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ALTERNATIVE TRACK OF ENERGY IN EGYPT

Abstract:

Bioenergy is considered an important source of energy in modern era that ensures the preservation of environment and achieves sustainable development. Moreover, it preserves the triple bottom line which cares about all aspects of environmental and social as well as economic aspects of development. Bioenergy is considered a wide field of generating energy from different treated material using different types of technology, while Egypt is now going for a National Program to sustain energy through the treatment of animal, agriculture and even human waste. This is initiated through the Bioenergy for Sustainable Rural Development Project which works on several levels, the first level includes household units which depend on the anaerobic fermentation from the waste of animal, in which methane gas is produced to replace butane gas; used in homes. The second level includes the production of gas from poultry farm units aiming to solve the diesel crisis in which both large poultry farms and those small ones, relaying on the cylinders, need the diesel. And finally, the third level which includes generation of electricity from rice straw. So, the goal of the study is to present an analysis of the Egyptian experience in the production of Bioenergy in addition to achieving sustainable development and ways for overcoming the obstacles that hindered the application of this experience previously.

Keywords:

Egypt- Renewables- biomass- biogas- Sustainable Rural Development- Bioenergy Technology(BET)

JEL Classification: Q16, Q42, Q50

1. Introduction

Energy plays a vital role in the economic development and also in the social development to achieve better standard of living. And according to the competition of world demand on energy, there is a world direction toward the renewable energy because of its sustainable existence, like solar energy, wind power, and Biomass, to cover growing human needs of energy in one side, in the continuous population increase, and to departure from the specter of finishing the supply of non-renewable energy on the other side, on top of it are the oil and natural gas. In addition to the achievement of sustainable development and the triple Bottom line.

Therefore, over last decade, interest has increased in the potential for biofuel as a means of reducing dependency on fossil fuels and developing environmentally friendly and renewable energy, and Biofuel demand is increasing because of a combination of growing energy needs; rising oil costs; the pursuit of clean, renewable sources of energy; and the desire to boost farm incomes in developed countries. In turn, the need for crops- such as maize and sugarcane- to be used as feedstock for biofuels has increased dramatically. That demand has had a significant and increasing impact on global food systems.

The effects of growing biofuels demand are interwoven with tightening grain markets, which reflects demographic shifts and improved diets. In developing countries, as populations grow and incomes rise, diet preferences are shifting from staple crops to higher- value products like meat and dairy.

As a result, the demand for grain- and protein- based animal feed is soaring and competing with food needs. These changes have led to increasing pressures on global agricultural markets and higher food costs. And because of the drawbacks of the first generation of biofuel which depends on the food plants, as we will see later, the world started to use the animal and human wastes, and also agricultural residuals .this type of biofuel called second generation of Biofuel. There is also third generation of biofuel which depends on algae which can be cultured using sea and wastewater (Mario Giampietro, 1997).

Regarding Egypt, it took the same world track and began(in the growing population increase, the reduction of pollution which affects the public health, and the price increase of fossil fuel and its shortage supply) to depend on the renewable energy and support its development, and to achieve efficient use of the traditional energy and rationalize its use. In the field of renewable energy sources, Egypt possesses multiple wealth which need only sound political willing and good economic management to maximize benefit from these renewable sources in the coming period (Shadia R. Tewfik, 2013).

Regarding the biomass field, Egypt has many experience in that field, last of them is the Sustainable Rural Development project which started in 2010 and works on many levels, as we will discuss later.

The paper is organized as follows, section 2 briefly describes the methodology and section 3 reviews the literature. Section 4 presents the definition, development, and generations of Bioenergy. Section 5 illustrates types of Biofuel. Section 6 discusses advantages, and disadvantages of first generation of biofuels. Section 7 presents the Bioenergy in Egypt by introducing the previous experiences of Bioenergy and the Rural Sustainable Development Project in Egypt (2010- 2014). And finally section 8 concludes and section 9 is the bibliography.

2. Methodology

In this study, we will depend on case study approach by showing the Egyptian case and determining the type of the produced biofuel in Egypt reflecting its impact on the environment and its role in achieving the sustainable development and offering alternative source of renewable energy.

3. Literature Review

Early studies of the operational level of biofuel analyzed economic factors, for example, estimating the cost of each operation from farm to conversion plant. The primary objective of most early studies was to assess the economic feasibility of the biofuel industry by estimating the cost of biomass logistics. Jenkins et al. estimated costs for alternative processes in biomass logistics, including collection and transportation of several types of biomass (e.g., rice, wheat, and barley straws; corn and sorghum Stover; cotton stalks; orchard pruning; and forest slash).

Hamelinck et al. addressed international Bioenergy logistics. They reported that, in Sweden and the Netherlands, several green-energy producers already import biomass, requiring the supply of long-distance biomass transportation. They estimated the cost for each possible operation in such an international biomass. Gronalt and Rauch proposeda method to evaluate the total cost of supplying woody biomass from forest to conversion plants for a state within Austria, comparing central and local chipping alternatives. The system cost they calculated includes the costs of transportation from forest to terminals and from terminals to conversion plants and of operating terminals, but does not include harvesting costs (Heungjo An, 2011).

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In 2006, Sokhansanj et al. reported a similar; integrated biomass supply analysis and logistics (IBSAL) model. Their Extend Sim simulation model is similar to that of De Mol et al. but it calculates the carbon emissions that result from processing and transportation, and includes formulas that give good estimates of physical phenomena and logistics operations, including biomass availability, moisture content, weather factors affecting field operations, equipment performance, dry matter loss, and costs.

They analyzed a numerical example that applied their model to corn Stover collection and subsequent transportation in bales. In 2007, Kumar and Sokhansanj employed IBSAL to study switch grass logistics and compared several options for collection and transportation. They noted that the simulation approach is limited because it uses a given network structure, which specifies facilities and their capacities as well as transportation distances, which depend on facility locations. Ravula et al. used a simulation model to study transportation in the cotton logistic network as a possible model for the biomass system.

Typically, cotton is collected and then compressed in long blocks, known as cotton modules, for transportation. Then, cotton modules built by several farmers are transported to a gin for processing. To consider continuous cotton module supply in a biomass transportation system, they proposed a knapsack optimization model with binary decision variables that prescribe truck schedules and module pickups. They used their simulation model to study a transportation system, investigating greedy strategies, such as “shortest first” or “longest first, shortest second,” to schedule transportation operations using a limited number of equipment that are specialized for harvesting cotton.

Two other important issues in biomass are maintaining two other important issues in biomass are maintaining sustainable supply and assuring reduced environmental impact. Forests are a primary source of cellulosic biomass and related studies have been focused on harvest sustainability since the 1980s.

Those studies are applicable but, since they focus on forest products rather than biofuel, this paper simply outlines recent trends in forest harvesting research. Major concerns associated with scheduling forest harvests include producing greatest benefits, achieving consistent and stable harvest yields, and reducing the environmental impact of required treatment operations.

Murray reviewed two basic harvest-scheduling models: the unit restriction model (URM) and the area restriction model (ARM). These two models differ in just one constraint, which involves spatial restrictions. URM does not allow harvesting in an area that is adjacent to another one that has been harvested, while ARM limits the extent of contiguous harvesting areas in each cluster of areas.

Most recent studies have focused on different solving methodologies to overcome the computational challenges of the ARM. Martins et al. posed a column-generation approach that solved sub-problems using heuristics. Gunn and Richards formulated a mixed integer program (MIP), including strengthening and lifting constraints, to improve the basic ARM formulation. Goycoolea et al. proposed a MIP based on the node packing problem. They devised an exact-optimizing algorithm that uses strong valid inequalities, which form clique representations of a projected constraint.

Constantino et al. presented a new MIP model, which comprises polynomial numbers of variables and constraints, and used branch and bound to solve it. Since first-generation biomass (e.g., edible crops, such a scorn and sugarcane) has been used to produce ethanol, we also consider SC research in the agri-food area.

A few papers have dealt with the sugarcane SC. Higgins formulated a MIP to improve yield by scheduling sugarcane harvests and solved it using several heuristics. Higgins and Postma addressed a scheduling problem to optimize the roistering of harvesting groups into sugarcane rail and road sidings to reduce transportation and harvesting costs.

4. Definition of Bioenergy and its Generations

Fossil Fuels are dwindling and in order to maintain the current levels of energy use and there are environmental concerns about the effects of using fossil fuels such as pollution and climate change. Bioenergy may be part of the solution to these problems. So, Bioenergy is the energy derives from harvesting biomass such as crops, trees or agricultural waste and using it to generate heat, electricity or transport fuels.

Biomass includes all plants and plant- derived materials, including animal manure, not just starch, sugar, and oil crops already used for food and energy. The biomass resource base is composed of a wide variety of forestry and agricultural resources, industrial- process residues, and municipal- solid and urban- wood residues (Pretty, 2008).

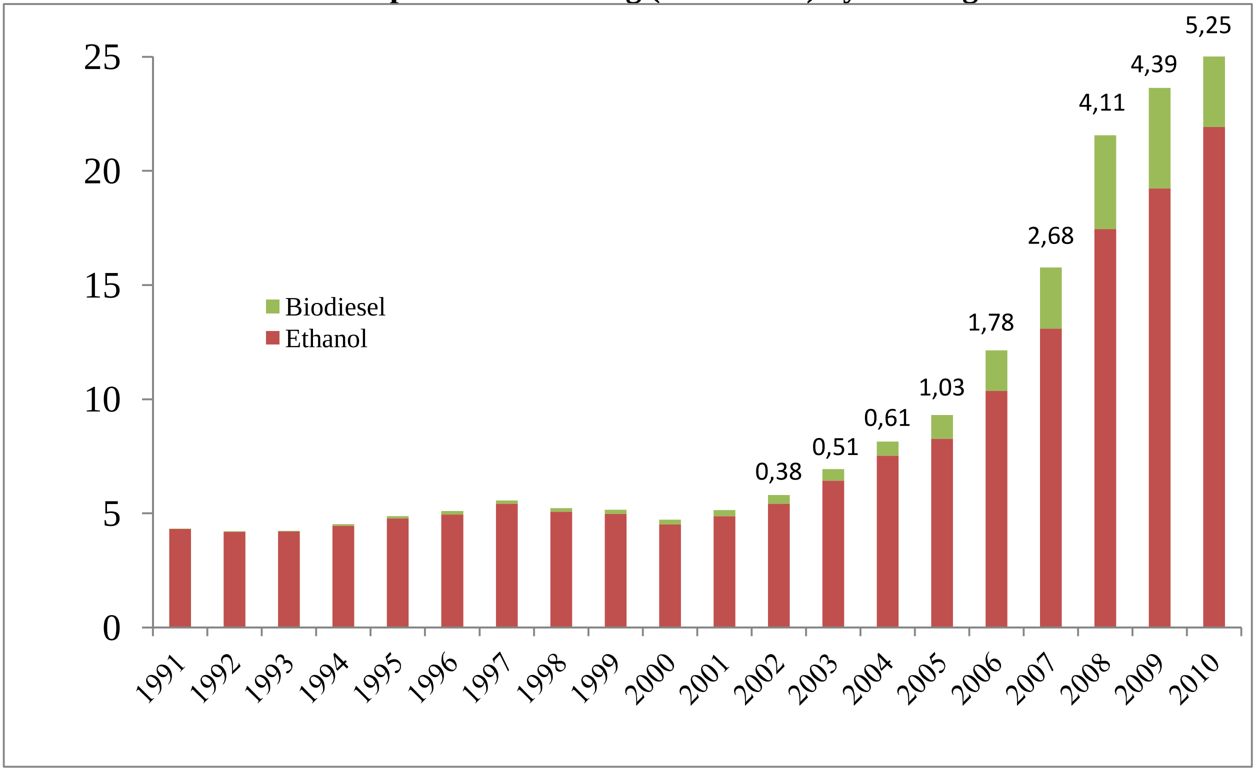
Biofuel is a type of energy derived from renewable plant and animal materials. Examples of biofuels include ethanol (often made from corn in the United States and sugarcane in Brazil), biodiesel (vegetable oils and liquid animal fats), green diesel (derived from algae and other plant sources) and biogas (methane derived from animal manure and other digested organic material). Biofuels are most useful in liquid or gas form because they are easier to transport, deliver and burn cleanly Biofuel produced from biomass are generally classified according to three generations of processing technology, which we will summarize below.

Most feedstock for **first-generation biofuels** could also be used for animal or human food and have, thus, caused concern that they could lead to a global food crisis flower, palm oil, and hemp and field pennycress using transesterification. Bio-alcohols (e.g. ethanol), the most common biofuel worldwide and especially in Brazil are produced by fermentation of sugars derived, for example, from sugar crops (e.g. sugarcane and sorghum) and starch crops (e.g. corn, wheat, and potato). Biogas can be produced either from biodegradable waste materials or by feeding energy crops into anaerobic digesters. Syngas, a mixture of carbon monoxide and hydrogen, is produced by gasification. Most feedstock for first-generation biofuels could also be used for animal or human food and have, thus, caused concern that they could lead to a global food crisis.

These concerns have stimulated development of the **second-generation biofuel**. Cellulosic ethanol, which is produced from lingo cellulosic biomass, is a representative second-generation biofuel. Lignocelluloses biomass consists of the residual, non-edible parts of food crops (e.g., stems, leaves and husks) as well as other non-food crops (e.g., switch grass; jatropha; cereals that bear little grain; fuel wood and industrial waste such as wood residues, skins and pulp from fruit pressing).Other second-generation biofuels are under development, including biohydrogen, bio-methanol, 2,5dimethylfuran, biohydrogen diesel, mixed alcohols and wood diesel.

Recently, algae fuel, which is a biofuel produced by algae, was spotlighted as the **third-generation biofuel**. Algae can be cultured (i.e., bio-manufactured) using sea or wastewater, are biodegradable, and are relatively harmless to the environment if spilled. The National Renewable Energy Laboratory has reported that 2000 square kilometers (less than 0.1% of climatically suitable land areas in the U.S.) for culturing micro-algae could produce about 3 GL of fuel. This productivity means that 38,850 square kilometers, less than 1/7th of the area used to raise corn in the U.S. in 2000, could produce enough algae to meet all of the U.S.A.’s ground transportation needs.

Figure (1)
Global biofuels production during (1991- 2010) by billion gallons



Source: International Energy Agency

Biofuels have been increasingly explored as possible alternative source to gasoline with respect mainly to transport. Global biofuel (bioethanol and biodiesel) production tripled from 4.8 billion gallons in 1991 to 16 billion in 2007 and 27 billion gallons in 2010. So the interest in biofuels is increasing for a number of reasons: reduced reliance on fossil fuels, reduction in greenhouse gas emission, national independent security of fuel supply, and employment and economic benefits through the development of a new fuel production.

5. Types of Biofuels

As Ford predicted so long ago, fuel can be created using numerous different organic materials. Biofuels may be in the form of ethanol or biodiesel. While ethanol is made from fermented sugars, biodiesel is made from the oils of certain plants. Examples of biofuels include corn-derived ethanol, sugarcane-derived ethanol, cellulosic ethanol, and various waste products (Zilberman, 2007).

5.1 Corn-derived ethanol

Corn-derived ethanol is the United States current staple biofuel. In recent years, production of corn for ethanol has increased substantially. In 2003, the United States produced less than 3 billion gallons of ethanol. By 2008, only five years later, that amount had tripled.

The corn-derived ethanol boom spilled over into politics; Obama enjoyed great political successes in Illinois and Iowa, two corn-growing states. The previous Bush administration also supported corn-derived ethanol development. By November 2008; over 75% of federal subsidies for renewable fuels were going to supporting ethanol made from corn.

In response to concerns and criticisms, the corn industry recently decided to push back by founding an organization known as Growth Energy. The purpose of organization, funded by the country's largest ethanol producers, is to offer a "fresh, aggressive voice in the energy debate." While corn-derived ethanol is currently the mainstream biofuel, new research and the development of new refining technology has rendered corn-derived ethanol less desirable than some second- and third-generation biofuels.

5.2 Cellulosic fuel sources

Cellulosic material is the "most common biological material on earth." Despite this fact, cellulosic fuel sources have not been viable commercial options because of lagging technology and the prohibitive cost.

Many politicians and some environmentalists see cellulosic ethanol as the fuel of the future, though. Congress, for instance, has established tax credits for cellulosic biofuels producers. Also, according to the United States Department of Energy, cellulosic fuel could reduce greenhouse pollution by 86 percent. Potential sources of cellulosic fuel include grasses, husks, and algae.

5.2.1 Grasses as biofuel sources

Grasses in particular have been singled out as a feasible alternative to corn-derived ethanol. In President Bush's 2006 State of the Union Address, the president mentioned the necessity of developing the technology needed to process switch grass to be used as a type of biofuel. While President Obama remains a stalwart supporter of corn-derived biofuels; he also supports the development of grass-derived biofuel. President Obama's Secretary of Energy Steven Chu is a strong proponent of using grasses to produce cellulosic biofuel.

Unlike corn, grass is not eaten by humans; presumably growing grass for fuel would not disturb food prices. Grasses also need less fertilizer than corn crops. Also, compared to corn-derived ethanol, switch grass has a superior energy balance.

5.2.2 Algae as biofuel material

Algae are another cutting-edge possibility for fuel derivation. The company Algenol Biofuels has developed the technology to turn algae into fuel. Algae may be a greener alternative to some other cellulosic fuels because algae would not require the same amount of land for production. The current drawback to algae is the prohibitive expense of the technology needed to produce it on a large scale.

5.2.3 Waste products as biofuel material

Husks and other waste products would be excellent sources of fuel because they are byproducts of other processes. While showing strong support for corn-derived fuels, Obama indicated during his campaign that husks and waste products, along with grasses, will be the future direction of development for biofuels.

Waste coffee grounds are one waste product that has recently received substantial attention. Last year, a Nevada study found that used coffee grounds may contribute up to 340 million gallons of biodiesel to the global fuel supply. Additionally, oil from waste coffee grounds is more stable than some other biofuels because of its high antioxidant content. Stability is important, as it has been one hurdle in the way of incorporating higher percentages of corn-derived ethanol into gasoline. If the necessary technology were developed, waste product biofuels could be the greenest biofuels yet.

6. Advantages and disadvantages of First Generation

The biofuels debate focuses on an analysis of the pros and cons of using plants to produce fuel. The benefits of using biofuels may include reduced reliance on foreign oil, reduction of pollution, the production of a by-product that cattle may eat, and economic benefit to American farmers and processors. The detriments of biofuels may include vehicle safety issues, increased pollution, soil erosion, deforestation, and increased food prices.

6.1 Advantages of biofuel

6.1.1 6.1.1 Cost

Biofuels have the potential to be significantly less expensive than gasoline and other fossil fuels. This is particularly true as worldwide demand for oil increases and oil supplies dwindle.

6.1.2 Source Material

Whereas oil is a limited resource that comes from specific materials, biofuels can be manufactures from a wide range of materials including crop waster, and other by-products. This makes it an efficient step in recycling.

6.1.3 Renewability

It takes a very long time for fossil fuels to be produced. But biofuels are much more easily renewable as new crop are grown and waste material is collected.

6.1.4 Security

Biofuels can be produced locally, which decreases the nation’s dependence upon foreign energy. By reducing dependence on foreign fuel sources, Countries can protect the integrity of their energy resources and make them safe from outside influences.

6.1.5 Economic Stimulation

Because biofuels are produced locally, biofuel manufacturing plants can employ hundreds or thousands of workers, creating new jobs in rural areas. Biofuels production will also increase the demand for suitable biofuels crops, providing economic stimulation to the agriculture industry.

6.1.6 Lower carbon emissions

When biofuels are burned, they produce significantly less carbon output and fewer toxins, making them a safer alternative to preserve atmosphere quality and lower air pollution.

6.2 Disadvantages of biofuel

The detriments of biofuels usage, such as potentially higher food prices, vehicle safety issues, increased pollution and deforestation, and a potentially negative energy balance have caused the public to re-examine the push for an increased use of biofuels (Larkum, 2010).

6.2.1 Rise in food prices

As demand for food crops such as corn grows for biofuels production, it could also raise prices for necessary staple food crops .One of the American public’s concerns about ethanol is the potential for a rise in food prices.

The Economic Research Service of the United States Department of Agriculture states: “A gradual shift to corn away from other crops reflects the high levels of domestic corn-based ethanol production and gains in exports that keep corn demand and producer returns strong.”

While the corn ethanol boom results in large profits for farmers, this type of ethanol causes food prices to rise.

As more corn is diverted for the biofuels market, the demand for corn as food is stressed by a decreased supply. Rising food prices hurt consumers generally, and they hurt poorer consumers in particular. The poor are especially vulnerable to harm through climbing food prices because the poor tend to spend greater percentages of their income on food items (Morgan, 2010).

6.2.2 Energy output

Biofuels have a lower energy output than traditional fuels and therefore require greater quantities to be consumed in order to produce the same energy level Several studies have been conducted to analyze the carbon footprint of biofuels and while they may be cleaner to burn, there are strong indications that the process to produce the fuel- including the machinery necessary to cultivate the crops and the plants to produce the fuel (Alexandratos, 2008).

6.2.3 Vehicle safety concerns

There are several safety and performance concerns related to the use of biofuels in automobile and plane engines. While the use of flexible fuels in cars appears to be unproblematic in the short term, the long-term effects on the engine of using biofuels have yet to be determined.
Some opponents to increased use of biofuels also contend that engine performance may be significantly compromised by the use of a high percentage of biofuels. The government is currently undertaking a study aimed at learning more about the long-term effects of biofuels on automobile engines.
One safety concern regarding the use of biofuels in commercial airliners is that plant-derived fuels are more likely to freeze than fossil fuels are when surrounded by low temperatures. While pilots have been completed one hundred percent plant-fuelled flights successfully, most airline industries are not ready to use pure biofuels in passenger flights until more research has been gathered.

6.2.4 Pollution

Ironically, one disadvantage of biofuels may be pollution. Biofuels may result in an increase in some pollutants because fossil fuels are used in the production of biofuels. The release of greenhouse gases is at the top of a list of environmental concerns. Increased ethanol use may cause changes in land use that would actually increase greenhouse gas emissions.70 Times published a series of negative articles on the biofuels trend (A.Romijn, 2011).

7. Bioenergy in Egypt

7.1 Overview

The Egyptian government encourages renewable energy including biomass energy. Egypt has accumulated experience of modern renewable technologies because of strong national and international promotion of renewables.

7.2 Energy Situation and Policy of Egypt

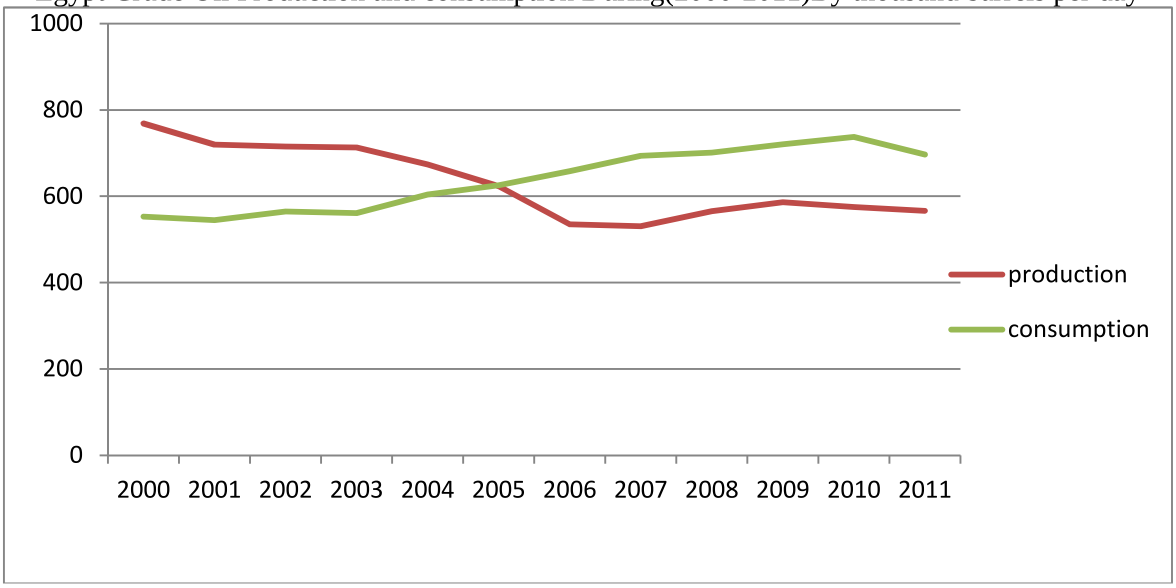
Egypt has several energy resources, as Egypt’s proven oil reserves stand at 4.4 billion barrels, an increase from 2010 reserve estimates of 3.7 billion barrels. Natural gas production exceeds 60 billion m3 per year as for the same year. Oil and gas account for about 98% of total commercial energy productions, while hydropower represents the remaining 2%. Egypt has also limited coal reserves estimated at about 27 million tons (MT).

Egypt primary energy demand is expected to grow from62 Mateo in 2006 to approximately 88 Mateo in 2020 and109 Mateo in 2030 at an average rate of 2.6% per year .In addition to its commercial energy resources, Egypt has potential in renewable resources including, solar, wind and biomass such as fuel wood, agricultural wastes and dried animal dung, which are used in some rural areas to meet part of the energy demand (Sorour, 2013).

The following two charts represent the production and the consumption of the oil and natural gas in Egypt during the period (2000-2011)

Figure (2)

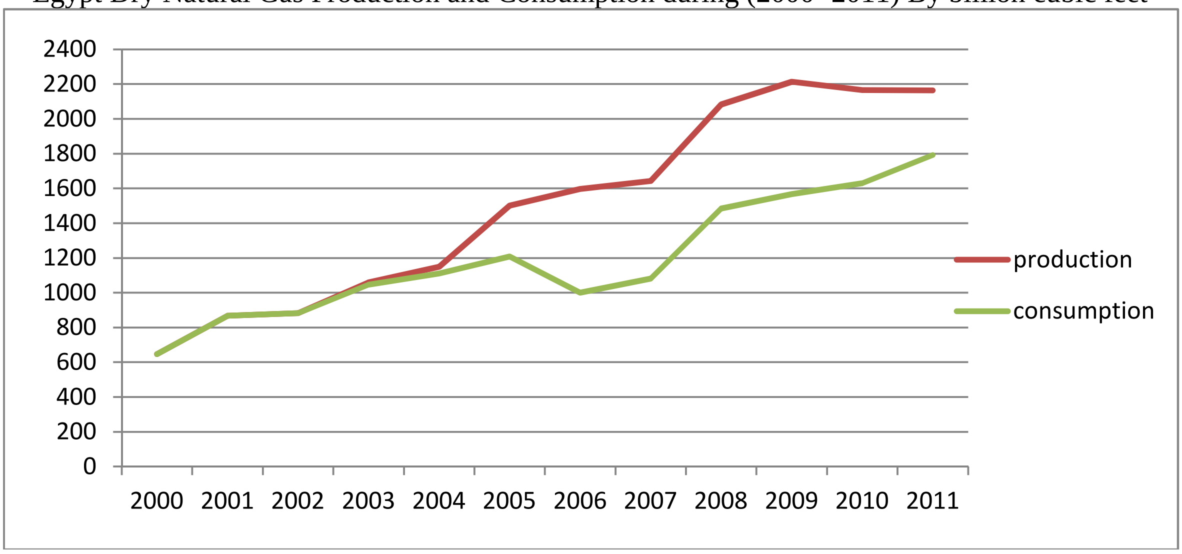
Egypt Crude Oil Production and consumption During(2000-2011)By thousand barrels per day



Source: U.S. Energy Information Administration

Figure (3)

Egypt Dry Natural Gas Production and Consumption during (2000- 2011) By billion cubic feet



Source: U.S. Energy Information Administration

From previous figures, we can see that the consumption of crude oil exceeds its production from 2005 during the concerned period, but the production of the dry natural gas exceed its consumption from 2003 during the same period .

Yet we cannot depend only on the surplus of natural gas to cover and face the growing demand of energy in the continuous population increase, as the Egyptian government depends on energy and power sector as a catalyzer of growth, so it focuses on developing and enhancing this sector by securing sufficient energy supply to meet the requirement of the economy, and improving the efficiency of the sector.

But the energy sector faces many challenges like:

- Huge capital investment needed to secure sufficient supply to meet the continuous increasing demand of energy.
- Deteriorating financial performance of companies which are responsible for producing and distributing energy because of almost constant prices of liquid petroleum fuels, natural gas, and electricity. In addition to the increasing of the production cost. Also, the subsidized energy prices affect the efficiency of energy sector.

Therefore, the government had started to remove energy sector constraints in line with overall economic reform, as energy prices (petroleum fuel, natural gas, and electricity) have been increased to reflect the cost supply including the approval 5% annual tariff adjustment up to 2009/ 2010.

The government also encourage strategy of diversification its energy resources by developing new and renewable energy resources, like solar energy, wind energy, and Bioenergy(United nations Programme (UNDP), 2008).

Regarding Solar energy, there are number of projects are being implemented in Egypt with collaboration with other partners, such as:

- Project of solar heaters in hotel buildings: in this project, Egypt collaborates with Italian governorate and UNDP(United Nations Development Programme)to implement solar heaters in hotels and tourism villages in both Red Sea and South Sinai governorates, with total budget about USD 500 thousands(New and Renewable Energy Agency(NERA), 2009/2010).

- Heating Solar Station in Kurimat, with power 140 MW (Mega Watt and the total cost of the project is about USD 340 million. This project is one of three projects that are being implemented in Africa (in Morocco, Algeria, and Egypt. And the finance of the project comes from:
    - An endowment from GEF(Global Environment Facility) and the World Bank(USD 50 millions)
    - Soft loan from Japanese Agency for International Cooperation (USD 190 millions) that will be paid with paying period 40 years, including 10 years grace period and interest rate 0.75% (New and Renewable Energy Agency(NERA), 2009/2010).

Regarding Wind energy, Egypt has number of wind stations such as Hurghada station and Zafarana Station. According to Hurghada station, it has worked since 1993 and the production of the station is about 7 GW/hour during 2010/2011. It provides about 1.5 thousand tons of equivalent oil and prevents polluted emissions of environment, about 400 tons of Carbon dioxide (Co_2) yearly(New and Renewable Energy Agency (NERA), 2011).

According to second station, it has been implemented on number of stages stating from 2001 in collaboration with Germany, Denmark, Spain, and Japan. It was financed by soft loans and endowments, and the total production of the station in mid-2010 was about 545 MW and the electricity produced from the station was about 1134 GW/hour. The station also produces about 250 thousand tons of equivalent oil and prevents polluted emissions of environment, about 637 thousand tons of Co_2 (New and Renewable Energy Agency (NERA), 2011).

In addition, there are other projects in Egypt to implement other wind stations with power 1120 MW/hour such as: the project of constructing a wind station in Oil Mountain with power 200 MW in collaboration with German Construction Bank, European Investment Bank, and European Commission. There are also two projects to construct a wind station with power 120 MW in Suez Gulf in collaboration with Spanish government, and a wind station with power 200 MW in collaboration with German Construction Bank, French Development Agency, European Investment Bank, and European Union.
Regarding Bioenergy in Egypt, we will discuss it in detail below.

In addition, there is a change in the energy consumption pattern in rural areas in Egypt from using kerosene to electricity for lighting (about 92.5% of rural households are currently connected to electricity). There are also market shift from using agricultural residues and dung cakes to use LPG(Liquid Petroleum Gas) cylinders in cooking, baking, and water heating (about 69% of households use LPG)(United nations Programme (UNDP), 2008).

7.3 Previous experiences of Bioenergy in Egypt

There are some small-scale projects that had been implemented to improve the low efficiency of biomass fuels (around 10% or less) by local NGOs(Non- Governmental Organizations), through the GEF small granted programme. One of the important projects implemented in Egypt was what the Egyptian Ministry of Environmental Affairs was participated, in collaboration with Petroleum Ministry, Ministry of Agricultural, and Military Production Ministry to produce biogas by using Chinese experience for transforming rice straw to biogas like in el sharkia and el dkahlia. Yet, this type of technology was not succeed, as a tare produced during production process leads to an obstruction in the produced gas and leads to health problems for users in the long run, and decrease the efficiency of biogas.

Therefore, the current direction is to use Indian technology to generate electricity from straw rice. About 850 small biogas units (family type) had been installed since 1970s through grants offered by donors and Ministry of Agricultural. About 90% of the plants were of Indian type, with a floating gas storage drum, and the remaining 10% are based on Chinese models with fixed domes. DANIDA (Danish International Development Agency) evaluated biogas units in 2000 and concluded that about 50% or more of the biogas plants were not operating, and the remaining didn’t produce the target amount of gas, because of lack of maintenance and technical follow-up.

As a result, the owners were dissatisfied and almost abandoned the plant. Also, the lack of resources prevented the expansion of a successful model introduced by some local NGOs to construct family scale biogas in selected rural areas (www.egy.undp.org).

Finally, according to Climate Change Program Study (CCPS, 2004) and draft programming framework for GEF, we can say that the removal of market barriers which are related to policy, finance, business skills, information, and technology can form replicable, sustainable, and cost effective market development strategy (www.egyptbiomass.com).

7.4 The Rural Sustainable Development Project (2010- 2014)[1]

Bioenergy for Sustainable Rural Development is one of GEF projects that it is implemented in cooperation with UNDP Cairo in collaboration with The Egyptian Environmental Affairs Agency.

The project works on three phases, either on small or large scale, as follows:

- The first phase is related to households and it depends on gasification combined for animal wastes which produced biogas to be used instead of cylinders in houses.
- The second phase is related to poultry farms as biogas is generated from poultry wastes to solve solar crisis that poultry farms need.
- The third phase is to generate electricity from rice straw.

7.4.1 Project Goal and Objective:

The goal [2] of the project is to improve the market development for new Bioenergy technologies (BETs) in Egypt to promote the sustainable socio-economic development of the rural communities in Egypt and decrease the negative global and local environmental effects from using fossil fuels, and also manage the agricultural wastes in a useful way.

The objective[3] of the project is to eliminate the technical, institutional, information, financial, and market barriers to develop the BET market in Egypt by achieving four outcomes as follows:

- New business and financing models successfully introduced and tested.
- An enabling policy framework, effectively promoting rural Bioenergy development adopted.
- Enhanced capacity of the local supply chain to market and deliver sustainable rural Bioenergy products and services, including financing.
- Institutionalization of the support provided by the project

7.4.2 The Budget of the project (according to its outcomes), and the Partners

The next table shows the budget of the project according to its outcomes and the amount of money that each partner shared with.

Table (1): Total Budget of the project according to its outcomes

Outcome	Total USD	Baseline USD	GEF Incremental USD

[1] Some of information and data related to the project, regarding goal, Objective, budget, Achievements and evaluation, are obtained from electronic sites of United Nations Development Programme (UNDP), Egyptian Environmental Affairs Agency (EEAA), and Global Environment Facility (GEF), and others are based on unpublished information from UNDP office in Egypt related to this project.

[2] The project goal is the overall result to which the project will contribute, along with various other, external interventions.

[3] The project objective is the overall result that the project itself will achieve, independent of other interventions i.e. what the project is accountable for delivering.

Outcome 1: New business and financing models successfully introduced and tested	6,000,000	MISR[1]: 2,500,000 (Estimated co-financing) Est. Private: 500,000 Est. SFD[2]: 1,000,000 EEAA[3]: 350,000	1,650,000
Outcome 2: An enabling policy framework, effectively promoting rural Bioenergy development adopted.	200,000	UNDP: 50,000	150,000
Outcome 3: Enhanced capacity of the local supply chain to market and deliver sustainable rural Bioenergy products and services, including financing.	9,170,000	EEAA[4]: 8,700,000 Est. Private: 100,000	370,000
Outcome 4: Institutionalization of the support provided by the project	300,000	UNDP: 100,000	200,000
Project Management	430,000	-	430,000
Monitoring and Evaluation	200,000	-	200,000
GRAND TOTAL	**16,300,000**	**13,300,000**	**3,000,000**

Reference: United Nations Development Programme (UNDP), 2008, Bioenergy for Sustainable Rural Development, UNDP Project Document, and P.48.

Regarding partners of the project, they include:

Civil Society Organizations/NGOs: which they work with the project in the area of public awareness, applications collection, and unit installation for the second phase of the targeted household units.

Indigenous People: which they support the project to spread information about biogas technology among others.

[1]Municipal Initiatives for Strategic Recovery Project.

[2]Social Fund for Development.

[3]EEAA (Egyptian Environment Affairs Agency) contribution for two gasification units.

[4]EEAA activities to support the collection and compression of agricultural waste.

Private Sector: as the project introduced the main idea of it to two petroleum companies; namely Dana Gas and Sahara Forum and encourages them to financially support the main idea of the project as a renewable and clean source of energy.

GEF Small Grants Programme: Either with the NGOs succeeded to be granted from it or others who are planning to receive a grant.

7.4.3 Expected global, national and local benefits of the project

The expected global environmental benefits are that using Bioenergy instead of fossil fuels will lead to decrease GHG (Greenhouse Gas) emissions and sound management of agricultural and animal wastes.
Also the expected National and Local benefits are:

- Supply an alternative energy source to rural population with lower costs than other competing sources.
- Reducing dependency by decreasing imports of energy.
- Decreasing pollution by managing agricultural and animal wastes in producing Bioenergy instead of burn them.
- Health benefits associated with the killing of the pathogens and seeds during the digestion process.
- Promoting socio-economic development in rural areas which is the key element of Egypt's Development Policy (2002/2017), and improves employment opportunities.

7.4.4 Project Achievements during the first phase of its implementation(2010- 2014)

➢ **confidence level on modern BET as a mean to contribute to rural energy needs**

- **Baseline Level:** Low level of confidence.
- **Target Level at end of project:** High level of confidence.
- **Level at 30 June 2010:** in the inception phase, the project made a social survey to evaluate the existence of biomass technology in Egypt technically, environmentally, and socially. This survey helped in choosing locations to apply and utilize sustainable biogas household digesters. Study report was ready on 30 September 2010.
- **Level at 30 June 2011:** at this level, depending on the results of the social survey which shown strong potentials of the use of BET in Egypt, an Argentine expert visited Egypt to assess the possibility of BET on a farm scale and the extent of the benefit of BET on that scale.
  By the end of this period, the UNDP staff from Indian office and an Indian expert visited Egypt to collect information and determined the needed units in the intended governorates to import them.
- **Level at 30 June 2012:** the project started the actual work to install biogas units on both household scale and poultry farm scale. All needed data about targeted governorate had been collected. The project tended to implement 100 biogas household units (in July 2012) and 4 large scale poultry farm units (in mid-august 2012) in the first level of the project.

- **Level at 30 June 2013:** The project, through the contracted Indian NGO, succeeded in the implementation of 100 household biogas units in both Assuit and Fayoum. The installation process started August 2012. 75% of the units are working well and generating gas with a highly satisfaction from the users.

  The contracted NGO, in collaboration with the project, organized 4 training programs for beneficiaries in Assuit and Fayoum to teach them how to deal with the units.

  Another practical training held for four engineers and four professional masons/builders to construct and install the units.

  Regarding the poultry farms units, the project terminated contract with the Indian NGO, as India itself does not have any successful functioning model that could be applied in Egypt. That leads to change in the target of the project to install big size biogas units to treat huge amount of animal wastes.

➢ **The market growth of BET**

- **Baseline level**: No market growth of BET.

- **Target level at end of project**: Average annual 20% market growth at the end of the project, as compared to the previous year.

- **Level at 30 June 2010:** there was a discussion between Supreme Council of Energy and Ministry of Electricity and Energy about the ability of opening the market for BET with an emphasis on biomass in the coming government strategy.

- **Level at 30 June 2011:** the social survey shown the desire of people in rural areas to use BET as they were pleased to acquire units which open the track for such technology in Egypt.

- **Level at 30 June 2012:** The market started to open to BETs especially after the government adopted a coupons policy[1] for butane cylinders and intended to remove butane subsidies. Therefore, there was no option for the users in the rural area except shifting to Bioenergy.

  Many private companies had contacted with the project to benefit from its experience and apply it in other governorates.

- **Level at 30 June 2013:** at this level Market opened widely for the BET, especially after the project installed 100 biogas household units in Assuit and Fayoum, and the users of these units were highly satisfied and began to spread their experience to others.

  Also, the project began to deal with many governmental and non- governmental organizations to widen the market for BET, as many NGOs organizations cooperated with the project in the fields of public awareness, applications collection, and unit installation for the second phase of the project.

[1]The Government's coupons policy means that each family registered with the Ministry of Social Solidarity will receive only one butane cylinder at the subsidized price per month; if more is needed, a family must purchase at the market price

At this level, the project was ready to sign an cooperation agreement with the Ministry of Housing and the Training Centre for Building and Construction which provides a professional and certified training for constructing biogas units, in addition to cooperate with number of constructing companies in the field of construction and installation of units.
The project also was cooperating with military factory to produce biogas stoves and other needed materials that were imported from India.

Therefore, all previous cooperation strategies helped in opening the market widely and encourage people to apply BET instead of LPG.

Market is now ready with supply, demand, and service providers.

➢ **Supportive public policies for BET**

- **Baseline level**: Inadequate public policy support to initiate and sustain the BET market growth and subsidized fossil fuels and electricity prices.

- **Target level at end of project**: Supportive government policies, including required financial and fiscal incentives, in place to sustain market growth.

- **Level at 30 June 2010:** only there was an initial discussion with Supreme Council of Energy, and numbers of dialogues between the project and governmental entities to study the ability to make changes in policy actions to cope with RE (Renewable Energy) promotion (including Biomass) and sustainable Development biomass energy, like gradual energy subsidies Removal.

- **Level at 30 June 2011:** the critical political situation in Egypt postponed any policies changes or subsidies removal, although the project succeeded in highlighting the importance of depending on biomass as a cleaner source of energy, and there was a perfect communications with counterparts to begin to apply subsidies removal gradually.

- **Level at 30 June 2012:**although Egypt faced very critical economic, social, and political period, government decided to use rational coupons instead of butane subsidies, as the project started to cooperate with the most concerned ministries : Ministry of Local Development, Ministry of Petroleum, Ministry of Electricity, and Ministry of Environmental Affairs to put coordination policy and assist government to take the decision of gradual removal of butane subsidies which represented strong support policy for Bioenergy to compete with butane for family needs and promote the implementation of new technology in front of fossil fuels.
- **Level at 30 June 2013:** policies were affected directly and negatively by the continuous critical political situation in Egypt which led to delay implementation of gradual subsidies removal that affected negatively on citizens. The only action could be taken was double subsidized price of LPG.

➢ **The operational and financial data of the systems installed**

- **Baseline level**: Inaccurate financial data and no operational data available.

- **Target level at end of project**: at least 4 MW will be reached by the end of the project.

- **Level at 30 June 2010:** Inaccurate financial data and no operational data available, as the new system was not specified or installed yet.
- **Level at 30 June 2011:** there were many site visits during the reporting period to determine the appropriate location for installing the units.

- **Level at 30 June 2012:** data for the use of household biogas digester were available, but no technical and financial data were available at this level. 4MW will be reached by the end of the project after implementing 1000 household units (poultry farm units as well as the gasification units).

- **Level at 30 June 2013:** Accurate financial data had been available about local market price list of needed materials, daily fees for workers (for different sizes). Regarding the operational data, engineers of the project were trained on everything related to the units, and all data are documented and will be published in the project publication.

➢ **The level of customer satisfaction**

- **Baseline level:** The new units are not specified or installed yet.

- **Target level at end of project**: Over 90% of the customers satisfied with the new units.

- **Level at 30 June 2010:** the project tested the customer's satisfaction towards previously installed biogas, as new units were not specified and installed yet.

- **Level at 30 June 2011:** The new units were not installed yet.

- **Level at 30 June 2012:** The new units were not installed yet, but the reactions of potentials users of units had been positives, according to survey work.

- **Level at 30 June 2013:** 100 household biogas units were installed and over 90% of users are highly satisfied. The evaluation depended on units' visits during mid-term evaluation, individual interviews with beneficiaries, forms signed by users on a monthly M&E (Monitoring and Evaluation) either by contracted NGO or by project field engineers, and the numbers of applications received to request units.

➢ **Adequate product standards and quality control mechanism**

- **Baseline level:** lack of adequate product standards and quality control mechanisms.

- **Target level at the end of project**: Adoption of adequate product standards and quality control mechanisms.

- **Level at 30 June 2010:** the project decided the importing country and the quality specification of the units to start a dialogue with decision makers.

- **Level at 30 June 2011:** the regulatory framework was proposed to the Supreme Energy Council by the international consultant including the specifications for the pilot units and incorporating the results of social survey and field visits to targeted areas.
- **Level at 30 June 2012:** at this level, the contract of implementing the household biogas digester units was signed to start the process in July 2012. The project worked with implementation agency, the project consultants, and the Egyptian Organization of Standardization (EOS) to achieve the required standards and quality control mechanisms.

- **Level at 30 June 2013:** After the installation of the biogas household units and transferring technology from the Indians to Egyptian Engineers and Masons, the project was drafting cooperation protocol with Faculty of Engineering, Ain Shams University, to present consulting assistance and to be responsible for the quality control of the units from the technical side.

The project aims at cooperating with other entities in different governorates.

- **Enhanced capacity of the local supply chain to market and deliver sustainable rural Bioenergy products and services, including financing**

- **Baseline level**: Inadequate capacity of the supply chain to effectively market and deliver products and services for rural Bioenergy development.

- **Target level at end of project**: At least 20 new local entities to serve as Bioenergy Service Providers (BSPs) identified and their capacity built by the end of the first 18 months.

- **Level at 30 June 2010:** will start after deciding units specifications and the importing country.

- **Level at 30 June 2011:**will start after deciding the importing country

- **Level at 30 June 2012:** many private companies and governmental agencies were willing to enter the field of Bioenergy and planned to establish departments in their institutions for Bioenergy units depending on project specifications of installed units, and that after publishing the tender document.

Also, there were two groups of youth who had registered new companies working on providing Bioenergy unit’s services had asked the project for technical assistance.

- **Level at 30 June 2013:** there were number of companies expressed their desire to work in unit installations and after sales services, and that after the project published a request for the expression of interest in El-Ahram newspaper.

  Also, there were many individuals registered in their private companies and started to work in the same field after receiving a practical experience. NGOs also started entering the field especially in awareness field.

  The project cooperated with military factories to produce biogas stoves instead of importing from India.

➢ **The level of follow-up activities of the trained BSPs**

- **Target level at end of project**: an increasing trend, leveraging financing from a variety of sources.

- **Level at 30 June 2010**: will start after deciding units specifications and the importing country.

- **Level at 30 June 2011:** will start after deciding the importing country.

- **Level at 30 June 2012:** numbers of masons and engineers were trained by BSPs to promote the development of BET market on a self- sustaining basis after the end of the project.

- **Level at 30 June 2013:** After the installation of the units and preparing to the second phase, the trained engineers and masons provided a practical training to others, either individuals or companies, and also to trainers of the training center of the ministry of housing to find widely spread training center to present this type of training to maximum number of people. Therefore the project drafted a cooperation protocol with ministry of housing to benefit from the 62 branches of this training center all over Egypt.

  The project also cooperate with different specialized faculties to spread Knowledge especially Engineers faculty that shown its interest to support this technology especially in the area of awareness either by awareness workshops for students or finding an elective course during the coming academic year for the graduation year on the BET.

➢ **Institutionalization of the support provided by the project, including monitoring, learning, adaptive feedback and evaluation**

- **Baseline level**: Discontinuing support at the end of the project.

- **Target level at end of project**: An entity continuing the Bioenergy market promotion after the project established and its funding secured.

- **Level at 30 June 2012:** After the installation of the units as a successful base.

- **Level at 30 June 2013:** The project started negotiations with the Egyptian Environmental affairs Agency to take this responsibility through it's widely spread branches all over Egypt. There will be more negotiation during the coming year

➢ **The level of information available for evaluation of the project activities**

- **Baseline level**: Inadequate information for measuring the impact and for adaptive management.
- **Target level at end of project**: Required information available during the implementation of the project for adaptive management**.**

- **Level at 30 June 2012:** After the installation of the units as a successful base.

- **Level at 30 June 2013:** there is a database developed by the project including detailed information about installed units, date of installation, date of production, amount and quality of gas produced, specific route and location of the unit, etc. This will be available on the project website as well as the implementing agency.

7.4.5 Evaluation Indicators of the Project during the first phase

➢ **Meeting Development Objectives**

The project started from scratch in terms of applicable technology and reached a concrete floor that could be a good start for a national program targeting the spread of the technology all over the country which is main target ten years ago. Although Egypt has experience about biogas technology, it didn't succeed in developing and promoting it to cover needs of the community.

The bad reputation of the BET in Egypt is the main challenge faced the project, therefore, the project had a burden to convince users in rural areas and the project actually succeed in opening new market for BET in Egypt and encouraging all parties to enter this field by awareness creation and marketing campaign especially for youth to change minds towards the importance of Bioenergy in general and biogas in particular.

There was also support for the project from the government through the gradual removal of subsidies on LPG.

So, we can say that the project achieved highly satisfaction in meeting development objectives especially when we take into account the progress the project achieved during the critical political, economic, and social situation in Egypt.

➢ **Implementation Progress (According to Project's Outcomes)**

Outcome 1: introducing new business and financing models for BET

The project focused on implementing not only household units but also poultry farm units.
But actually, after the visit to India which has not any successful model regarding poultry farms, the project changes its plan and it is planning to scale up household units to cattle farm units during the next year, but we can't deny that it will affect negatively on the budget of the project.

Outcome 2: Adopting of an enabling Policy framework, effectively promoting rural Bioenergy development

Although the project negotiated with decision makers about gradual removal of subsidies on LPG, the critical political situation delays this action. But the only available decision was to replace the subsidies with coupons to achieve equality for all citizens. Yet the idea stills in mind and will be discussed again during the coming year.

Outcome 3: Enhanced capacity of the local supply chain to market and deliver sustainable rural Bioenergy products and services, including financing.

In this outcome, the project made a good relation with people especially in targeted villages and encouraged them to share in training to get all experience needed for units.

Outcome 4: Institutionalization of the support provided by the project

The project succeeded in opening channels with the academic and educational institutions and encouraged them not only to visit the units to see the technology from a technical aspect, but also encouraged introducing the concept of Bioenergy in the academic study.

8. Conclusion

Egypt depends on a combination of energy resources, most of them are from fossil fuel with percentage about 98%, while it depends with percentage about 2% on other renewable energy resources to cover its needs. The electricity sector consumes about 30% from its production of fossil fuels while industrial activities in Egypt consume about 40% from its production[1].

Egypt produce considerable amount of fossil fuel represented in oil and natural gas, yet Egypt consume the energy intensively as according to U.S Energy Information administration, the consumption rates of crude oil in Egypt during (2000-2011) are in continuous increasing over the production rates, but the production rates of natural gas exceed its consumption which leads to export some of its production abroad.

The Energy crisis in Egypt comes from the gap between the available energy resources and the it's consumption levels, as the natural gas can not only cover the growing demand of energy in the continuous population increase.

Therefore, there are two ways for Egypt to solve the problem of Energy, and achieve the sustainable development which becomes the concern worldwide:

First, depending on renewable energy resources,

And in that field Egypt has several renewables such as solar energy, wind power, and biomass. According to solar energy, Egypt collaborates with number of International Agencies, such as German Construction Bank and the Japanese Agency for international cooperation, to implement solar energy production projects, like project of solar heaters in hotel buildings and heating solar Station in Kurimat.

Moreover, according to wind power, there are many projects to implement wind stations in Egypt in addition to the existing ones, such as the wind stations in Hurghada and Zafarana.

While regarding the biomass, the last experience of Egypt in that field is the Bioenergy for Sustainable Rural Development Project which is one of GEF projects that it is implemented in

[1] http://www.imc-egypt.org/ar/pgmenergy.asp

cooperation with UNDP Cairo in collaboration with The Egyptian Environmental Affairs Agency.

The objective of this project is to remove the technical, institutional, information, financial, and other market barriers to increase using of biomass energy in the attempt to encourage and promote rural sustainable development in Egypt, and to decrease the negative global and local environmental impacts as a result of using fossil fuels, and finally to benefit environmentally from the agricultural and solid wastes which hurt the environment.

In the first phase of the project, it, through the contracted Indian NGO, succeed in installing not only the contracted 100 household units but also 2 experimental unit in Assuit and Fayoum governorates, and the project achieved a highly satisfaction from users of the units and that was clear either through (Mid-Term Review) or the weekly M&E visits to the units. The project also succeed in opening new market for BET in Egypt as the market is now ready with supply, demand, and service providers.

The project succeeded in cooperating with different entities to promote Development of BET as:

- The project drafted a cooperation protocol with ORDEV (Organization for Reconstruction and Development of the Egyptian Village) to provide soft loans to beneficiaries.

- The project cooperated with Ministry of Military Production to produce materials (like stoves) needed for installing units instead of importing them from India.

- The project drafted a cooperation protocol with faculty of engineering, Ain Shams University, to support BET especially in the area of awareness.

But we cannot deny that the political and security situations in Egypt affect negatively on implementation and outcomes of the project, as it delays the field visits to selected governorates, however, the project does its best to recover this in the second phase.

Second, Rationalization of current consumption of energy and improving the efficiency of its use

As the Industrial Modernization Centre (IMC) made a study aiming at reducing the energy consumption with 20% in 2022 distributed on many sectors as: 9.4% in industrial sector, 5.4% in transportation sector, 3% in trade and housing sector, 0.45% in governmental building and public building, 0.05% in agricultural and irrigation sector, in addition to 2.5% in the natural gas production.

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E-sites

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