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RESEARCH ARTICLE OPEN ACCESS

The contribution of photovoltaic in the state of Kuwait and method of their installation

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ABSTRACT:
In recent years due to the rising in demand of electricity consumption in Kuwait, using renewable energy will reduce environmental pollution such as air pollution caused by burning fossil fuels that leaves harmful residues in the environment which threatens the public health. the government of state of Kuwait aims to secure 15% of the domestic demand for electricity using solar energy in al- shagaya complex and that was the Amir of Kuwait vision, which will save 2.5 $ billion, considering the price of barrel of oil 45 $. The three phases of the Shagaya renewable power complex will contribute 302 GW connected to the national electricity grid in (2025-2026).
I am in the process of this evaluation to present the extent of benefit from subsidizing the electricity network of Kuwait.
KEYWORDS: electrical consumption, environmental impact, solar energy, domestic demand , renewable power complex , national electricity grid .

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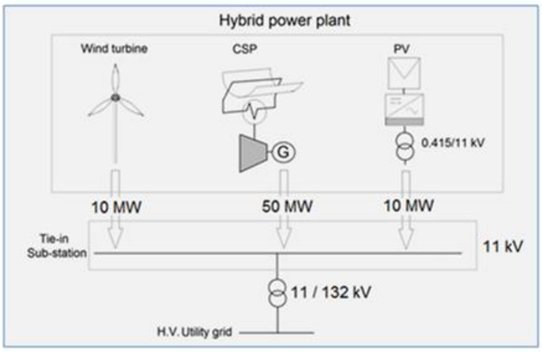
I. INTRODUCTION

Kuwait started A pilot project to install Renewable Energy sources, It contains of 10 MW of Photovoltaic solar (PV) which is divided by 5MW Thin film and 5 MW Polycrystalline, 10 MW Wind power and 50 MW concentrated solar power (CSP). The Wind power was operated in May 2017, The CSP was operated in Dec 2018, and the official Grand Opening for the Shagaya Renewable Energy Park was held in February 2019. (fig.1)



(fig.1)

The assimilation average of solar energy which is superior substitutional is 29% annually. My goal of this paper is to talk over about sharing the solar energy power with Kuwait's peak demand.

Energy type	Name-plate power [MW]	Energy storage	Capacity factor [%]	Maximum Design [MWh-year]
CSP	50	TES (10 hrs@73%)	41 (with TES)	179,580
PV solar	10	Nil	22	19,272
Wind power	10	Nil	40	35,040
Total	70			233,892

Table.1 al-shagaya park basic data

II. METHODOLOGY

In the very beginning, the Shagaya PV plant was established to generating electricity to the grid in a fully operational environment. By comparing the total size of the PV plant (11.15 MW) with a medium sized project, we can see that it can inject a reasonable amount of electricity to the grid. Moreover, the essential goal of the whole Shagaya plant is to highlight and review the performance of different kinds of renewable energy technologies (table.1) that are working under a difficult climate such as in Kuwait. To get this result, all parts of the TF and PC subsystems were chosen to be practically identical in terms of the installed capacity, inverters, transformers, and cabling method**.**

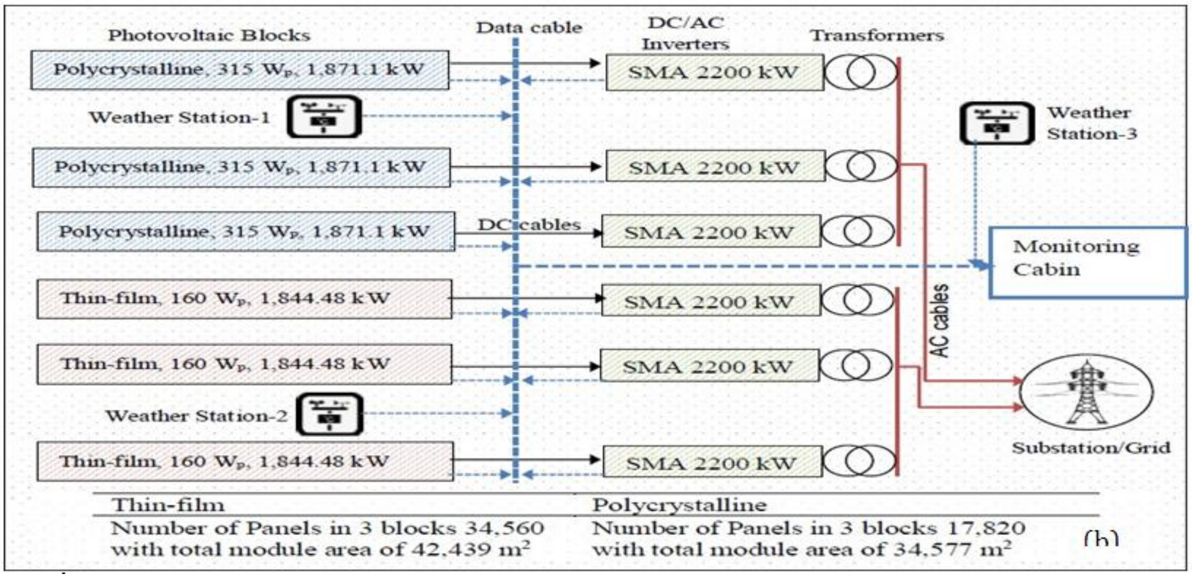


Fig.2 Shagaya PV power plant synoptic

2.1 PV capacity factor:

The general appearance of the statistical system for the two branches as in(fig.2). 36 lines of PV arrays and current converters from DC to AC and rise-up voltage and collecting boxes and cabling for each substation.

The capacity factor C.F. of Shagaya PV plant was calculated based on its actual produced power throughout its first year after commissioning as per the following equation:

:

$$Capacity\ Factor = \left(\frac{Annual\ Electrical\ Energy\ Output\ Wh\text{-}Yr}{365\ \ X\ 24\ hrs\ \ X\ \ Namepale\ Power}\right)\ X\ \ 100$$

2.2 climatic description and measurement

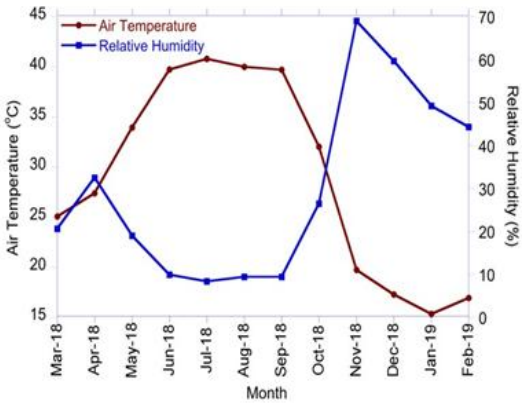
Each block has an output of 2200 KW connected to 132 KW final grid. some power pulled back at night to the main cabin usage. The (PC) and (TF) have a power of 315 WP and 49160 WP at series with actual officiating percentage 16023% for (PC) and 13% for (TF).

The total slabs of (PC) are 34577 operating in space of 79801 squared meter for with ground coverage ratio (GCR) 0.47% and total slabs of (TF) are 96694 square meters with a ground coverage ratio (GCR) 0.48%

Fig.3 Geographical situation of Shagaya Plant

Distributed PV technology into three blocks with a full capacity 5.531 MW (TF) and 5.613 MW (PC) each block of (TF) consist of 1.844 MW built of 8 slabs by 1440 series likewise the block of (PC) consists of 1.871 MW built of 20 slabs by 297 series

meter for with ground coverage ratio (GCR) 0.47% and total slabs of (TF) are 96694 square meters with a ground coverage ratio (GCR)



Ffig.4 Air temperature and humidity (monthly)

The dimension of the land is 87.5 square meters at 100 KM western state of Kuwait (figure 3). It is classified as infertile and semitropical area and distinguished as a hot and harsh zone. In summer, the temperature points to 40 Celsius degrees and a short winter season with a low temperature of 10 Celsius degrees. (Fig. 4)

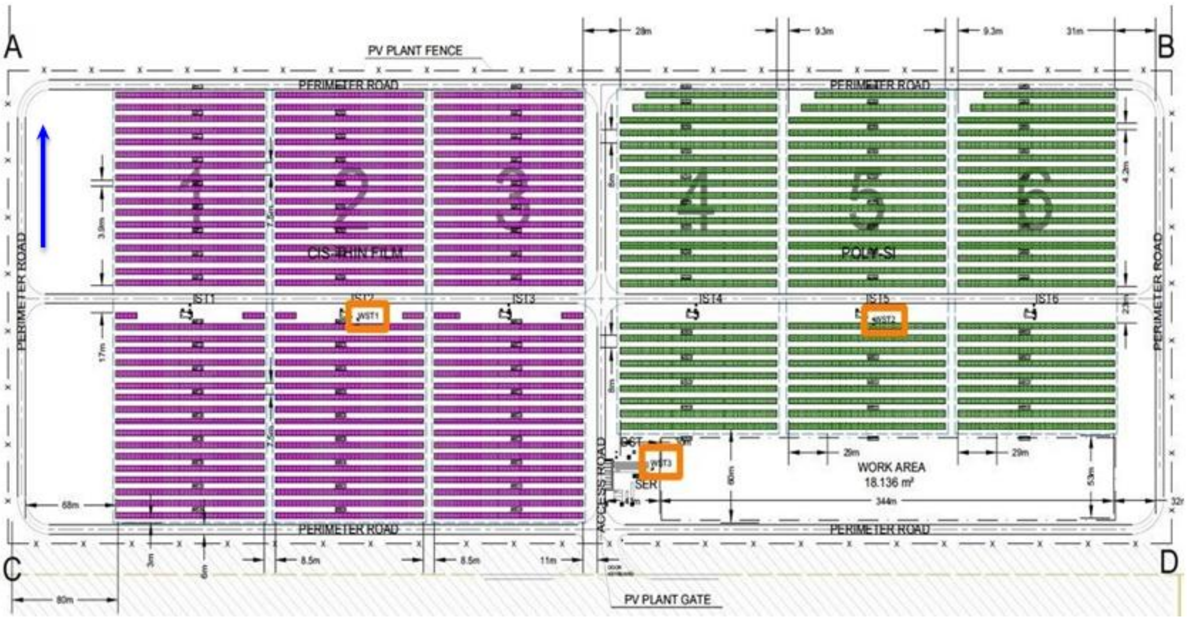


Fig.5

A three weather stations has been installed to measure horizontal irradiance, tilted irradiance, humidity, temperature, energy of PV slabs, input, and output power. The three weathers stations have been installed in selected places as in(fig.**5**). Each one close to the supervision cabin, a sensor fixed in each separate back panel that it gives ability to read the upper and lower panel temperature.

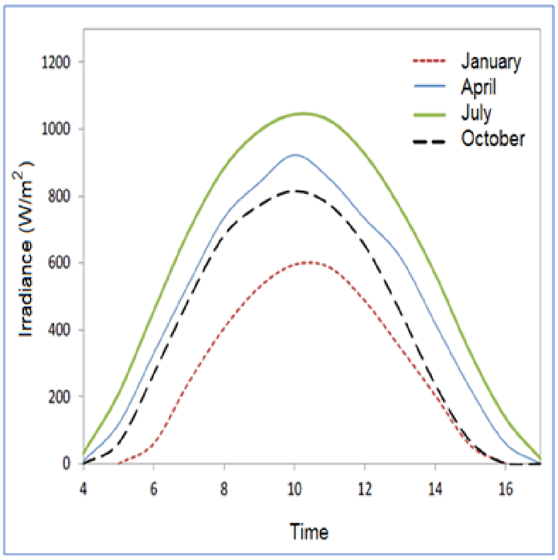


fig.6

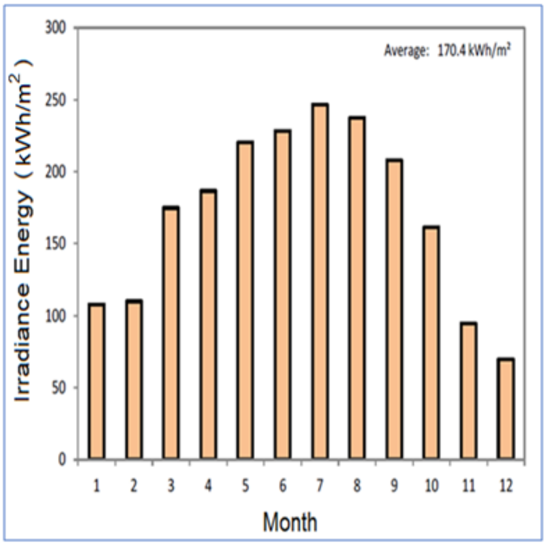


fig.7

2.3 solar irradiation:

The average irradiance in the state of Kuwait (600 – 1020 W/m squared) as shown in fig.6. however, the daily gross irradiance energy is 170 KWH/m squared as in fig.71941 (kwh/m squared – year) is the gross annual isolation analogous to the horizon and possibility to reach 2098 (kwh/ m squared- year) at an angle of 30 degrees with azimuth`s analogous orientation according to 4535 daylights 1941 (kwh/m squared – year) is the gross annual isolation analogous to the horizon and possibility to reach 2098 hours. Accordingly, to the weather difficulties like dust storms which decreases the total photovoltaic by sand and mud sediment. Al Shagaya current total production is 70 MW equals electrical voltage of 11 KV transferred to the local grid to rise into 132 KV by tie-in substation as well as the complex contribution to decrease carbon emission of amount 93.513 (metric tons/year) as per every KW/H produced by the combined cycle power generators which fueling with petroleum or gas causes of percentage equals to 0.5 (KG/KWH).

2.4 Ambient temperature effect

The weather temperature in Kuwait at summer can reach a peak point of 52 ºC

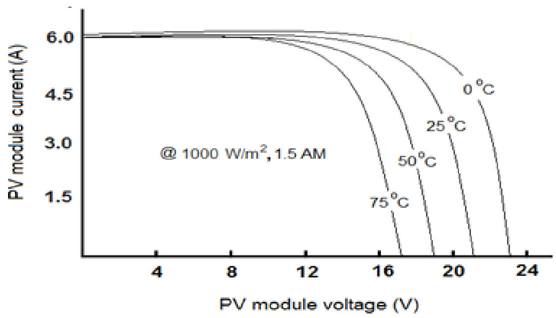


Fig.8

especially in July, but the average value throughout summer day time is 45º C, Hence according to Equation fig.8) , the rating voltage of the PV panels can declined by 1.5 V if we considering the PV temp coefficient as (0.08) Volt / ºC) , respectively we can use the PV typical characteristic thermal behaviour (Figure. 5) as a refernce line to our case.

2.5 Peak shaving & Net-load

As per the irradiant annual statistical histogram of northern Kuwait (as per equation below) which signifies an abundance amount of irradiance for the period from May until September at which the power demand of Kuwait ramps up to the peak during daytime due to the heavily usage of the air-conditioning systems across the country.

$$V_{oc\,(ambient)} = [\,Temp.\ Coefficient * (T_{STC} - T_{ambient})] + V_{oc,\ rated}$$

Hence, with reference to the annual power consumption data (Figure. 9) the PV plant production will assist in peak-shaving the grid's demand and ultimately it will stabilize the net-load.

Month	Max. Consumption
January	110784
February	117488
March	173600
April	182197
May	249504
June	269312
July	271842
August	269911
September	264300
October	219536
November	139713
December	122932

Fig.9

III. DISCUSSION AND RESULTS:

Today's event is the result of the tremendous efforts made by several Kuwaiti parties to achieve the aspirations of the political leadership to introduce renewable energy in the production of electric power, as the electricity produced from the sun and wind has become a tangible reality after the project of the Al-Shaqaya Renewable Energy Complex was linked to the national electricity grid and supplied the country with about 23 million kilowatt-hours in six months.

Thus, Kuwait follows the example of the developed countries in the world towards renewable energy applications to maintain a clean environment and to benefit from solar and wind energy to provide for the use of fossil fuels, reduce emissions and preserve the environment by promoting the use of renewable energy.

IV. CONCLUSION:

Lessons learned from developing, designing, constructing, commissioning and operating the multiple technology plants of Phase I of the Shagaya Renewable Energy Park provide excellent input to future phases of the Park and are applicable to other developments under similar conditions.

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