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STUDY TO TURNING SUMMER HOME TO GREEN ENERGY BUILDING THROUGH DESIGN SMART GRID

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ABSTRACT

A green or zero energy building is a building that produces as much energy as it consumes on an annual basis analysis. Smart Grid is a network created through information technology, communication technology and electrical power system. It is simply a "smarter" power grid which ensures a two-way communication between user and the power supplier. It mainly takes into consideration the renewable energy resources for its operation. The study in this paper is handled to convert summer home to a green energy building reducing electricity consumption and to gain profits from selling back electricity to the grid. Summer Home is occupied from two to three months only in the year. The paper proposes a smart micro grid design in a summer home in the Egyptian North Coast using solar PV panels, wind turbines. HOMER software is used for simulation and optimization of the hybrid power plant including the cost aspects for various loads throughout one complete year.

Key words: Homer, Smart Grids, Egypt, North Coast, Renewable resources, Green Energy Building.

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1. INTRODUCTION

Due to the shortage of fossil resources in Egypt and in the whole world. And at the same time Egypt has very good potentials due to very good renewable resources. The government is already accomplished many projects manly 550 MWatt Wind farms and 140 MWatt solar plants [1] .A thinking to overcome that shortage beside the governmental efforts is the main idea of my research. It is noticed that summer home is occupied two or three month in the year. The hybrid unit will supply the home with electricity. If the unit is not enough the rest is purchased from the grid through occupying months. The owner of the summer home will gain profits from selling back the electricity the rest of the year.

2. INTRODUCTION TO HOMER

To design stand-alone electric power systems HOMER (Hybrid Optimization Model for Electric Renewables) is the program to be used. It employs combination of wind turbines, photovoltaic panels or diesel generators to generate electricity. HOMER is application software by National Renewable Energy laboratory in USA. It is used for designing and analyzing smart grid systems. By calculating different combinations of possible designs depending on the given inputs the power system network is simulated [2]. Simulation, optimization and sensitivity analysis are main Functions of HOMER. Modeling of the power system network is done hourly in the simulation process to determine the technical feasibility. Then, many different system configurations are simulated. Which meet the required demands and also follow the technical constraints in the optimization process. In the simulation process, it calculates four types of costs:

- NPC (Net Present Cost)
- COE (Cost of Energy)
- O&M (Operations and Maintenance Cost)
- Initial Capital Cost

The life cycle cost of a system is represented by total net present cost (NPC) of the system. Cost of initial construction, maintenance, fuel, penalties from pollutants and all other costs are included in NPC. The average cost/kWh of useful electrical energy is cost of energy (COE) [3-5].

3. SYSTEM DESCRIPTION

3.1. System Load Profile

The north cost in Egypt is the area of consideration. The residential load profile is plotted on Homer showing the hourly load variations for the summer home model for one complete year as shown in figure. The load in the figure is only for four months the summer home is used in and the rest of the year the load is approximately zero as shown in the Fig. 1. All the load values (in kWatt) are measured from the home devices [refrigerator, television, water pump, cloths watching machine]. The measurements were taken alone a full day as shown in Fig.2. Assuming the same power consumption and the same devices along the occupying months.

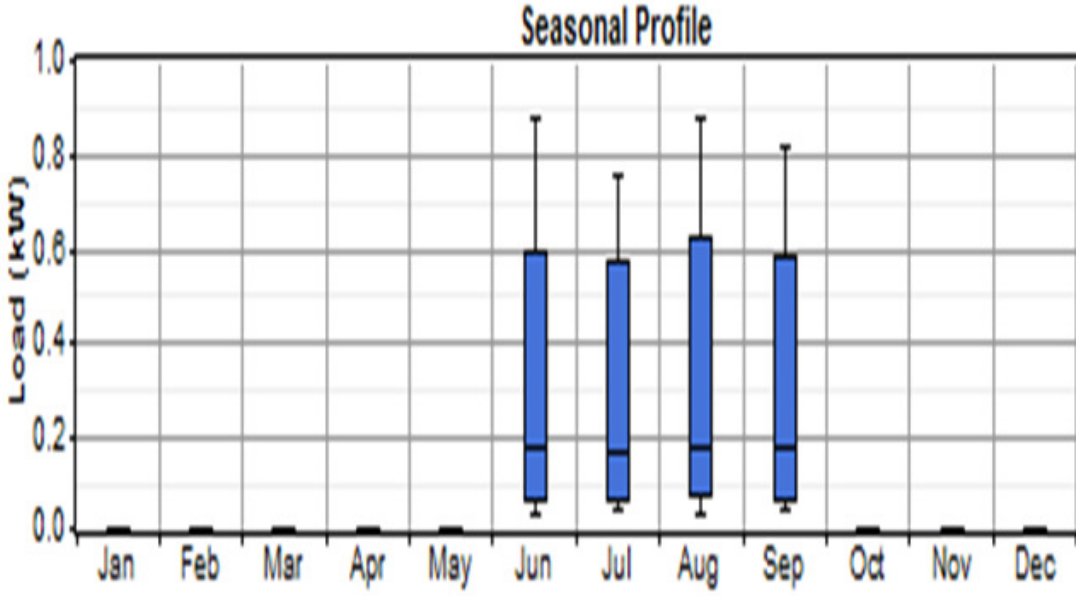

Figure 1 Annual Load Profile (Monthly).

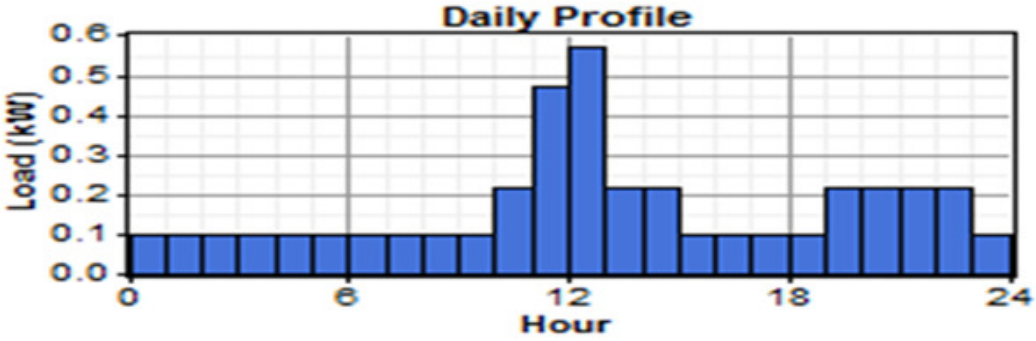

Figure 2 Daily Load Profile (Hourly).

In this study the average energy consumption from the load profile selected is 1.4 kWh/d, 0.88 kW is the peak load consumption of the area considered with scaled annual average assumed as 1.36 kWh/d.

3.2. Wind speed and Solar Radiation

The Physical and numerical research department in the Egyptian meteorological Authority is the source of the solar radiation and wind speed data (see Appendix). The Monthly average Global Solar radiation values are converted from MJ/m^2 to KWh/m^2 /day to fit the software requirements. Microsoft Excel was used to operate the conversion equation [(KWh/m^2 /day) = (MJ/m^2)*3.6] [6] as shown the Fig.3. . Wind speed is obtained at 50m above the surface of earth is shown in Fig.4. The latitude and longitude of the area considered is 30°59’ N, 28°59’E, respectively.

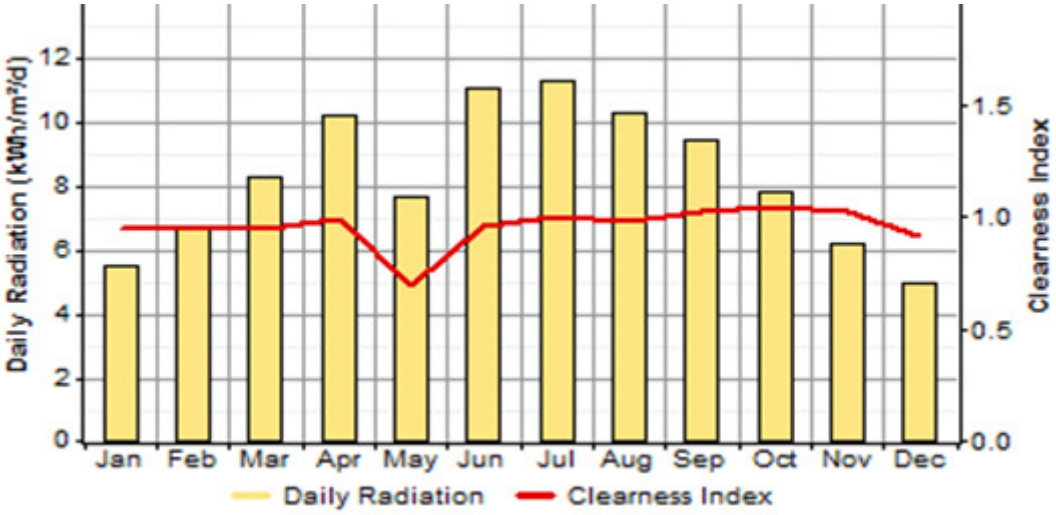

Figure 3 Monthly Average Global Solar Radiation and Cleanness index.

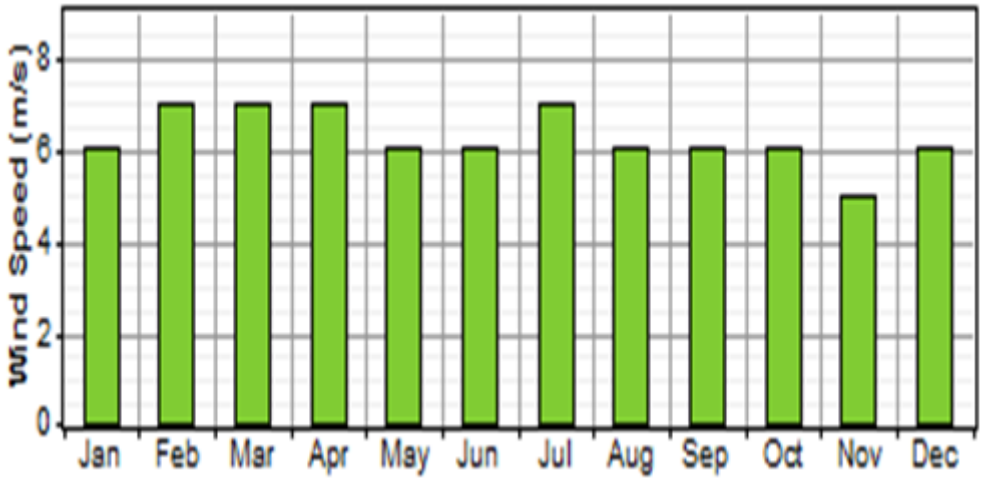

Figure 4 Monthly Average Wind Speed.

3.3. Simulation Model

HOMER components are chosen to perform simulation. Fig.5. shows the hybrid power system design using wind generator, PV array, converter and load. For economic analysis the following values have been used:

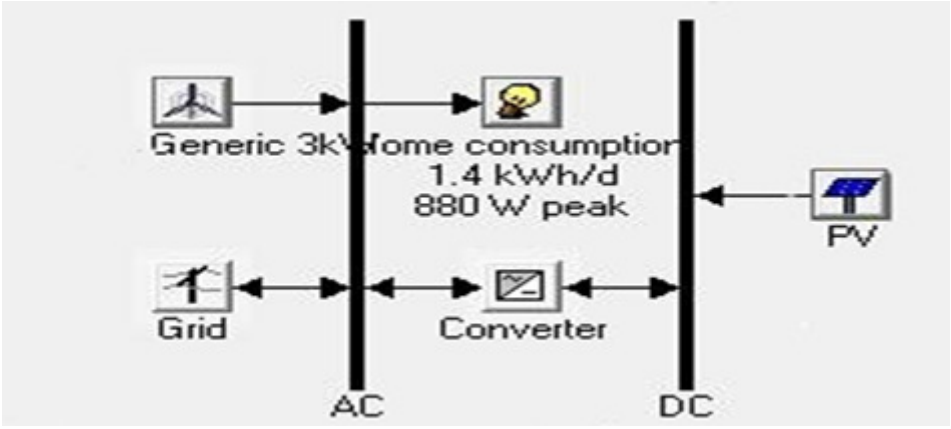

Figure 5 Hybrid System Diagram.

a) Wind Turbine

Generic 3 kW turbine manufactured by Generic have been used with a hub height of 17m and lifetime of 20 years. The capital and operation and maintenance costs are $2000 and $10 respectively.

b) Photovoltaic Array

Generic 1 kW flat plate PV, manufactured by Generic have been used with a lifetime of 25 years and initial capital cost of $350 and replacement and operation and maintenance cost being zero.

c) Power Converter

1 kW System Converter, manufactured by Generic with efficiency of 95% and lifetime of 20 years with capital and replacement cost of $300 and operation and maintenance cost being zero.

4. OPTIMIZATION RESULTS

From the results, the total yearly production of the hybrid model is 8043 kWh/yr and the load demand is 496 kWh/yr as shown in figure 5. The rest of the energy will be sale to the centralized grid to profits. The optimization results for the hybrid power model are shown in Table (1). The minimum COE (cost of energy) obtained is ($- 0.256). The renewable energy contribution is 100%. The NPC (net present cost) comes out to be - $1626. The negative value is due to exceeds of the power production to the consumed power from the grid (Summer Home is occupied only four months in the year where power is consumed from the grid) .The monthly average electric energy production from different units is shown in Fig.7.

Table 6 Optimization Results.

Production	kWh/yr	%	Consumption	kWh/yr	%
PV array	2302	29	AC primary load	496	6
Wind turbine	5658	70	Grid Sales	7493	94
Grid purchases	83	1	Total	7990	100
Total	8043	100			

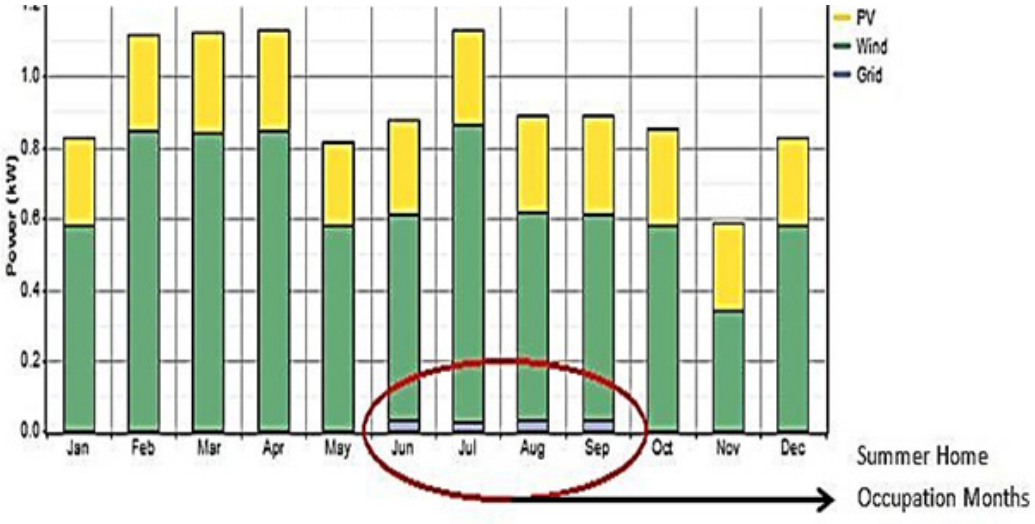

Figure 7 Monthly Electric Energy Production from PV, Wind Turbine and Grid.

In this study there are no generators used so no emissions is produced from the system. As a renewable energy sources is used the usage from power plant is reduced. The reductions in emissions according to our system capacity are: 4683 kg of Carbon dioxide, 20.3 kg of Sulfur dioxide and Nitrogen oxides 9.93 kg/year as shown in the Table 8.

Table 8 Reduced Emissions Due to Using Renewable System.

Pollutant	Emissions [kg/yr]
Carbon dioxide	-4683
Carbon monoxide	0
Unburned hydrocarbons	0
Particulate matter	0
Sulfur dioxide	-20.3
Nitrogen oxides	-9.93

5. CONCLUSION

A hybrid micro grid is modeled for Summer Home in Egyptian North Coast. That Summer Home is used only three months all over the year. The modeling is handled by using HOMER the optimization results show that by using renewable energy units of flat plate PV panel of 1kW capacity, a wind turbine of 3kW capacity and a 1kW system converter the summer home can generate electricity for itself in summer (with little aid from the grid just only 1% of the consumption/year) . Moreover profits are gained the rest of the year. As no fuel generator is used no direct reduction of emission. But as the system reduce the demand from the grid so emission from power plants will reduced by (4683 kg of Carbon dioxide, 20.3 kg of Sulfur dioxide and Nitrogen oxides 9.93 kg/year)

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شـــبكه تصـــميم خـلال من النزيفـــة بالطاقـــة يعمـل مـنزل الـي الصـــيف مـنزل لتحويـــل دراسـه هومـير برنـــامج بســـتخدام زكيـــه

نظيفـــة طاقـة الأخضـر المـنزل ينتـــج الســـنوى التحليـــل علـي بنـــاءا, المتجـددة النظيفـــه الطاقـه يســـتخدم مـنزلاً الاخضـر المـنزل ان ونظـام الإتصـــالات تكنولوجيـــا و المعلومـات يكنولوجيـــا علـي بنـاءا تكونـت شـبكة هي الزكيـة الشـبكه .اسـتهلاكه من أكـثر متجـددة مسـتهلك و منتـج بيـن الاتجـاهين فـي الإتصـال تـؤمن كهربيـة شـبكة عن عبـاره ببسـاطة هي الذكيـة الشـبكة إن الكهربائيـة القـوي مـنزل تحويـل دراسـة يتنـاول البحـث هذا.المتجـددة الطاقـة انـواع مختلـف هو الرئيسـي الممول ان الاعتبـار فـي تاخـذ إنما .الكهربـاء عليـه أجريـت الـذي الصـيف مـنزل نموزج أن .المـنزل لمالـك ارباحـا ومدرا للطاقـة منتجـا, الطاقـة لاسـتخدام موفـرا أخضـر مـنزل الـي الصـيف تتكـون ذكيـه صـغيره شـبكة البحـث يقـدم.العـام مدار عي فقـط ثلاثـة او شـهرين لمـدة يسـتخدم المصـري الشـمالي السـاحل فـي الدراسـه المهجنـة الطاقـة وحدة تحسـين و المحاكـاة , المنمزجـة لعمـل هومـير برنـامج اسـتخدام تـم قـد .هوائيـه وتربينـه شمسـية طاقـة الـواح من .العـام مدار علـي الكهـربي للحمـل الاسـعار معـاير تتضـنم