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Economical and Environmental Feasibility of the Renewable Energy as a Sustainable Solution for the Electricity Crisis in the Gaza Strip

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Abstract:- Energy crises in the Gaza Strip push interested and concerned parties to start investigating new energy alternatives for energy security. Energy security includes the conservation and reliability of energy supplies to satisfy demand at all times and at good prices, while also avoiding human health and environmental impact. In fact The Palestinian Electricity Authority has made strenuous efforts in order to relieve suffering of Gazans, including the planning to construct the gas pipeline from Israel to provide the power station with gas instead of distillate oil as well as increasing the capacity of the station to reach 550 MW. In light of the political context in the Gaza Strip and in relation to many conditions of energy and electricity supply problems, sustainable energy can play a key role in guaranteeing energy security of the Gaza Strip in the long-term. The present paper analyzed the current energy situation in the Gaza Strip, and proposed four scenarios to get out of this impasse. Economical and Environmental assessment has been established in order to find out the scenario which achieves higher revenues. The renewable energy plants were won in this competition. The study made a schedule for the full transmission of the electricity industry from traditional to renewable energy. It shows that the annual cost of distillate oil fuel for 110 MW power plant (the current situation) is 735,475,000 [ILS/year] and the environmental damage cost is 445,069,320 [ILs/year] in addition the Palestinian electricity authority pays Israeli electricity company the cost of 120 MW (that Israel provides the Strip) about 462,528,000 [ILS/year]. This money together (1,643.7232 million ILS) is enough to construct 150MW wind farm power plant, and year by year the situation will be better and through 4 years the crisis will be vanished and without any additional pressures on the Gazans, further more increasing the quality of the environment, reducing the amount of CO_2 emitted to the atmosphere by 484,250 kg/day. To remove the doubt about the wind energy effective (and renewable in general), our neighbor Jordan has built a wind station with 117 MW capacity at a cost of 289.05 million USD (1,120.7278 million ILS). But unfortunately, the provision of a sustainable and renewable source of energy for the Gaza Strip has not been a priority for any of the donors or successive Palestinian governments. It remains the duty of the international communities and national agencies to defend the property of the Palestinian people, especially on the infrastructure level against the repeated attacks of the Israeli army against the Gaza Strip, otherwise, it is worthless any attempt to advance the Palestinian people.

Keywords:- Gaza Strip, electrical crisis, solar energy, wind energy, sustainable energy, economical assessment, environmental assessment.

I. INTRODUCTION

The Gaza Strip is a small self-governing Palestinian territory on the eastern coast of the Mediterranean Sea, that borders Egypt on the southwest for 11 km and Israel on the east and north along of 51 km border [1], as it shown in figure 1. The territory is 41 km long, and from 6 to 12 km wide, with a total area of 365 km^2 with around 1.85 million Palestinians. Gaza ranks as the 6th most densely populated polity in the world, with an annual population growth rate of 2.91% [2]. The Gaza Strip is a high-density populated area with very limited resources, depending on energy suppliers. It suffers from a serious energy problem. This problem has increased over time due to the rapid population growth and unstable political situation that has negatively affected the development in the Gaza Strip. Currently, the Gaza Strip depends mainly on fossil fuels to produce electricity from a local generating plant, in addition to electricity imported from the Israeli and Egyptian electricity companies. Despite the problem exists from 11 years ago and still gets worse and it seems no radical solution until now. There is a lack of information and almost no researches on this issue. Beside that, Gaza has high potentials of solar radiation and wind speed which can be used to produce electricity even with high benefits (as it proved in this research). Solar energy has become an important component in the portfolio of global power generation. It is seen as a cheaper source of energy when compared to traditional fossil fuels and immune to fluctuations in global fuel prices. For this reason, solar energy is now considered to be an economically reliable solution in Palestine, where the sun's rays are the most abundant and readily accessible energy source for supporting the needs of Palestine in general, and the Gaza Strip in particular.

All of these were the motive behind this study. To achieve this aim a technique was established to evaluate the impacts on the human health and the environment caused by burning the fossil fuel in The Gaza power station, also the study outlined the economical and environmental consequences of converting the plant from diesel oil fuel to natural gas, and many options were proposed to overcome this problem.

II. STATE OF THE PROBLEM

Despite Israeli disengagement with Gaza since 2005, Israel still boosted its direct external control over Gaza and indirect control over life within Gaza: it controls Gaza's air and maritime space, and six of Gaza's seven land crossings. Gaza depends on Israel for its water, electricity, fuel, telecommunications, and other utilities. Environmental problems are including desertification, salination of fresh water, lack of adequate sewage treatment, and depletion and contamination of underground water resources, causing to rely on sea water desalination plants.

Furthermore, the Gaza Strip is suffering from shortage of electricity, its repercussion reaches all spheres of lives. The shortage of fuel required to operate the Gaza's power station, as well as the amount of the electricity supply from Israel is continuing at the same rate, leading to many health, social, and economic consequences, even on the level of infrastructure as the water and sewage systems, beside disable the education, communication, public services, and business, notably the following:

2.1. Impact of shortage of electricity on the health situation

Many health services face the threat of being discontinued because of the daily interruption of electricity for long hours combined with the shortage of daily supplies of diesel fuel needed to operate electric generators in hospitals and primary care centres, and which vary from 8,000 to 10,000 liter daily. The stoppage of many surgical operations – only those of an urgent and critical nature take place. Shutting-down of a number of oxygen-generating stations, which need high levels of power that cannot be supplied by small generators. X-ray units run at 50% capacity.

The increased suffering of kidney failure patients owing to disruption and stoppage of dialysis units because of power outages. The halting of central air-conditioning systems in hospitals is adversely affecting the performance of duties, especially in enclosed areas such as operating theatres and intensive care units, particularly for newborn infants. The compromised validity and viability of blood and plasma supplies, which can be damaged when power outages last more than two hours. The use of dangerous traditional means of energy and light production (such as wax, firewood, petrol lamps) by families, especially during the night hours and in winter, has led to cases of asphyxia and the death of tens of individuals, and even of entire families [3].

2.2. Impact of shortage of electricity on drinking-water and sewage systems

There are 180 water and sanitation facilities in the Gaza Strip, including 140 wells, 37 water pumping stations and sanitation plants and three sewage treatment plants. The Water Authority secured only 50% of its fuel needs, resulting in the irregular supply of drinking-water on a permanent basis. Also, the stoppage of sewage treatment plants causes large quantities of untreated sewage water to be discharged into the sea, thereby polluting sea water, fish and beaches. The sea shores of the Gaza Strip are badly polluted, because untreated sewage water is pumped into the sea at a rate of 40 million liter per day, thus exacerbating the environmental crisis and continuously damaging public health. Some 76,134 families, 12.2% of the total, still have no access to safe drinking-water. The cuts in power to the Gaza Strip hinder the operation of water pumps, domestic refrigerators and health centres, since water is pumped for only two to three hours a day [3].

III. ELECTRICAL POWER SITUATION ANALYSIS IN THE GAZA STRIP

According to the Gaza Electricity Distribution Company, statistics show that the Gaza Strip needs 550 MW of electricity. The available quantity is 250 MW, coming from the Israeli Electricity Company 120 MW (48%), the Gaza Power Plant up to 110 MW (44%), and an Egyptian source of 20 MW (8%). Therefore, the Gaza Strip shortage of electricity is about 55%, assuming that all current sources work up to standard, which is doubtful! As a result of this deficit the Gaza Electricity Distribution Company relies on a contingency schedule is based on eight hours (sometimes even more) ON and a similar OFF electricity.

The total production capacity of the Gaza's electricity generation station 140 Mega Watts, the production is based on four gas turbines (GTG) type "ABB GT10B2" where operates as a combined cycle with two steam turbines (STG), thus the station is consisting of two generation units, each unit contains two gas turbines and one steam turbine. Currently, the gas turbines fired liquid fuel (diesel oil distillate No. 2). The fuel used in the plant is stored in two large tanks each with capacity of 10,000 cubic meters, where the average daily consumption of diesel oil about 800 cubic meters with full capacity, i.e. When filling fuel tanks full enough to

run the plant for 30 days in the event of interruption of the fuel. At the present time, it is producing a little more than 80 MW, with daily fuel consumption of 420,000 liters. It should be noted that, the station can be also operating by natural gas instead of diesel oil. A gas line project will be constructed to supply the gas station from Israel at a cost of 18 million USD in the near future, furthermore, the power plant needs to additional 7 million USD to put the station in ready to work with gas so as to change the torches in the combustion chamber.
The question that will be always remained: Are these projects will provide the Gaza Strip with secure, reliable and sustain electrical power?

Figure 1. The Gaza Strip power supply and the deficit and location map [4]

IV. METHODOLOGY

The objective of this work is to evaluate the repercussions on the human and environment that resulting from electricity production from fossil fuel fired power plants. The method may be concluded to find out the annual payments through the electricity generation and provision process, these payments are: cost of the environmental damage, cost of fuel consumption, cost of electricity imported and the annual levelized capital cost of the station. This procedure will be followed for all variants of electrical generation. The details of the technique will be followed. Of course, the minimum total annual payment was the reference to choose the best candidate between all offered scenarios.

4.1. Environmental assessment

Generally, the method of determining these valuations comes from a Damage Function Approach (DFA). The studies translate emissions into ambient air concentrations and then into damage to human health, materials, plants and animals, visibility and aesthetics, and ecology. Burning of hydrocarbons producing large amounts of Carbon dioxide CO_2 and other emissions as it indicated in table 1. CO_2 is the first accused in global warming. Increasing amounts of CO_2 and other greenhouse gases in the atmosphere appear to be having substantial impacts on the environment and human health in a variety of places on the planet already. These impacts could include rising sea levels, melting of glaciers and polar ice caps, altered ocean currents, increased heat stress and mortality among people in summer and wider ranges of insect-borne diseases of humans and crops. In addition to CO_2 there are many other air pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), ozone (O_3), particulate matter (PM), volatile organic compounds (VOCs). The Gaza power station is not fitted with pollution control equipment to reduce emissions.

Table 1: Emission factors for uncontrolled furnaces [5,6]

Combustor	PM	SO_2	NO_X	VOC	CO	CO_2
Distillate oil (kg pollutant /m^3 fuel)	0.24	34.6	2.4	0.024	0.6	745
Natural gas (kg pollutant/10^6 m^3 gas)	40	9.6	2240	44	560	420

The effects of air pollution on human health and the environment have also economic impacts. According to the Healthy People report, each year in the United States: The health costs of human exposure to outdoor air pollutants range from $40 to $50 billion and the Environment costs $6 billion by acid rains damages. These human and ecological impacts translated into economic values and the externalities are identified. Table 2 provides a high level economical assessment of impacts during the usage of fossil fuel fired power plants**.** This procedure has been performed for typical power plant emission in Europe conditions as a damage cost per kg of pollutant [7].

Table 2: Typical damage cost per kg of pollutant emitted by power plants in Europe

Pollutant	Impact	Cost* (ILS/kg)
PM (primary)	Mortality and morbidity	67.3812
SO_2 (primary)	Crops and materials	1.31262
SO_2 (primary)	Mortality and morbidity	1.31262
SO_2 (via sulfates)	Mortality and morbidity	43.5352
NO_2 (via nitrates)	Mortality and morbidity	63.4433
NO_2 (via O_3)	Crops	1.53139
NO_2 (via O_3)	Mortality and morbidity	5.03068
VOC (via O_3)	Crops	0.87490
VOC (via O_3)	Mortality and morbidity	3.06215
CO (primary)	Morbidity	0.00875
CO_2	Global warming	0.12686

***Exchange rate 1URO = 4.3745 ILS**

4.2. Economical assessment

To solve the problem of electricity deficit, authors are suggesting four scenarios for analyzing and making decision. These scenarios are:

- The total power demand is 550 MW, 140 MW generated by the local power plant and the deficit will be imported from the Israeli company, it means that Israel will provide Gaza with 410MW;
- The Gaza power plant will provide all the demand 550 MW by adding another three power generation units to the existing one, so we have 140MW/unit x 4units = 560MW;
- The Israeli electricity company will provide the Gazans with 550 MW.
- Build up a stand-alone renewable energy power plant of 550 MW capacity.

In order to make a meaningful comparison between different power generating choices, an economic analysis must be based on open market costs and reliable data, the insufficient information will distort the whole process. In this position The authors would like to announce that, there is a significant conflict between the advertised figures and true information from engineers working in the station, as well as what published for politicians in the local newspapers, especially mentioning the amount of energy generated from the Gaza station, the exact amount of imported energy from Israel, quantities of fuel as well as the conflict of fuel prices even in the price of electricity that the authority is providing to Gazans. However, to overcome this problem, all collected data subjected to double check and then selecting the values those are putting the decision makers in the safe side.

To achieve the calculations we have to consider the following assumptions:
1. The interest rate is equal to the inflation rate;
2. The power plant working at full capacity 140MW;
3. No insurance and no taxes on the equipments and money's processes;
4. The maintenance cost of the power plants not considered.

The adopted data for calculations are presented in table 3.

Table 3: Operating and economical data for Gaza power plant station

Item	Current situation	Target situation	Units
Total demand	450	550	MW
Capacity of the power plant	110	140	MW
Electrical power supply from Israeli side	120	0	MW
Electrical power supply from Egyptian side	20	0	MW

Deficit in electricity	200	0	MW
Cost of electricity from Israeli side	0.44	0	ILS/kWh
Cost of electricity from Egyptian side [8]	0	0	ILS/kWh
Authority selling the electricity to Gazans	1.1	0.4	ILS/kWh
Distillate oil consumption	650	795	m^3/day
Natural gas consumption	764,555	934,457	m^3/day
Cost of Distillate oil	3,100	-	ILS/m^3
Cost of natural gas	3.2	-	ILS/m^3
Capital cost of the power station	$2{,}326.368 \times 10^6$	-	ILS
Capital cost of the pipeline and gas supply	96.932×10^6	-	ILS
Exchange rate of 1USD	3.87728	-	ILS
Exchange rate of 1URO	4.3745	-	ILS
Exchange rate of the Egyptian Pound	0.4951	-	ILS

Source: operation and maintenance department of the station

V. VALUATION OF THE SUGGESTED SCENARIOS

The valuation includes the summation of the following costs for both fuels Distillate Oil and Natural Gas:

1. Cost of the health and environment damages (-ve sign);
2. Cost of the consumed fuel in the power plant (-ve sign);
3. Capital of the additional power units to meet the required load (-ve sign);
4. Cost of the gas pipeline and the additional equipments in case of natural gas fuel (-ve sign);
5. Cost of imported electrical power from Egypt and Israel (-ve sign);
6. The income from selling electricity to the people (+ve sign).

Introducing the whole process and all parameters in table 4.

Table 4: Environmental and economical assessment of the current situation of the Gaza power plant

Item	PM	SO_2	NO_2	VOC	CO	CO_2	Total daily cost of the environmental damage
Daily amount of pollutants of distillate oil, [kg]	156	22,490	1,560	15.6	390	484,250	
Daily amount of pollutants of Natural gas, [kg]	30.58	7.34	1,713	33.7	428	321	
Daily cost of environmental damage of distillate oil, [ILS]	10,512	1,038,149	109,209	62	4	61,432	1,219,368
Daily cost of environmental damage of Natural gas, [ILS]	2,061	339	119,920	133	4	41	122,498
Annual cost of environmental damage of distillate oil, [ILS]							445,069,320
Annual cost of environmental damage of Natural gas, [ILS]							44,711,770
Annual cost of fuel consumption of distillate oil, [ILS]							735,475,000
Annual cost of fuel consumption of natural gas, [ILS]							893,000,240
Annual payment capital cost of the station, [ILS]*							46,527,360
Annual additional payment in capital cost of natural gas, [ILS]*							1,938,640
Annual cost of imported electricity from Israel (120MW), [ILS]							462,528,000
Annual cost of imported electricity from Egypt (20MW), [ILS]							0
annual income from selling electricity to the public, [ILS]							2,476,452,000
Annual benefits of the electrical authority in case of oil, [ILS]							786,852,320
Annual benefits of the electrical authority in case of gas, [ILS]							1,027,691,990

*** Life time 50 years**

The obtained results are plotted in figure 2. The current situation and for the three scenarios are presented as a tornado diagram in where the annual payments were illustrated. Table 5 summarizes updated cost that estimates the generic utility-scale generating plants, including two powered by wind and eleven by solar energy. Five of them are thermal solar and the rest are photovoltaic [6,9-13]. Table 5 also contains the required information to economic analysis of power plants such as, life time, capacity, capital cost for each technology (columns 1, 2 and 3). Also, the number of required units to produce 550 MW have been calculated and tabulated in (column 5) and the levelized annual payments for several types of renewable energy sources were calculated (column 6). The results were graphically illustrated in figure 3.

Figure 2: Tornado diagram, break down the annual categories of payments in ILS for the present situation and for the other three suggested scenarios with natural gas supply and distillate oil supply to the Gaza power plant.

VI. ANALYSIS OF THE RESULTS AND DECISION MAKING

After the disengagement between The Gaza Strip and Israel at the end of 2005, the local government is carrying responsibilities of the Strip management, the greatest challenge that faced, is the provision of secure, reliable and sustain electrical energy to the public. At the present time all efforts are focused toward supplying the unique power plant of 140 MW with natural gas from Israel will cost about 25 million USD (96.132 million ILS). Primarily, this money is enough as a first payment for 100 MW of many variants for solar or wind power plants (as it indicated in table 5). This procedure is the first step in the way of the sustainable development of Gaza and to reduce the suffering of Gazans. Of course, the natural gas is cheaper and less harmful to the environment than the distillate oil. All of these will be reflected on the price of kWh electricity for the public. But the exposure of the Gaza Strip disorders security and political does not guarantee the continuation of the gas flow to the station if these projects have been implemented as well as the case for the provision of electricity from Israel (these are the first three scenarios), from this point of view the authors believe that, there is only one choice for the Gazans which is the fourth scenario. Even though the electricity is generated in Gaza, the fuel, which is rotating the turbine blades is still imported. However, our approach is more realistic and scientific.

Introducing the term balance of payments which equals the sum of the points 1 to 5 (the -ve sign terms) in the previous section, and the balance of intakes which presents the only income money from selling electricity to the people (+ve sign). The difference between the two quantities will be the benefits of the Palestinian electricity authority. The entire process is tabulated numerically in table 6 and illustrated graphically in figure 4, for all scenarios for Distillate oil and for the future project natural gas. For the renewable energy scenario, the construction cost is twice the capital cost of the renewable station.

Analysis of figure 4 shows that, approximately all types of renewable energies have the best profits than any of the three proposed scenarios. After proving the economic success of renewable energy compared to the current situation, it remains to put a schedule for the transition from the traditional electricity generation to the renewable energy. It has been shown that the annual cost of distillate oil fuel for 110 MW power plant (the current situation) is 735,475,000 [ILS/year] and the environmental damage cost is 445,069,320 [ILs/year] in addition the Palestinian electricity authority pay to Israeli electricity company the cost of 120 MW (that Israel provides the Strip) about 462,528,000 [ILS/year] these money together (1,643.7232 million ILS) is enough to construct 150MW wind farm power plant and during 4 years Gaza will have their 550MW, and year by year the situation get better and through 4 years the crisis will vanished and without any additional pressures on the Gazans, further more increasing the environment quality, reducing the amount of CO_2 emitted to the atmosphere by 484,250 kg/day.

Table 5: Summary of renewable energies electricity generation technologies

Technology	**Life time (year) (1)**	**Nominal Capacity (MW) (2)**	**Capital Cost ($/kW) (3)**	**Annual payment ILS/year (4)**	**Number of units (5)**	**levelized annual cost (6)**
Onshore Wind	20	100	2,213	42,902,103	5.5	589,903,918
Offshore Wind	20	400	2,030	157,417,568	1.375	744,043,975
Solar Parabolic Trough with thermal storage (SPTwTS)	30	250	5,538	178,936,472	2.2	656,100,399
Solar Parabolic Trough without thermal storage (SPTw/oTS)	30	250	3,892	125,753,115	2.2	461,094,755
Solar Power Tower without Storage (SPTw/oS)	30	100	4,240	54,798,891	5.5	502,323,169
Solar Power Tower with 6 hours Storage (SPTw6hS)	30	100	5,906	76,330,719	5.5	699,698,259
Solar Power Tower with 11 hours Storage (SPTw11hS)	30	100	6,560	84,783,189	5.5	777,179,234
Solar Photovoltaic (SPV)	20	7	6,289	8,534,475	79	1,685,558,813
Solar Photovoltaic (Thin-Film) (SPVTF)	20	20	4,020	15,586,666	27.5	1,071,583,288
Solar Photovoltaic (Single-Axis) (SPVSA)	20	20	4,038	15,656,457	27.5	1,076,381,420
Solar Photovoltaic (Thin-Film) (SPVTF)	20	100	3,242	62,850,709	5.5	864,197,250
Solar Photovoltaic (Single-Axis) (SPVSA)	20	100	3,264	63,277,210	5.5	870,061,638
Solar Photovoltaic (PV)	20	150	3,873	112,625,291	3.7	1,041,783,943

Regard less the advantages of thermal solar power plants, there is a problem related to the required land to build a solar plant of 550 MW on it. It needs about 4.0 km^2 to do so which is relatively very large area in Gaza. For this reason authors think that the wind energy seems a good candidate to win in this competition.

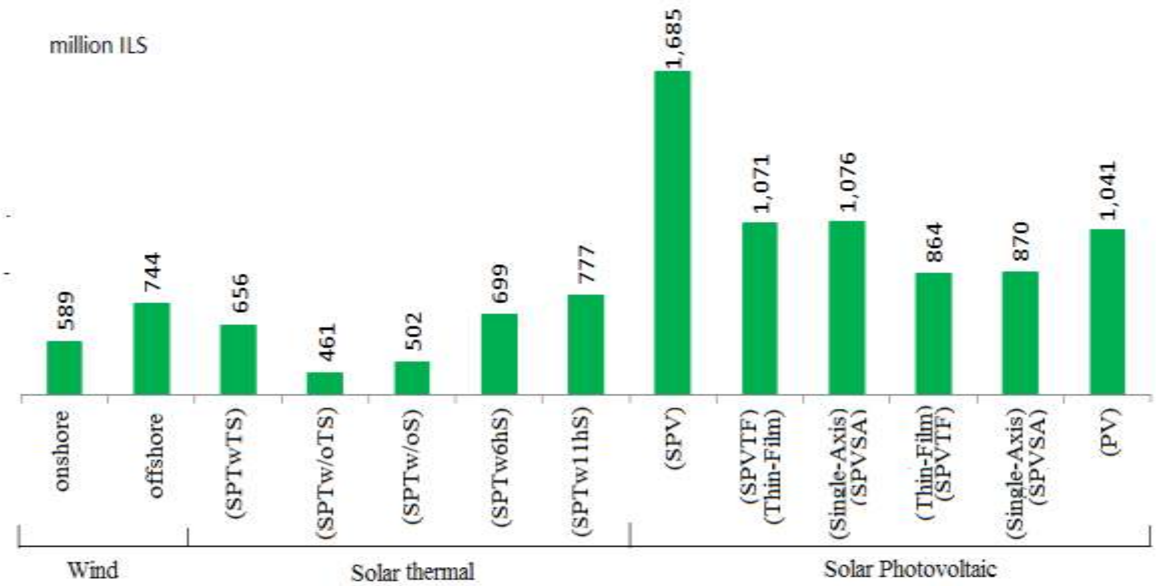

Figure 3. The fourth scenario, presents the levelized annual capital cost of 550 MW power plant for various types of renewable energy sources

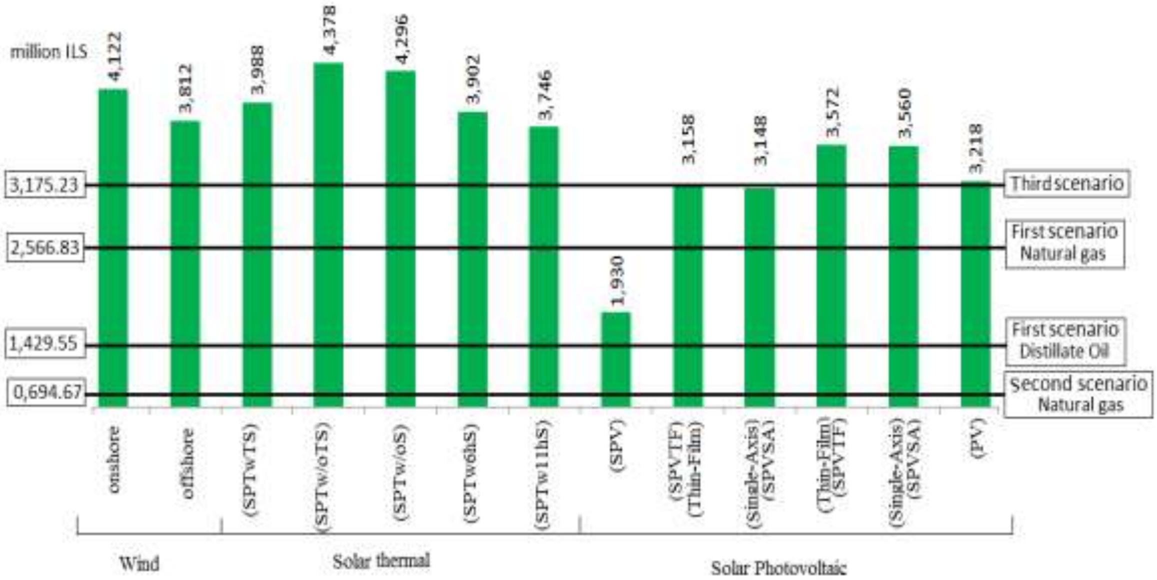

Figure 4. Profits comparison between the proposed scenarios and all renewable energy technologies

While the provision of a sustainable and renewable source of energy for the Gaza Strip has not been a priority for any of the donors or successive Palestinian governments, here are some of the important projects that have been implemented by Arab countries that serve as examples for future developments in the Gaza Strip [14]:

- World Bank project for the extraction of solar thermal energy in electricity production at Ouarzazate in southern Morocco in order to create a new electric solar power plant of 350 MW at a cost of $519 million. The World Bank provides $400 million, and the remaining $119 million were financed by the Clean Technology Fund and managed by the World Bank.
- "Oonnera" Company Project systems for new and renewable energy production recently completed the establishment of two solar rooftops on the two Egyptian companies premise of Petrochemicals Holding

Inc. and Midtab company. The total capacity is 51 megawatt hours per year, which is the equivalent of 1,260 MWh over a period of 25 years. Solar plant project worth $28 million on behalf of the Kuwait Oil Company. The plant will generate 10 MW over 32 thousand units and 12 conversion centres, with an estimated annual electricity production of 17,600 MWh, and will reduce 9100 tons of carbon dioxide emissions in the air.

- The Construction of the first plant for generating electricity from wind energy in the Harweel area in Dhofar Governorate in the Sultanate of Oman.
- A new wind farm under construction of 16 wind turbines at 70 m height with capacity of 27 MW in natural reserve of Msallata on the Libyan coast [15].
- Construction of 117 MW wind electricity plant with total cost about 289.05 million USD in Tofila city in Jordan [16].

Table 6: Economic procedure including the balances of payments, intakes and the profits

		Natural Gas supply	Distillate Oil supply
Present situation	Balance of payments	-1,406,811,831	-,335,662,921
	Balance of the intakes	+2,409,000,000	+2,409,000,000
	Profits	+1,002,188,169	+73,337,079
First scenario	Balance of payments	-2,732,968,023	-3,870,254,178
	Balance of the intakes	+5,299,800,000	+5,299,800,000
	Profits	+2,566,831,977	+1,429,545,822
Second scenario	Balance of payments	-4,604,828,171	+9,159,800,710
	Balance of the intakes	+5,299,800,000	+5,299,800,000
	Profits	+0,694,9971,829	-3,860,000,710
Third scenario	Balance of payments	-2,124,572,736	-2,124,572,736
	Balance of the intakes	+5,299,800,000	+5,299,800,000
	Profits	+3,175,227,264	+3,175,227,264
Fourth scenario	Balance of payments	minimum capital cost	maximum capital cost
		-1,282,129,510	-3,371,117,626
	Balance of the intakes	+5,299,800,000	+5,299,800,000
	Profits	+4,017,670,490	+1,928,682,374

VII. CONCLUSIONS

We have briefly outlined the process of economic calculation including the cost of human health and environmental damage by using the fossil fuel fired in the traditional electrical generation power plants. A meaningful comparison between the proposed scenarios in order to determine the most economically profits variant. A practical tool for decision makers is presented that facilitates a primary estimate of the costs of power generation plants under local and global conditions. From this point of view the study has a significant scientific and practical value in the field of energy engineering. Without any pressure on the public, the electricity authority can construct a stand-alone or hybrid plants with load capacity even more by using the money saved from the fuel consumption, and of course, increasing the environment quality. Further investigation is required in order to determine the station type that to be constructed.

One of the problems is the lack of knowledge or insufficient information for scientific research and the gap between scientific institutions and decision-makers and potential users of technologies for renewable energy about possibilities of economically beneficial use of renewable energy sources and technologies applicable under concrete conditions limit the possibilities of the development of this energy sector.

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