-4.00
Operations	-46.03	-10.24	-35.8
Variation of Account Payable	1.52	1.52	0.00
Variation of Cash Balance	-0.01	-0.01	0.00
Total Cost	**2676.20**	**2715.96**	**-39.8**

Chapter 7

SENSITIVITY ANALYSIS

According to Belli (2007), Sensitivity analysis helps to highlight the risky variables that can affect the project's net benefits or determine their influence on the project objectives.(Elshaer, 2013) The variation effect is measured through testing the changes in the selected variables that has a direct impact on financial and economic NPV and IRR. The following are the variables in the tested parameters, Plant load factor, investment cost overrun, Real interest rate, subsidized cost of natural gas, Inflation, Additional demand tariff. The risky variables chosen for the sensitivity analysis are the plant utilization, investment cost overrun, real interest rate, subsidized cost of natural gas inflation, and additional demand tariff. The results are given below.

7.1 Plant Utilization

One of the crucial factors is the plant utilization, which has a serious influence on the performance of the proposed project. Due to certain cause, if the proposed plant utilization decreases by 10%, then the financial NPV and economic NPV fall by EGP 733.53 and 818.56 million. To keep the turbines in a proper working condition, as well as to maintain them, quintessential for the management in order to stabilize the financial and economic returns, as we can see in table 8. It is a known fact that, if the plant utilization works below the expectation, then the cost of energy is increased by financially and economically.

Table 11: Plant Utilization

	Financial Analysis			***Economic Analysis***		***Stakeholder Impacts***		***Utility Debt Service***					
%	*FNPV*	*FIRR(%)*	*Financial Unit Cost*	*ENPV*	*Economic Unit Cost*	*PV Net (Externalities)*	*PV (Government)*	*ADCR 2013*	*ADCR 2014*	*ADCR 2015*	*LLCR 2013*	*LLCR 2014*	*LLCR 2015*
	880.3	13.7%	2.63	1739	4.747	3131.226	3091.462	1.036	1.151	1.202	1.381	1.429	1.470
60.0%	-586	4.1%	3.34	102	5.587	2495.728	2455.964	1.016	1.113	1.162	1.334	1.379	1.418
70.0%	146	9.0%	2.94	921	5.107	2813.477	2773.713	1.026	1.132	1.182	1.358	1.404	1.444
80.0%	**880**	**13.7%**	**2.63**	**1739**	**4.747**	**3131.226**	**3091.462**	**1.036**	**1.151**	**1.202**	**1.381**	**1.429**	**1.470**
90.0%	1613	18.4%	2.40	2558	4.467	3448.976	3409.211	1.047	1.170	1.222	1.405	1.455	1.497
100.0%	2347	22.8%	2.21	3376	4.243	3766.725	3726.960	1.057	1.189	1.242	1.428	1.480	1.523

7.2 Investment Cost Overrun

An increase of 10% in the investment cost has an adverse impact, which causes a loss in the financial and economic returns. Around 412.1 million in financial and 366.5 million in economic terms loss, is calculated in case of 10% escalation. The given table 9 indicates the range of possible cost overruns, presenting the result of the financial and economic outcomes. The cost overruns heavily impact on the plant cost of the supplied electricity; due to this the power is more expensive.

Table 12: Investment Cost Over run

	Financial Analysis			***Economic Analysis***		***Stakeholder Impacts***		***Utility Debt Service***					
%	*FNPV*	*FIRR(%)*	*Financial Unit Cost*	*ENPV*	*Economic Unit Cost*	*PV Net (Externalities)*	*PV (Government)*	*ADCR 2013*	*ADCR 2014*	*ADCR 2015*	*LLCR 2013*	*LLCR 2014*	*LLCR 2015*
-20%	880.3	13.7%	2.63	1739.5	4.747	3131.226	3091.462	1.036	1.151	1.202	1.381	1.429	1.470
-10.0%	1292.5	19.6%	2.49	2105.4	4.555	3084.050	3044.285	1.036	1.151	1.202	1.381	1.429	1.470
0.0%	880.3	13.7%	2.63	1739.5	4.747	3131.226	3091.462	1.036	1.151	1.202	1.381	1.429	1.470
10.0%	**468.2**	**10.4%**	**2.78**	**1373.7**	**4.939**	**3178.403**	**3138.639**	**1.036**	**1.151**	**1.202**	**1.381**	**1.429**	**1.470**
20.0%	56.0	8.2%	2.93	1007.8	5.131	3225.580	3185.816	1.036	1.151	1.202	1.381	1.429	1.470

7.3 Loan Interest Rate

Sensitivity test results for the African Development Bank loan real rate are illustrated in table 10.The real base rate is 2.80% and the rate of inflation is considered to be 2% which makes the nominal borrowing rate around 4.50% p.a. In a case when the base rate increases by 4%, then the nominal rate will increase by 6.08% p.a. the FNPV will decline by 229 million, and ADCR and LLCR will reduce by 0.273, 0.11 respectively.

Table 13: Real Rate Interest

	Financial Analysis			***Economic Analysis***		***Stakeholder Impacts***		***Utility Debt Service***					
%	*FNPV*	*FIRR(%)*	*Financial Unit Cost*	*ENPV*	*Economic Unit Cost*	*PV Net (Externalities)*	*PV (Government)*	*ADCR 2013*	*ADCR 2014*	*ADCR 2015*	*LLCR 2013*	*LLCR 2014*	*LLCR 2015*
	880.3	13.7%	2.63	1739.5	4.75	3131.23	3091.46	1.04	1.15	1.20	1.38	1.43	1.47
2.0%	1033.0	15.0%	2.63	1739.5	4.75	3131.23	3091.46	1.11	1.23	1.28	1.46	1.51	1.55
2.5%	937.6	14.2%	2.63	1739.5	4.75	3131.23	3091.46	1.06	1.18	1.23	1.41	1.46	1.50
2.8%	**880.3**	**13.7%**	**2.63**	**1739.5**	**4.75**	**3131.23**	**3091.46**	**1.04**	**1.15**	**1.20**	**1.38**	**1.43**	**1.47**
3.0%	842.2	13.4%	2.63	1739.5	4.75	3131.23	3091.46	1.02	1.13	1.18	1.36	1.41	1.45
4.0%	651.3	12.0%	2.63	1739.5	4.75	3131.23	3091.46	0.94	1.05	1.10	1.27	1.32	1.36

7.4 Subsidized Cost of Natural Gas

The cost of natural gas is a very important component for the proposed project. It is sensitive due to important role it plays a minor change in the price of gas will increase the economic and financial NPVs. When the price jumps from 0.141 to 0.18 EGP/m3, it can cause an increase in the financial NPV of EGP 172.8 million and economic NPV of EGP 533.848 million. This is the reason, why the project is more attractive as a utility point of view. As we can see from table 11, the harmony of an increase in the price causes larger amount of savings achieved by considering this plant in comparison to the other plant of EEHC. The government offers anexemption on a certain fuel amount, in case of removing this subsidy; it will cause an increase in the cost of electricity per-KWh. On the other side, a facility on natural gas is provided by the government, if it is finished, then the proposed project consumes more fuel which means the cost will increase resulting in a difficulty in payment of the debt.

Table 14: Subsidized Cost of Natural Gas

	Financial Analysis			***Economic Analysis***		***Stakeholder Impacts***		***Utility Debt Service***					
%	*FNPV*	*FIRR(%)*	*Financial Unit Cost*	*ENPV*	*Economic Unit Cost*	*PV Net (Externalities)*	*PV (Government)*	*ADCR 2013*	*ADCR 2014*	*ADCR 2015*	*LLCR 2013*	*LLCR 2014*	*LLCR 2015*
	880.3	13.7%	2.63	1739.5	4.75	3131.23	3091.46	1.04	1.15	1.20	1.38	1.43	1.47
0.12	793.9	13.2%	2.58	1413.9	4.45	2864.30	2824.54	1.16	1.28	1.34	1.55	1.60	1.65
0.14	880.3	13.7%	2.63	1739.5	4.75	3131.23	3091.46	1.04	1.15	1.20	1.38	1.43	1.47
0.18	**1053.1**	**14.8%**	**2.74**	**2390.9**	**5.35**	**3665.07**	**3625.31**	**0.79**	**0.89**	**0.92**	**1.04**	**1.08**	**1.11**
0.2	1139.5	15.4%	2.80	2716.6	5.65	3932.00	3892.23	0.66	0.76	0.79	0.87	0.90	0.93
0.22	1225.9	15.9%	2.85	3042.2	5.95	4198.92	4159.16	0.54	0.63	0.65	0.71	0.73	0.74

7.5 Inflation Rate in USA

The main purpose of this project is to generate electricity at a cheaper cost which is the cause of obtaining the system savings and the change of foreign inflation impact that is represented in table 11. An increase in the EU inflation is a reason for reducing the NPV. 1.5% increase in the rate of inflation would cause to reduce FNPV by 1.7 million. The investment costs are linked with the debt, so in case of inflation in the EURO, automatically, the purchase power of the foreign fund is reduced against the domestic currency.

Table 15: Inflation Rate in USA

	Financial Analysis			***Economic Analysis***		***Stakeholder Impacts***		***Utility Debt Service***					
%	*FNPV*	*FIRR(%)*	*Financial Unit Cost*	*ENPV*	*Economic Unit Cost*	*PV Net (Externalities)*	*PV (Government)*	*ADCR 2013*	*ADCR 2014*	*ADCR 2015*	*LLCR 2013*	*LLCR 2014*	*LLCR 2015*
	880.3	13.7%	2.63	1739.5	4.75	3131.23	3091.46	1.04	1.15	1.20	1.38	1.43	1.47
1.00%	972.5	15.2%	2.63	1739.5	4.75	3131.23	3091.46	1.11	1.21	1.24	1.33	1.36	1.38
2.50%	880.3	13.7%	2.63	1739.5	4.75	3131.23	3091.46	1.04	1.15	1.20	1.38	1.43	1.47
4.00%	**800.0**	**12.7%**	**2.63**	**1739.5**	**4.75**	**3131.23**	**3091.46**	**0.98**	**1.11**	**1.18**	**1.44**	**1.51**	**1.57**
6.00%	708.0	11.7%	2.63	1739.5	4.75	3131.23	3091.46	0.93	1.07	1.17	1.51	1.62	1.72
8.00%	630.0	11.0%	2.63	1739.5	4.75	3131.23	3091.46	0.89	1.05	1.17	1.59	1.73	1.87

7.6 Inflation Rate in EGYPT

If the inflation domestically increases from three and half percent to seven percent per annum after that the FNPV and ENPV will decrease by EGP 6.1 million and EGP 202.29 respectively. As the domestic (Egypt) inflation increases it will affect the unit cost, making the unit cost to gradually but consistently increase.

Table 16: Inflation Rate in Egypt

	Financial Analysis			***Economic Analysis***		***Stakeholder Impacts***		***Utility Debt Service***					
%	*FNPV*	*FIRR(%)*	*Financial Unit Cost*	*ENPV*	*Economic Unit Cost*	*PV Net (Externalities)*	*PV (Government)*	*ADCR 2013*	*ADCR 2014*	*ADCR 2015*	*LLCR 2013*	*LLCR 2014*	*LLCR 2015*
	880.3	13.7%	2.63	1739.5	4.75	3131.23	3091.46	1.04	1.15	1.20	1.38	1.43	1.47
2.00%	882.1	13.8%	2.63	1740.9	4.75	3045.92	3006.16	1.44	1.58	1.65	1.93	2.00	2.06
3.50%	880.3	13.7%	2.63	1739.5	4.75	3131.23	3091.46	1.04	1.15	1.20	1.38	1.43	1.47
5.00%	**878.6**	**13.7%**	**2.63**	**1738.3**	**4.75**	**3217.36**	**3177.60**	**0.67**	**0.76**	**0.79**	**0.88**	**0.91**	**0.93**
7.00%	876.4	13.7%	2.63	1736.6	4.75	3333.52	3293.75	0.23	0.29	0.29	0.28	0.29	0.29
9.00%	874.2	13.7%	2.63	1735.1	4.75	3451.15	3411.39	-0.16	-0.13	-0.15	-0.26	-0.27	-0.29

CONCLUSIONS

The integrated investment appraisal approach is considered in order to calculate the EEHC financial, economic and stakeholder analysis. The aim of using this methodology is to achieve effective and efficient results which will be feasible and sustainable for the proposed project.

In order to meet the diversified electricity demand, the Combined Cycle Power Plant is considered which has been selected as a unit in the system. Power requirements of the industry and residential users' demands have already been fulfilled by EEHC. During off-peak times the proposed plant is an alternative of the existing steam plants, and in peak times it minimizes the chances of adding additional capacity to the gas turbines.

The main reason behind the financial analysis is to check the proposed project from all angles, if it is feasible or not from the owners' and bankers' point of view. Furthermore, this analysis explains the worth of the project generated cash flows that are sufficient or not in opposite of the debt obligations and earning return is higher for equity holder or not. It is clear from the economic and financial analysis that for the EEHC the investment in this proposed project is feasible and sustainable, because it saves huge amount of fuel, operating and maintenance as well as capital costs. By using an 8% discount rate, the financial NPV of the proposed project is 880.3 million and the Financial Internal Rate of Return rate is 13.7%. Similarly, the economic opportunity cost of capital is set as 12%, in order to be calculated the economic NPV that is 1740 million, and the Economic Internal Rate of Return is 17.9%. Regionally and

internationally the set price of the levelized cost from the plant is quite low. The financial and economic levelized cost is US$ 1.71 cent/ kilowatts per hour and US$ 2.41 respectively. Regarding the debt service coverage ratio, in the first half of the decade which includes the investment period, the ratio is weak which means the proposed project cannot fulfill the bank requirement, since the ADSCR result is below the set criteria. Later on, in the following years, this project fulfills the requirement and generates the cash which meets the needs of debt obligations. In order to make this project more attractive for banker's point of view, it can be funded by equity in the debt service reserve account, especially at the time when the ADSCR ratio are weak or go for debt sculpturing.

The consequences of the project implementation for various associated interest groups are estimated under the stakeholder analysis. Furthermore, the net beneficiaries and the net losers of the project are determined under this analysis. The data for estimating the stakeholder impact is collected through financial and economic analysis. A huge amount of natural gas will be saved by installing this project, which can be mean of enhancing the exports of LNG in foreign countries. The EEHC is required to pay less in comparison to the net back value of the gas sold, so the economic impact of this project is high. The project economic NPV is EGP 9070 million. Both economic and financial NPVs are discounted by the EOCK of 12% real and the difference between them is the present value of all externalities which is EGP 2676.2 million created by the project.

The critical variables are examined under the sensitivity analysis, in order to determine and to check how they affect the proposed project outputs. The examined variables – plant load factor, investment cost overrun, real interest rate, subsidized cost of natural gas, inflation, additional demand tariff and subsidized cost of natural gas, were highlighted that can possibly influence the proposed project outputs. In other to minimize the project possible connected risk, it is needed to focus on some contractual arrangements that can help to decrease the potential risks of the proposed project. Regarding the loan repayment the AfDB has some issues, so the Government of Egypt takes the responsibility for the debt servicing. In terms of this issue the Government sectioned a fund and transferred this amount into the account of EEHC, which helps to maintain the smoothness of the project and makes it bankable. (zimmermann, 2012)

To conclude, the Combined Cycle Power Plant is feasible only if all the connected risk exposures are effectively handled by the project staff, further it achieves the maximum return for them who invested their funds in the proposed project, as well as it is beneficial to the stakeholders and the Egyptian economy.

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APPENDIX

Appendix A: Free Cash Flow Statement from Total Investment Perspective, Nominal

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2025	2030	2033
INFLOWS														
System off-peak cost savings														
Fuel cost savings				180.2	186.5	193.0	199.7	206.7	214.0	221.5	229.2	323.3	384.0	
Operating cost savings				428.9	444.0	459.5	475.6	492.2	509.4	527.3	545.7	769.8	914.3	
System peak cost savings														
Capital cost savings				215.5	223.1	230.9	239.0	247.3	256.0	264.9	274.2	386.8	459.4	
Fuel cost savings				24.8	25.6	26.5	27.5	28.4	29.4	30.5	31.5	44.5	52.8	
Operating cost savings				37.3	38.6	39.9	41.3	42.7	44.2	45.8	47.4	66.9	79.4	
Residual value (civ. works)														713.3
Total Inflows				**886.7**	**917.7**	**949.8**	**983.1**	**1017.5**	**1053.1**	**1089.9**	**1128.1**	**1591.3**	**1889.9**	**713.3**
OUTFLOWS														
Investment Costs														
A: Civil Work	198	250.5	306.4											
B: Gen set and Aluxiery		1948.4	2177.9											
Operating Costs														
Gas exp.(subsidized)				130.5	135.1	139.8	144.7	149.8	155.0	160.5	166.1	234.3	278.2	
Fixed O&M				199.6	206.6	213.8	221.3	229.0	237.0	245.3	253.9	358.2	425.4	
Variable O&M				43.7	45.2	46.8	48.5	50.2	51.9	53.7	55.6	78.4	93.2	
Labor expenditure														
Managerial				2.742	2.866	2.996	3.132	3.274	3.422	3.577	3.740	5.827	7.274	
Operations				20.6	21.5	22.5	23.5	24.6	25.7	26.8	28.0	43.7	54.6	
Variation in Account Payable				-32.473	-1.176	-1.219	-1.264	-1.310	-1.358	-1.407	-1.459	-2.091	-2.505	76.5
Variation in Cash Balance				48.709	1.764	1.829	1.896	1.965	2.037	2.111	2.188	3.137	3.758	-114.8
Total Outflows	**198**	**2198.9**	**2484.3**	**413.3**	**411.8**	**426.5**	**441.7**	**457.4**	**473.7**	**490.6**	**508.1**	**721.4**	**859.9**	**-38.3**
NCF Before Financing	**-198**	**-2199**	**-2484**	**473**	**506**	**523**	**541**	**560**	**579**	**599**	**620**	**870**	**1030**	**752**

Appendix B: **Economic Resource Flow Statement**

	P.V	C.F	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2025	2030	2033
INFLOWS																
System off-peak cost savings																
Fuel cost savings	*5543*	*5.456*	0	0	0	886.5	886.5	886.5	886.5	886.5	886.5	886.5	886.5	886.5	886.5	
Operating cost savings	*2274*	*0.94*	0	0	0	363.8	363.8	363.8	363.8	363.8	363.8	363.8	363.8	363.8	363.8	
System peak cost savings																
Capital cost savings	*2032*	*1.672*	0	0	0	324.9	324.9	324.9	324.9	324.9	324.9	324.9	324.9	324.9	324.9	
Fuel cost savings	*762.2*	*5.456*	0	0	0	121.9	121.9	121.9	121.9	121.9	121.9	121.9	121.9	121.9	121.9	
Operating cost savings	*197.5*	*0.94*	0	0	0	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	
Residual value (civ. works)	*10.02*	*0.879*	0	0	0	0	0	0	0	0	0	0	0	0	0	239.3
Total Inflows	**10819**		0	0	0	**1729**	**1729**	**1729**	**1729**	**1729**	**1729**	**1729**	**1729**	**1729**	**1729**	**239**
OUTFLOWS																
Investment Costs																
A: Civil Work	*564.3*	*0.879*	174	212.69	251.36											
B: Gen set and Aluxiery	*3104*	*0.94*		1770	1911.6											
Operating Costs																
Gas exp.(subsidized)	*4016*	*5.456*	0	0	0	642.4	642.4	642.4	642.4	642.4	642.4	642.4	642.4	642.4	642.4	
Fixed O&M	*1058*	*0.94*	0	0	0	169.2	169.2	169.2	169.2	169.2	169.2	169.2	169.2	169.2	169.2	
Variable O&M	*231.7*	*0.94*	0	0	0	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1	
Labor expenditure																
Managerial	*12.2*	*0.736*	0	0	0	1.8	1.8	1.9	1.9	1.9	1.9	1.9	2.0	2.2	2.3	
Operations	*78.24*	*0.63*	0	0	0	11.7	11.8	11.9	12.0	12.2	12.3	12.4	12.5	13.8	14.5	
Change in A/P	*-23.84*	*0.94*	0	0	0	-27.5	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	27.5
Change in C/B	*38.04*	*1*	0	0	0	43.9	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	-43.8
Total Outflows	**9079**		**174.0**	**1982.7**	**2163.0**	**878.6**	**862.9**	**863.0**	**863.1**	**863.3**	**863.4**	**863.6**	**863.7**	865.2392	866.0461	-16.344252
NCF Before Financing			**-174**	**-1982**	**-2319**	**850.2**	**865.9**	**865.7**	**865.6**	**865.5**	**865.3**	**865.2**	**865.0**	**863.5**	**862.7**	**255.6**

PV of costs before financing	**7462.5**
PV of energy supplied	**47250.3**

ENPV, (EGP million) @ EOCK:	**12%**	**1740**
EIRR		**17.9%**
Levelized energy cost, real (EGPiaster/kWh		**28.48**

4.75 US cent