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Simulations of Grid-Connected Photovoltaic System in Qena Al-Gadida City

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Abstract: This paper introduces grid-connected PV system to provide electricity for loads fractions of the governmental building in "Qena Al-Gadida" through two plans with different prices of electricity according to consumption rates. The first plan assuming the price of electricity purchased from the grid is equal to the price paid by the utility for electricity sold to the grid (sellback price). The second plan assumes that the sellback price is higher than the grid power price. HOMER package used for simulation.

Keywords: Photovoltaic, Modules, Inverter, NPC, COE, Grid, Sale, Sellback, Electricity, Simulation, Load, Consumption, Homer, Kwh, Prices, Connected, Temperature, Governmental, Buildings, City, Qena Al-Gadida, NUCA, Diesel.

I. INTRODUCTION

Egypt is endowed with natural resources and enormous potentials of renewable energy, especially solar, which encourages implementing renewable energy projects in the country. Applications of photovoltaic systems have been spread for lighting, water pumping, telecommunications, cooling and advertisement purposes on the commercial scale in Egypt [1]. This study introduces electricity supply of a percentage of loads for the governmental building in Qena Al-Gadida city to make reduction of loads on the grid., and make comparison between electricity cost (L.E/kWh) using PV panels and the local electricity supply, it aims to investigate at which extend on grid system is cost effective and to find the optimum solution of on grid PV systems that will be suitable to the building assuming PV fractions to supply loads (0, 25, 50, 75) % [2-9].

II. INPUT DATA

HOMER can accept input data either directly through the user interface or through file import [10].

A. The Load Profile

The typical operating hours for most governmental buildings in Egypt is from 8:00am to 5:00pm for five days a week with two days off. During working hours, it was assumed that the building used the highest load with only a minimum load used during the evenings and the nights. The load was assumed to be 90% during operating hours and 10% during the evenings and nights in the winter seasons. During the summer season, the load was assumed to be 80% during the operating hours and 20% during the evenings and nights [11]. The annual peak load is 427 KW with energy consumption of 2.6 MWh/day and the daily profile of the load is shown in Figure (1).

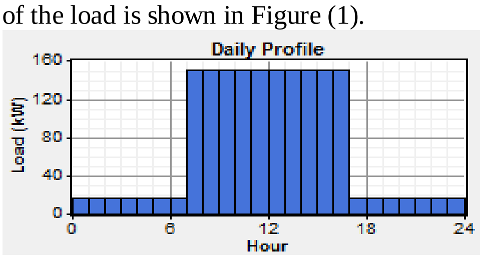

Figure (1): the load profile of Qena Al-Gadida

B. The Temperature of the City

When HOMER includes temperature effects in PV simulations, it requires the user to input the ambient temperature for the location of the panels as shown in figure (2).

Once again, HOMER gives the user the option of retrieving this data from, which provides an average ambient temperature for each month. The user also has the option to insert more precise data [12].

Month	Temperature (°C)
January	23.0
February	25.0
March	29.0
April	35.0
May	39.0
June	41.0
July	41.0
August	40.0
September	39.0
October	35.0
November	29.0
December	24.0
Annual average:	33.4

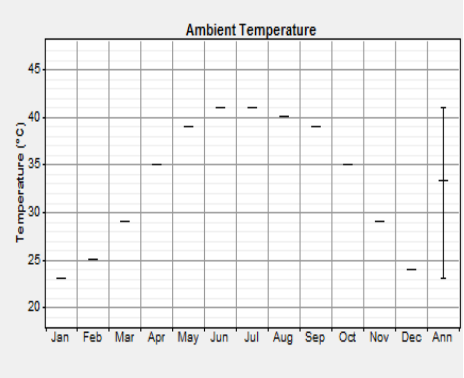

Figure (2): Temperature data of Qena Al-Gadida

C. The Grid information

The rate used is the current price of electricity in Egypt. The exact cost was used because the Egypt electricity company has different electricity prices depending on the sector, season, and time.

The Egypt price for the governmental buildings sector was obtained from the electricity utility [13] then converted to dollars and entered in to HOMER. For this study therefore two plans will be assumed.

In the first plan the sellback price will be equal to the price of the utility. Figure (3) shows the rate table for the Price used in the first plan.

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Rate	Price ($/kWh)	Sellback ($/kWh)	Demand ($/kW/mo)
0.32 L.E	0.046	0.046	0.000
0.50 L.E	0.071	0.071	0.000
0.61 L.E	0.087	0.087	0.000

Add Remove Edit...

Figure (3): First plan grid rate table

In the second plan, the sellback price is assumed to be the highest price. The reason for this assumption is that the PV system will be providing power during peak hours; therefore, it is fair to assume a peak hour price. Figure (4) shows the rate table for the second plan.

Rate	Price ($/kWh)	Sellback ($/kWh)	Demand ($/kW/mo)
0.32 L.E	0.046	0.130	0.000
0.50 L.E	0.071	0.130	0.000
0.61 L.E	0.087	0.130	0.000

Add Remove Edit...

Figure (4): Second plan grid rate table

D. Solar resource

The annual average insolation level at Qena Al-Gadida is 5.89 kWh/m2/day, the monthly clearness index and the daily radiation are shown in Figure (5) [14].

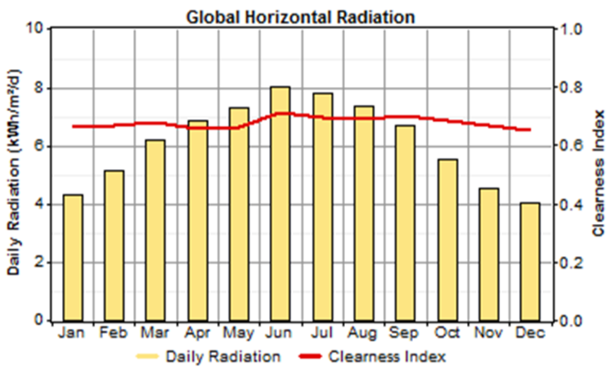

Figure (5): Qena Al-Gadida solar irradiance

E. Economic Entries

The most important economic factors for HOMER are the real interest rate and the project lifetime. For the real interest rate (discount rate) in Egypt 2% was added. The normal project lifetime for any PV system is between 25-30 years. A 25-year lifetime was chosen and was added to HOMER Figure (6).

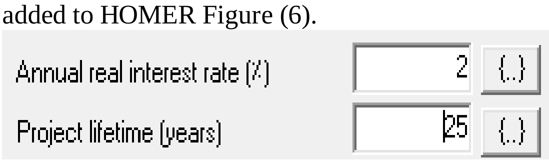

Figure (6): The economic information

F. Constraints

HOMER was forced to follow the assumption that chose the fraction covered by the PV System. The fraction chosen is shown in Figure (7).

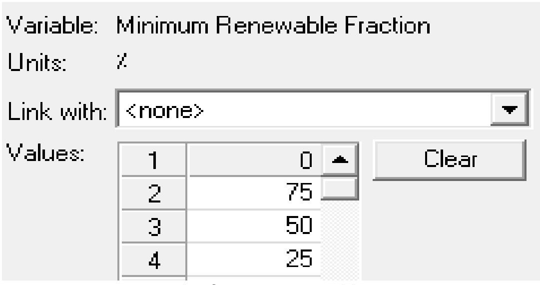

Figure (7): The fraction covered by PV system

All data was entered into HOMER for simulation. Figure (8) shows the final system configuration after all the data needed for the simulation was entered.

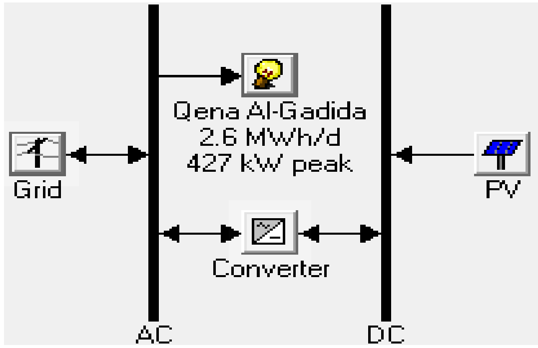

Figure (8): System configuration

III. SIMULATIONS

Figure (9) shows that increase in diesel price has a significant effect on the NPC by choosing to supply the load by a hybrid system (PV and diesel). From a base price of $0.25/L when the NPC is $ 107,255, the NPC increases almost linearly as a function of the diesel price. At a price of $0.50/L, the NPC is $ 115,015, which is a 10% increase in NPC for a 100% increase in diesel price. However, it may be noted that increase in diesel price can significantly reduce the emissions by altering the selection of energy supply options and shifting away from diesel to renewable energy generation. Increasing the diesel price to significantly high levels may also result in a reduction in NPC because of complete new selection of new supply options [15].

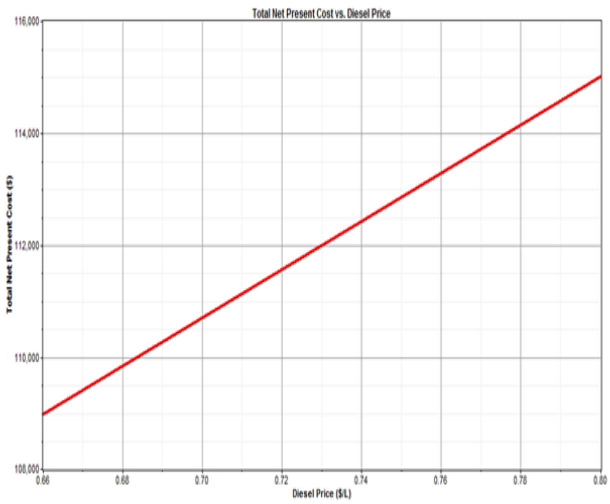

Figure (9): Total net present cost vs. diesel price

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HOMER generated a simulated option with an optimal system being one without an alternative source, which means the building load supplied electricity 100% from the grid as shown in Figure (10).

The total NPC of this grid-only method came solely from the grid since the grid was the only supply.

The output shows that a total energy of 945,350 kWh/year was purchased from the grid and no power supply came from the PV system as illustrated in Table (1).

It can be noted there is no capital cost because no alternative system needed to be purchased or installed in this phase of the analysis.

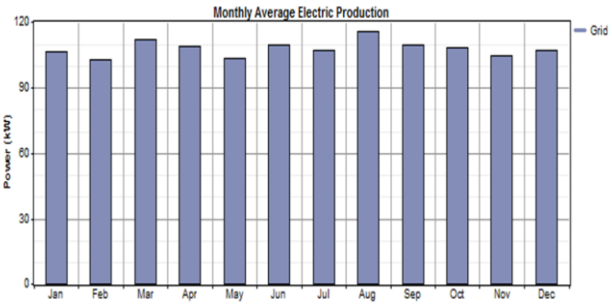

Figure (10): The monthly average electricity

Table (1): Grid only system electricity consumption

Electricity	**Component**	**Production (KWh/yr.)**	**Fraction %**
Production	Grid purchase	945,350	100
Consumption	AC primary load	945,349	100

Figure (11) shows the HOMER output results ordered from lowest NPC for adding the alternative system to the simulation.

The optimal result for HOMER depending on the NPC is to use a grid-only method as the first choice. This means that any alternative system will not be considered an optimal solution.

The reason for this is the grid-only system is assumed to carry no capital or maintenance cost.

It can then be deduced that the most cost effective option is to use the supply from the grid only system without a PV generator.

This option has a total net present cost (NPC) of $ 845,932 and the lowest cost of energy (COE) of $ 0.07/kWh. This option also results in an operating cost of $66,175/year.

The operating cost was generated by multiplying the total energy purchased by the purchase prices.

The initial capital cost in this case is zero due to the lack of a PV generator and inverter.

Min. Ren. Fraction (%) 0

Double click on a system below for simulation results.

PV (kW)	Conv. (kW)	Grid (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage
		1000	$ 0	66,174	$ 845,932	0.070	0.00	0.00
25	11	1000	$ 36,000	64,417	$ 859,468	0.071	0.04	0.00
25	10	1000	$ 35,000	64,526	$ 859,860	0.071	0.04	0.00
25	15	1000	$ 40,000	64,159	$ 860,162	0.071	0.04	0.00
25	9	1000	$ 34,000	64,652	$ 860,474	0.071	0.04	0.00
30	15	1000	$ 45,000	63,907	$ 861,950	0.071	0.05	0.00
30	11	1000	$ 41,000	64,321	$ 863,243	0.071	0.05	0.00
30	10	1000	$ 40,000	64,459	$ 863,999	0.071	0.05	0.00
30	9	1000	$ 39,000	64,607	$ 864,890	0.072	0.05	0.00
40	15	1000	$ 55,000	63,660	$ 868,792	0.072	0.07	0.00
40	25	1000	$ 65,000	62,928	$ 869,435	0.072	0.07	0.00
45	25	1000	$ 70,000	62,621	$ 870,506	0.072	0.08	0.00
30	25	1000	$ 55,000	63,873	$ 871,513	0.072	0.05	0.00
40	11	1000	$ 51,000	64,242	$ 872,233	0.072	0.07	0.00
45	15	1000	$ 60,000	63,601	$ 873,033	0.072	0.08	0.00
25	25	1000	$ 50,000	64,409	$ 873,364	0.072	0.04	0.00
40	10	1000	$ 50,000	64,412	$ 873,400	0.072	0.07	0.00
40	9	1000	$ 49,000	64,591	$ 874,695	0.072	0.07	0.00
45	11	1000	$ 56,000	64,235	$ 877,145	0.073	0.08	0.00
45	10	1000	$ 55,000	64,417	$ 878,462	0.073	0.08	0.00
45	9	1000	$ 54,000	64,607	$ 879,897	0.073	0.08	0.00
100	25	1000	$ 125,000	61,768	$ 914,602	0.076	0.16	0.00
100	15	1000	$ 115,000	63,693	$ 929,213	0.077	0.16	0.00
100	11	1000	$ 111,000	64,544	$ 936,084	0.077	0.16	0.00
100	10	1000	$ 110,000	64,768	$ 937,952	0.078	0.16	0.00
100	9	1000	$ 109,000	64,997	$ 939,880	0.078	0.16	0.00

Figure (11): The overall results from HOMER

For the optimal overall result HOMER gives only two systems, as shown in Figure (12).

Min. Ren. Fraction (%) 0

Double click on a system below for simulation results.

PV (kW)	Conv. (kW)	Grid (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage
		1000	$ 0	66,174	$ 845,932	0.070	0.00	0.00
25	11	1000	$ 36,000	64,417	$ 859,468	0.071	0.04	0.00

Figure (12): The optimization system results

From Figure (12) there is only one optimal system with a PV system. This system has a PV fraction of 4% with a grid fraction of 96%. For the optimal alternative system, the PV system and inverter size are 25, 11 KW as shown in Table (2) with a capital cost of $25,000and $11,000 for the PV kit and inverter respectively. For the O&M the PV cost was assumed to be zero while the inverter is $1,406.

Table (2): The PV system size and cost

Component	**Size (KW)**	**Capital cost ($)**	**O&M ($)**	**Total ($)**
PV Kit	25	25,000	0	28,426
Inverter	11	11,000	1,406	16,142

The alternative system with 4% fraction produces 42,109 KWh per year. On the other hand, the system purchases 910,671 KWh per year from the grid, as shown in Table (3).

Table (3): Electrical data from the simulation

Electricity	**Component**	**Production (KWh/yr.)**	**Fraction %**
Production	Alternative system	42,109	4
	Grid purchase	910,671	96
Consumption	AC primary load	945,349	100
	Grid sale	0	0

For the economic analysis, Table (4) shows that the NPC for the system is $859,468, which is higher than the NPC of the grid-only system. In addition, this increase in NPC

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makes the COE of the alternative system (0.071/KWh) higher than the COE for the grid-only system. The operating cost was reduced to $63,857/yr. This reduction was possible due to the excess of the load requirements being sold back to the grid during the day (when the PV system is generating higher power due to the greater amount of radiation).

Table (4): Economic data for the system

Component	Total ($)
PV system	44,568
Grid purchase	814,900
NPC	859,468
COE	0.071/KWh
Operating	63,857/yr

After the aforementioned analysis comparing the cost of the PV system with a grid only system, HOMER's optimal system was found not to be cost-effective.
One of the HOMER options used here is to force the PV system to cover any fraction of the load and give the optimization result for it. After choosing three different fractions 25%, 50%, 75% of the building load, the power consumption is considered.

1. The First Plan

a. Design System (1):

In the figure below HOMER shows the optimal system that covers 25% of the governmental building load. The optimal system presented required 33% coverage instead of 25% of the governmental building load as shown in Figure (13).

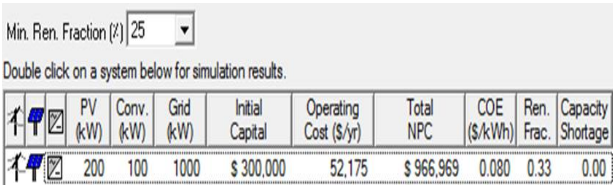

Figure (13): Plan (1), the optimal result for system (1)

With the new system the monthly average electricity production is shown in Figure (14).

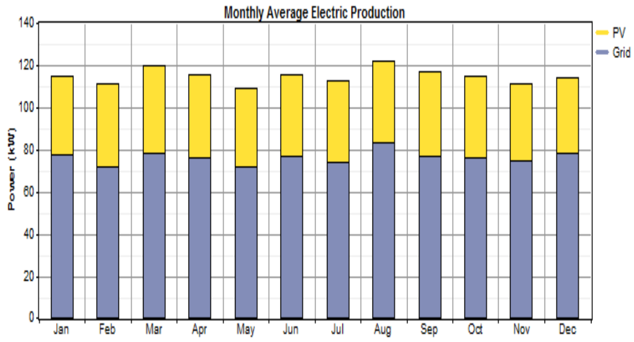

Figure (14): The monthly average electric production for system (1)

The new PV system configuration shown in Table (5) shows that the new bigger PV panel size obtained for the optimal system is the same size of the inverter. The PV size is 200 KW with a capital cost of $ 200,000while the maintenance costs are equal to zero. The inverter cost with the regular maintenance equals $12,783.

Table (5): Plan (1) system size and cost for system (1)

Component	Size (KW)	Capital cost ($)	O&M ($)	Total ($)
PV Kit	200	200,000	0	227,411
Inverter	100	100,000	12,783	146,743

Table (6) shows the details of the electrical production and consumption. The 33% of the building load supplied by the alternative system produced 336,872 KWh/yr while the rest of the load (67%) supplied by the grid produced 669,045 KWh/yr.

In this option, the system still gets most of the power from the grid. In addition the system sellback is 6,560 KWh/yr to the grid.

Table (6): Plan (1) Electrical detail for system (1)

Electricity	Component	Production (KWh/yr.)	Fraction %
Production	Alternative system	336,872	33
	Grid purchase	669,045	67
Consumption	AC primary load	945,349	99
	Grid sale	6,560	1

The cost of the alternative system is $ 374,154. The NPC, COE and operating cost of the new system are $ 966,969, 0.08/KWh and 52,157/yr respectively.

Most of the power is still purchased from the grid ($592,815) Table (7).

Table (7): Plan (1) Economic analysis for system (1)

Component	Total ($)
PV system	374,154
Grid purchase	592,815
NPC	966,969
COE	0.08 /KWh
Operating	52,157 /yr.

b. Design System (2):

In Figure (15) below HOMER shows the optimal system for a new fraction. The PV System size increased to 350 KW while the inverter size increased to 150 KW.

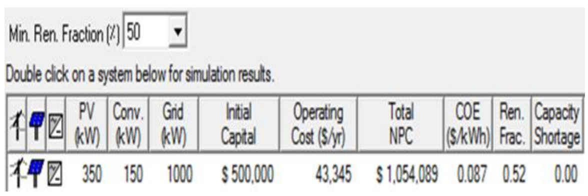

Figure (15): Plan (1), the optimal result for system (2)

The new system covers 52% of the total building load. The optimal system is to cover 52% instated of 50% of the building load. Figure (16) shows the monthly average electrical production with system 2.

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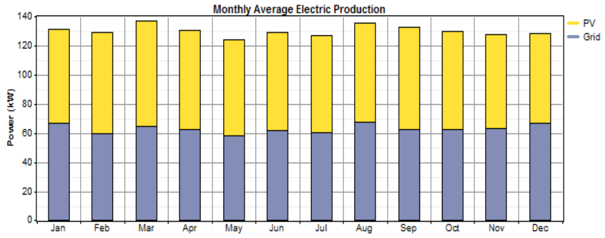

Figure (16): The monthly average of electric production for system (2)

The new PV system configuration shown in Table (8) shows that the new larger PV panel size costs $397,970 while the new inverter total costs $220,115.

Table (8): Plan 1 system size and cost for system (2)

Component	Size (KW)	Capital cost ($)	O&M ($)	Total ($)
PV Kit	350	350,000	0	397,970
Inverter	150	150,000	19,175	220,115

Table (9) shows the detail of the electrical production and consumption. The alternative system supplied 52% of the building load and produced 589,526KWh/yr while the rest of the load (48%) was supplied by the grid and produced 552,111KWh/yr. The system is starting to get a higher amount of power from the PV system than from the grid. In addition, the system sell-back was 64,865 KWh/yr to the grid.

Table (9): Plan (1) Electrical detail for system (2)

Electricity	Component	Production (KWh/yr.)	Fraction %
Production	Alternative system	589,526	52
	Grid purchase	552,111	48
Consumption	AC primary load	945,349	94
	Grid sale	64,865	06

The cost of the alternative system is $618,084. The NPC, COE and operating cost of the new system are $1,054,089, 0.087/KWh and 455,180/yr respectively. The grid purchase cost is $ 436,005, as shown in Table (10).

Table (10): Plan (1) Economic data for the system (2)

Component	Total ($)
PV system	618,084
Grid purchase	436,005
NPC	1,054,089
COE	0.087 /KWh
Operating	455,180 /yr

c. Design System (3):

Covering 75 % of the Total Load, HOMER shows the optimal system for a new fraction in Figure (17). The new PV system size is 850 KW while the inverter size is 400KW. The total net present cost is $ 1,353,079.

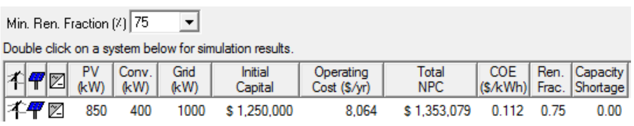

Figure (17): Plan (1), the optimal result for system (3)

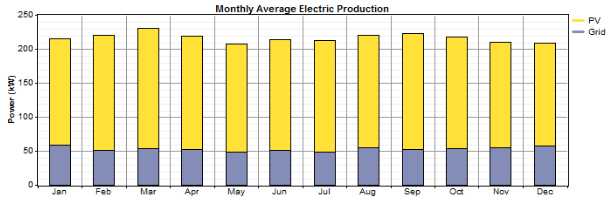

Figure (18): The monthly average electrical production

System 3 covers 75% of the building load. The optimal system is to cover 75% of the building load. The Figure (18) shows the monthly average electrical production with the new system. The new PV system configuration shown in Table (11) shows that the new bigger PV panel size cost $966,497 while the new inverter total cost $586,973.

Table (11): Plan (1) size and cost for system (3)

Component	Size (KW)	Capital cost ($)	O&M ($)	Total ($)
PV Kit	850	850,000	0	966,497
Inverter	400	400,000	51,133	586,973

Table (12) shows the detail of the electrical production and consumption. The 75% of the building load supplied by the alternative system produced 1,431,704 KWh/yr while the rest of the load (25%) supplied by the grid produced 466,369 KWh/yr. The new system gets most of the power from the PV system rather than from the grid. In addition, the system sellback was 690,311 KWh/yr to the grid.

Table (12): Plan (1), Economic analysis for system (3)

Electricity	Component	Production (KWh/yr.)	Fraction %
Production	Alternative system	1,431,704	75
	Grid purchase	466,369	25
Consumption	AC primary load	945,349	58
	Grid sale	690,311	42

Table (13) shows the cost of the alternative system is $1,553,470, which makes it the highest cost variable. The NPC and the COE of the new system are $1,353,079, 0.112/KWh respectively. The grid purchase and the operating cost in this system is a negative value that means the system produced more power than the required amount to cover the load and sell it to the grid.

Table (13): Plan1, Economic data for the system (3)

Component	Total ($)
PV system	1,553,470
Grid purchase	-200,391
NPC	1,353,079
COE	0.112
Operating	-149,258

2. The Second Plan

In the second plan we have changed the price to find a cost effective system, assuming the power utility will pay for electricity at a higher price ($0.13/kwh) than they sell the power to the governmental buildings.

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a. Design System (1):

Table (14) shows the size and the cost of system (1) of the second plan.

Table (14): Plan (2) system (1) size and cost

Component	Size (KW)	Capital cost ($)	O&M ($)	Total ($)
PV Kit	200	200,000	0	227,411
Inverter	100	100,000	12,783	146,743

In this plan's first system, 33% of the building load is supplied by the alternative system while the rest of the load (67%) is supplied by the grid, illustrated in Table (15). In addition, the system sells 6,560 KWh/yr to the grid.

Table (15): Plan (2) Electrical data for system (1)

Electricity	Component	Production (KWh/yr.)	Fraction %
Production	Alternative system	336,872	33
	Grid purchase	669,045	67
Consumption	AC primary load	945,349	99
	Grid sale	6,560	1

Table (16): Plan 2 Economic data for system (1)

Component	Total ($)
PV system	374,154
Grid purchase	587,783
NPC	961,937
COE	0.08 /KWh
Operating	52,157 /yr.

From Table (16) the only change with the new price is the grid purchase because the price for sellback change makes the grid purchase decrease. This makes the NPC of the system decrease, thus also making the COE decrease. Finally this shows the sellback is effective economically.

b. Design System (2):

From Tables (17, 18) there is no change in the size and the cost of the optimal system. Also there is no change in the electrical consumption.

Table (17): Plan (2) system (2) size and cost

Component	Size (KW)	Capital cost ($)	O&M ($)	Total ($)
PV Kit	350	350,000	0	397,970
Inverter	150	150,000	19,175	220,115

Table (18): Plan (2) Electrical data for system (2)

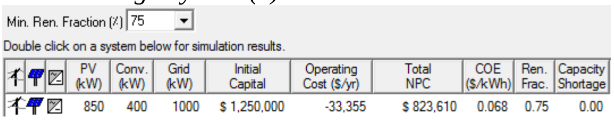
Electricity	Component	Production (KWh/yr.)	Fraction %
Production	Alternative system	561,513	52
	Grid purchase	519,993	48
Consumption	AC primary load	904,487	85
	Grid sale	158,33	15

The change in the new plan took place in the economic analysis portion. The grid purchase was reduced from $ 436,005 to $ 386,253. Thus the NPC also decreased, which affected the COE. The COE reduced from 0.087 /KWh to 0.083 /KWh, as shown in Table (19).

Table (19): Plan (2) Economic data for system (2)

Component	Total ($)
PV system	618,084
Grid purchase	386,253
NPC	1,054,089
COE	0.083 /KWh
Operating	31,715 /yr

c. Design System (3):


Min. Ren. Fraction (%) 75
Double click on a system below for simulation results.

PV (kW)	Conv. (kW)	Grid (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage
850	400	1000	$ 1,250,000	-33,355	$ 823,610	0.068	0.75	0.00

Figure (19): Plan (2), the optimal result for system (3)

For the biggest system fraction coverage of the load, the optimal system from HOMER totally changed. The new system with a different size and cost was obtained, as Shown in Figure (19). The monthly average electricity production for system3 is shown in Figure (20).

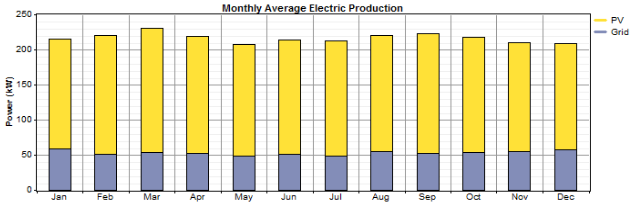


Figure (20): Plan (2) the monthly average for system (3)

For system 3, Table (20) shows PV system size and cost for the system.

Table (20): Plan (2), PV system size and cost for system (3)

Component	Size (KW)	Capital cost ($)	O&M ($)	Total ($)
PV Kit	850	850,000	0	966,497
Inverter	400	400,000	51,133	586,973

Table (21) shows the details of the electrical production and consumption. When 75% of the building load was supplied by the alternative system, the system produced 1,431,704 KWh/yr while the rest of the load (25%) supplied by the grid produced 466,369 KWh/yr. The system can cover the load but the electricity needed to operate during the evening and night still comes from the grid. In addition, the system sellback fractions increased to 42% and sold 690,311 KWh/yr to the grid.

Table (21): Plan (2), Electrical data for system (3)

Electricity	Component	Production (KWh/yr.)	Fraction %
Production	Alternative system	1,431,704	75
	Grid purchase	466,369	25
Consumption	AC primary load	945,349	58
	Grid sale	690,311	42

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Table (22) shows the cost of the alternative system is $ 1,553,470. On the other hand, the NPC and the COE of the new system are $ 823,610, 0.068/KWh respectively. This is less than in system 3 in the first plan1, and is due to the fact that the grid purchase increased to $ -729, 861 when the price changed in the second plan.

Table (22): Plan (2), Economic results for system (3)

Component	Total ($)
PV system	1,553,470
Grid purchase	-729,861
NPC	823,610
COE	0.068
Operating	-678,728

3. Effect of Temperature

It is critical to understand the negative effect on the performance of photovoltaic systems when the panels heat up due to the absorption of solar heat. This is not simply for locations with high ambient temperature. Even in mild climates, there can be degradation due to the heating of the panels. HOMER has the ability to simulate the temperature effects on a PV panel if the pertinent information is available, as seen in Figure (21). This is the temperature coefficient of power (%/^{0}C), the nominal operating cell temperature (NOTC, ^{0}C), and the efficiency at standard test conditions (%). Often these details are listed on or can be derived from the technical data sheets of the PV panel being evaluated [16].

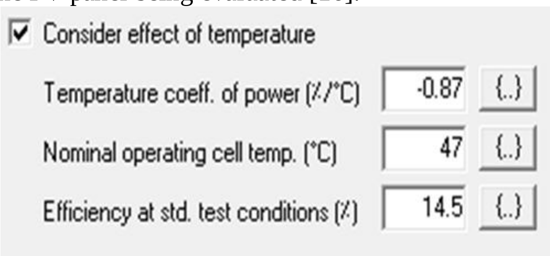

Figure (21): HOMER temperature effects inputs of Qena Al-Gadida

Both the NOTC and efficiency at standard test conditions are listed. They are 47^0 and 14.5%, respectively. The temperature coefficient of power is not listed and must be derived. Most often, technical data sheets will not list the temperature coefficient in terms of power. Instead, the temperature coefficients of the open-circuit voltage and the short-circuit current will be listed. To achieve a reasonably accurate temperature coefficient of power, equation (1) should be used [16]:

$$\propto_{v_{oc}} \times I_{mpp} = \propto_p \qquad \textit{Eqn.1}$$

In this equation, $\propto_{v_{oc}}$ refers to the temperature coefficient of the open circuit voltage, I_{mpp} the maximum power current, and $\propto_p$ is the temperature coefficient of power. The resulting equation (2) is:

$$-0.11\ {}^{V}/_{\circ C} \times 7.91\ A = -0.87\ {}^{W}/_{\circ C} \qquad \textit{Eqn.2}$$

IV. CONCLUSIONS

Comparing all systems to the grid-only system was not cost effective. All the systems of the first plan have a higher NPC because of the initial cost for the PV system and the fact that the grid system is the only system with a lower COE. In addition, the assumed sellback price is not acceptable because even the system selling the most power to the grid was still economically not acceptable. The NPC increases with the increasing size of the alternative system because the capital cost increases. The cost of energy also changes with the alternative system change. All the simulation results NPC and COE are higher than the only grid system. On the other hand, system 3 is the only system that benefits by the end of the year (because it sells to grid a larger amount of power than it purchases from the grid). The simulation for the second plan shows the same optimization results for the PV system 1 and system 2 in the electricity consumption but with a change in the NPC and the COE because of the new price. On the other hand, System 3 has the best optimization results with the lowest COE less than the COE on the grid only, and a reduction in power purchased to 21% but with high NPC.
The summary tables for the results from HOMER for the first and the second plans are shown in Tables (23, 24).

Table (23): Plan (1), the summary table for plan (1)

Load cover by PV	25%	50%	75%
Homer %	33%	52%	75%
PV size / inverter size	200/100	350/150	850/400
COE	0.08	0.087	0.112
NPC	966,969	1,054,089	1,353,079

Table (24): summary results for the second plan

PV % cover from the load	25%	50%	75%
PV/ inverter size	200/100	350/150	850/400
NPC	961,938	1,054,089	823,610
COE	0.08	0.083	0.068
Electricity From the grid (kwh/year)	669,045	519,993	466,369
Electricity Sale to the grid (kwh/year)	6,560	158,33	690,311

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