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Solar Panel in Kuwait

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Abstract:- Solar energy is one of the most important and prominent sources of renewable energy, which is the conversion of solar rays into electricity through photovoltaic solar cells. This is because it is clean energy and saves electricity. Each spot on the surface of the earth receives during one year a certain amount of light from the sun, which varies from one part to another. Usually one part of the earth receives less sunlight than another part, and these amounts of light are called photovoltaic radiation or solar radiation, Which is converted into solar energy by some modern technologies that capture it, in order to reuse and recycle it as different sources and forms of useful energy. In this article, we will talk about solar energy and its role in generating electricity.

I. INTRODUCTION

Sun is the owner of solar energy. solar panel that known also as PV panels are important to change sunlight that contain energy particles "photons", into electric which used in powering the electrical loads. solar panels application is very wide including, telecommunications equipment, cabins power system, remote sensing, and electricity generating for sure through commercial and residential systems that called solar electric one. On this research, we will show types, components, benefits and using of solar panels in electricity system in Kuwait (1).

Development of solar energy return to 100 years ago. In leading days, using of it was rarely for production of steam which used then to machinery drive. But it wasn't work before the discovery of photovoltaic effect by "Edmond Becquerel" this allowed converting sunlight to electric energy. This discovery then led to invention by Charles Fritts since 1893 of the first genuine of solar cell that was made by coating sheets of selenium with a thin golden layer. And from the point today, starting would arise the solar panel (2).

Today, complete systems of solar panel and solar panels are used to power on large range of different applications. However, they are used also to maintain the solar power into commercial buildings and entire homes, like Google's headquarters that located in California.

Solar cells technological developments tend to create more inventions that serve humanity, and this technology is what is known as solar cells, which is one of the modern achievements that contribute to relying on renewable energy by generating electrical energy from the sun, and solar cells can be defined as photovoltaic cells that absorb Photons (particles of light carrying electromagnetic energy Photons) that are emitted from the sun and converted into an electric current (3)

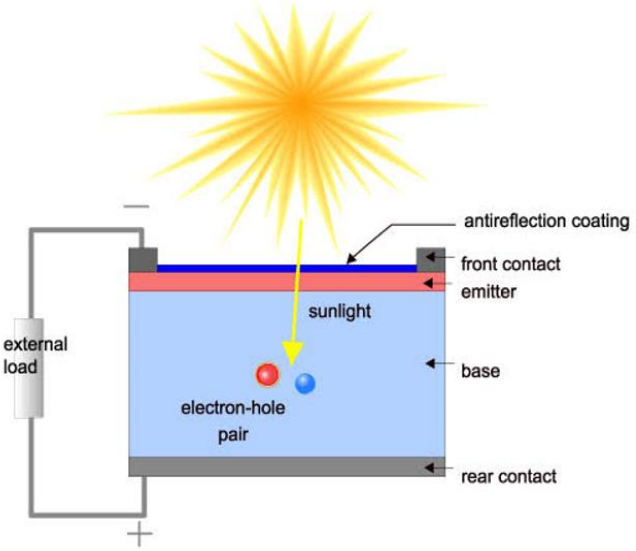

Fig1: show the generating of electrical energy from the sun

A. Solar Cell Components

The solar cell consists of the following components and in the following order:

- A layer of non-reflective glass. A layer of copper wire that conducts electricity and is called the cathode.
- A layer of negatively charged silicon crystals with phosphorous added.
- A layer of positively charged silicon crystals filled with holes, with the element boron added.
- A layer of copper wire that conducts electricity and is called the anode.
- The studies find that silicon is one of the most important elements that generate electrical energy (4).

II. THE PRINCIPLE OF SOLAR CELLS (MECHANISM OF ACTION)

When sunlight or photons of light enter the non-reflecting glass surface into the solar cell, the silicon atoms combined with the phosphorous atoms begin to generate movement in the electrons (5).

Through the phosphorous layer, electrical charges are generated depending on the strength of solar radiation. The electric charges liberated from the negative layer are transmitted to the holes of the lower layer that contain positively charged electrons, where the silicon united with boron absorbs these charges in order for the interaction to take place. This solar cell is connected to electrical devices, lamps, electrical machines, etc. The solar cell has become like a battery that contains solar energy (5).

A. Characteristics of solar cells

The amount of energy produced by the solar cells is measured by the current and voltage generated by the individual cells. Electric current is defined as the flow of electric charge through a specific area expressed in amperes, while voltage is defined as the potential difference between two points expressed in volts. Typical silicon cells produce an electrical current of 28 to 35 mA/cm², and a typical silicon solar cell produces between .5 to .6 volts with the output difference depending on the cell size. The voltage and current can be increased when the cells are grouped together (5).

B. Solar panels

Solar panels are also known as photovoltaic panels and the purpose is to convert sunlight (photons) into electrical energy that can be exploited in operating different electrical loads, and solar panels can be exploited in more than one form, for example, they can be widely used in wireless and wired communications equipment, and it is Can be used in homes and commercial establishments (6).

C. Types of solar panels

There are two types of solar panels:

➢ *Silicon plates:*

Among them are two types:

• Monocrystalline

These panels are made of pure silicon gem cut into few strips, because it is made of pure silicon, it is effectively recognized by its dull dark color, and the use of non-adulterated silicon makes the monocrystalline panels more space-saving. and the longest-lived of all types of solar panels, however this requires a small fraction of wasted silicon, and in some cases the sum of silicon wasted for a monocrystalline cell make can be more than 50% (6).

• Polycrystalline

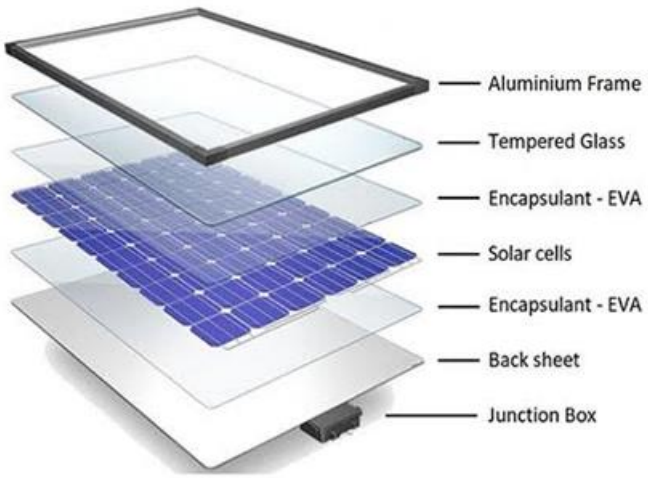

Fig2: show type of solar panel (Polycrystalline)

These are panels that come from different silicon crystals instead of a single crystal, where silicon fragments are melted and poured into a square mould, which makes polycrystalline cells low cost due to the lack of any amount of silicon used in their manufacture, unlike monocrystalline panels, and makes them It is also less efficient in terms of energy and space conversion, since the purity and structure of silicon is lower than that of monocrystalline panels, and its downside is that it can withstand lower temperatures than monocrystalline panels, making it less efficient in higher temperature environments (7).

Fig3: show solar panel (thin film panels)

➢ *Thin-Film panels*

They are thin sheets with exceptionally thin layers that make them adaptable, and not every panel requires a slab to support them, making them lighter and easier to apply. Not like crystalline silicon panels that come in standard sizes 60, 72 and 96 cells, Lean Can Film comes in multiple sizes to suit the many needs of distinct spaces, but it can be verified that it is less productive than silicon panels, as it is made of three different materials:

- Amorphous silicon (A-Si)
- Cadmium Telluride (CdTe)
- Copper Indium Gallium Selenide (CIGS)

➢ *Amorphous solar cells*

This type is characterized by low efficiency and lower price; This is as a result of the deposition of silicon on the face of the plastic or glass that is used in the manufacture of the cell, and the production of electrical energy in it ranges between 3 to 6%.

D. The best type of solar panels

The best types of solar panels are those monocrystalline panels. They have a higher efficiency than other types, as their efficiency ranges between 15: 20%, while the efficiency of polycrystalline panels ranges between 15: 17%. Thin-film panels come in the last place, where they do not exceed Its efficiency is only 12% (7).

E. Types of PV Systems

Photovoltaic energy systems are divided into two parts-:

- Solar photovoltaic systems that connect directly with low voltage distribution networks.
- Standalone solar PV systems, ie not connected to any low voltage distribution networks (8).
- Mostly, photovoltaic solar energy systems are installed on the roofs of buildings, and connected to the main electrical panel in the house. The electrical energy produced by

photovoltaic energy systems is consumed first in the house, and if there is an excess of it, it is exported to the distributed network (8).

- its components

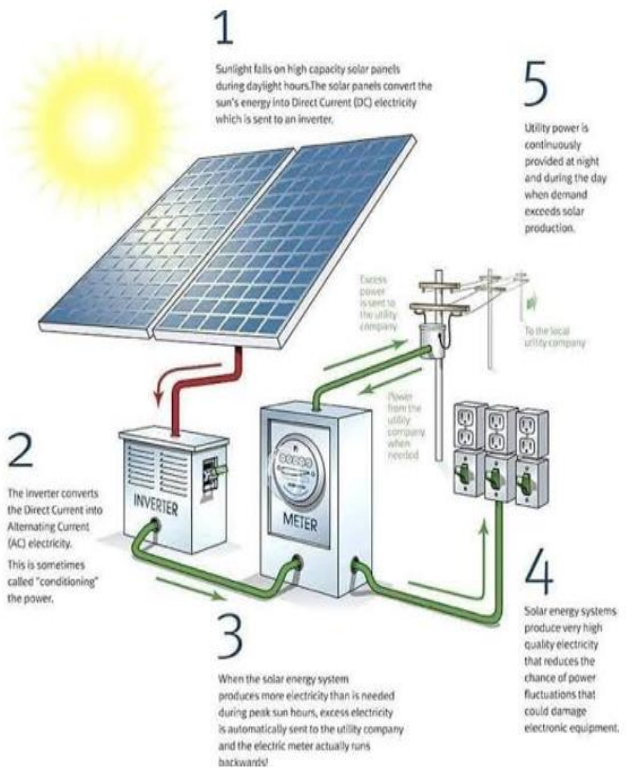

Fig 4: show PV Systems and how they work

The photovoltaic cell is the basic component of photovoltaic power systems, and each cell usually produces from 1 to 2 watts of energy, and the optimum exploitation of these cells is done by interconnecting the cells with cables and connectors to form units that produce more energy, so we say that photovoltaic power systems It consists of the following-:

- Solar cells that are interconnected through conductors and cables, thus forming chains.
- These chains are connected to transformers to convert the current generated from these chains into alternating current, thus facilitating the process of exploiting this current in the building.
- Electrical cables, control devices, switchgear groups, systems Monitoring, measuring and protection units
- Mechanical structures that support the panels as well as direct them towards sunlight (9)

F. Types of solar panels according to energy capacity

If we classify solar panels according to their energy capacity, they are arranged as follows:

- Monocrystalline solar panels have the highest power capacity, because they are made of a single material of silicon, this enables higher power output in a smaller package, and most monocrystalline panels can generate up to 300 Watts of power capacity.
- Polycrystalline solar panels, thanks to modern technology, it is possible to bridge the gaps between the crystals, so a polycrystalline panel consisting of 60 cells can produce between 240-300 watts, yet monocrystalline panels still outperform polycrystalline in terms of energy capacity per cell.
- Thin-Film panels, because they do not come in standard sizes, there is no standard measure of energy capacity, but they are known to be the lowest energy capacity types due to their size and components (9)

G. Types of solar panels by cost

When making a comparison in order to compare between solar panels in terms of costs, we will find the following:

- Monocrystalline solar panels are the most expensive, as a result of the manufacturing process in which more than 50% of the silicon used in manufacturing is wasted, making this type very expensive.
- Polycrystalline solar panels are the least expensive, because there is no waste during the manufacturing process, as the remaining crystal fragments are used from the production of monocrystalline panels, which contributes to reducing production costs significantly.
- Thin Film: The cost of purchasing the materials from which these panels are made is very high, but due to the nature of the materials and their light weight, it reduces the labor cost (10)

➢ *Double sided solar panels*

There are two-sided solar panels, and they mean the panels that have the ability to collect sunlight from the front side and the back side, and in this way energy is produced in larger quantities, and the two-sided panels are characterized by the presence of a back layer.Translucent enables sunlight to pass through the panel, and these are often manufactured . Solar panels are made of monocrystalline solar cells, but sometimes they are also made of polycrystalline panels (10)

➢ *Solar panels with more than 96 cells*

There are solar panels with more than 96 cells ,but it is not widely spread, as some manufacturers resort to producing solar panels by using half-cut cells, and this causes the number of solar cells to double within a single panel .Notably, the half-cut solar cells are monocrystalline or polycrystalline solar cells that have been cut in half by a laser cutter (10).

III. IMPACT OF THE ELECTRICAL NETWORK OF KUWAIT

The main source of electrical energy (and fresh water) consumed by Kuwait is chemical energy in fuels that consist of gas and liquid petroleum derivatives. The process of converting primary fuel energy into electrical energy requires large financial investments, and a huge boiler that collects a huge amount of fuel between these devices is a huge boiler. This chemical energy produces a large amount of compressed steam at very high temperatures, and this steam drives a generator that converts engine energy into electricity, and activates a steam turbine that changes thermal energy into kinetic energy. Represent. It issues energy to the electrical network for its transmission, distribution and delivery to subscribers (11).

Power suppliers mainly use the electrical energy required mainly, using the electrical energy required to meet the demand for electricity, usually the generation system. A total of about 28.7% of gas turbines are included. Emergency preparedness is greatly enhanced when maximum electrical load occurs due to the high locations of the gas turbine plant site and its low thermal efficiency (11).

Fossil fuels available in Kuwait from the local source are used to power plants, natural gas, heavy oil, crude oil and light oil, depending on the design of the plant's boiler. Gas within the limits of the available quantity. Older plants can burn gas as well as emergency diesel from newer plants (12).

The power plant has been developed in terms of quantity and quality during the past five years, to expand the scope of the power plant, after the introduction of the first steam power plant with a total capacity of 2.25 MW (3 units, unit capacity 0.75 MW) in 1952. Less. Until the 1980s when the Doha West plant was commissioned in 1983, in 1984 there was a capacity of 2,400 MW (8 units with a capacity of 300 MW), Az-Zour South and Subiya (12)

It is natural that building larger plants in terms of the number of units and their sizes was the only way to meet the increasing demand, which was rising at high rates in the 1950s, 1960s and even in the 1970s, but it began to subside during the 1980s. The horizontal expansion and vertical development in the means of generation resulted in the following results:

- The amount of thermal energy needed to generate the electric power unit decreased from 14012 thousand British thermal units in the old stations to 10,509.9.5 thousand British thermal units in the modern stations, which include the production of distilled water.
- Accordingly, the thermal efficiencies of the operating plants increased to about 42% in the modern plants, after taking into account the efficiency of the distillation units.
- The share of wages, administrative expenses and maintenance in the unit cost of the modern stations decreased.
- The established stations were geographically distributed better, which had benign effects on the electrical network and strategic advantages.

A. Solar panel efficiency in electricity of Kuwait:

Kuwait operates on electrical system about 230 Vas 50 Hz, and solar panels to attain emergency backup power. The panel is nonpolluting energy, clean unlike fuel powered generators. They help people to achieve independency in energy while helping to decrease footprints of environment. Inverters also are very important in Kuwait like power inverters, and solar inverter charger that are here to give power (13).

Buying a solar inverter charger 1500 watt is a large step toward energy independence achieving and in the event of an extended power outage it considered priceless. violent dust storms, scorching heat or harsh ocean climate can all be power outage contributors in Kuwait. So having power system backup with an AIMS power inverter as the backbone is personal priceless asset.

Reliable, friend to environment, little electricity are characters of power systems by AIMS power, as opposed to power generators of fossil-fuel that are polluting, noisy and require excessive maintenance.

The Kuwait market of solar energy is expected to register a CAGR about more than 7% during the period of forecasting of 2022 to 2027. The pandemic of COVID 19 affected the supply chain and led to economic turmoil leading to solar projects scraping like the 1.5 GW Al-dabdaba solar complex. The solar projects increasing number along with declining and investments solar PV costs are the major factors that drive Kuwait solar market during the period of forecast. However, the intermittent energy source, initial investment and requirement of large area of installation to set up large farms of set up and many other factors have been restraining the growth in the market of solar energy.

- The PV solar segment is likely to grow during the period of forecasting significantly, owing to upcoming projects and declining costs.
- Advances in technology in market of solar power including reduced overheads, increased efficiency, reduced solar PV films size, polymers use and an increase in solar power cells materials, are set to boost incentives for investment increasing in solar power. This scenario is likely to support opportunities of growth in the solar energy deployment in the coming future.
- Lack of policies and programs of government likely to restrain the market during the period of forecasting.
- PV solar segment to experience significant growth

Average solar intake of Kuwait is about 9-11 hrs. per day, with a daily average of solar insolation that can reach more than about 7.0 kWh/m2/day.

The cost of PV solar installation has dropped significantly in 2020 from USD 4,731 per kilowatt to USD 883 per kilowatt. Whereas the cost of installation of concentrated solar power decreased from USD 8,987 per kilowatt in 2010 to USD 4,725 in 2020. Occurring with less upkeep and less complicated technology, solar photovoltaics are a preferred energy choice over conc. Solar power.

In Feb. 2022, in Al Jahra, Kuwait, a 30 MW PV solar plant is planned named Subiya water storage solar PV plant. The plant is planned to be developed in construction of single phase likely to commence 2023 and expected in 2025 to be entered into commercial operation.

In December 2021, a company's group announced that they have a plan to build a solar power complex 5 GW, including PV solar power plants, in the north of Kuwait that will involve investment of about 3.5 billion USD. Developers want state approval for park building as a private project for investment, and then sell the electricity that is produced to the ministry of electricity, renewable energy and water.

Thus, taking in consideration the above points, the PV solar segment is expected to witness significant growth during period of forecast.

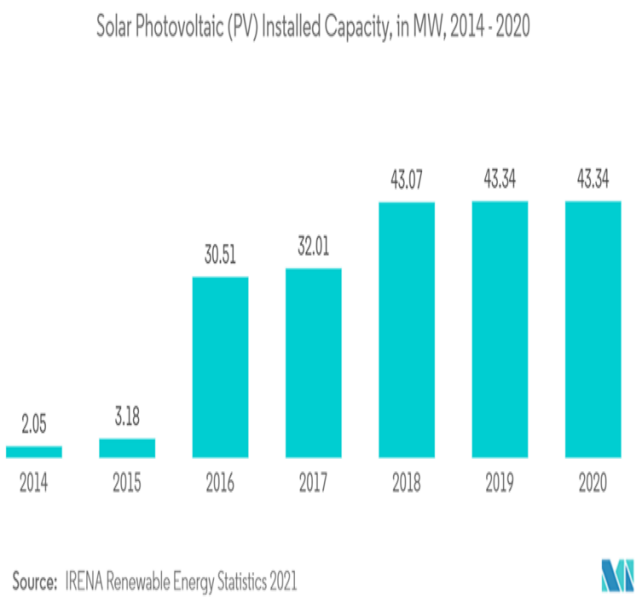

Fig5: show solar photovoltaiv installed capacity, in MW, 2014-2020

➢ *Competitive Landscape*

The solar energy market of Kuwait is consolidated partially. In the market some of the key players include JinkoSolar Holding Co. Ltd, Solarity Solar Energy, Kuwait National Petroleum Company, TSK Electronica y Electricidal SA and alternative projects of energy co. recent developments.

In Novem. 2021, Oil ministry in Kuwait announced at (ADIPEC) that the country is planning to develop renewable projects 2 GW, including wind and solar, through a joint venture between private sector and government (14).

B. Shakaya project for wind energy in Kuwait:

Kuwait institution for scientific researches has improved an important project that called "shakaya" project for wind energy, the first plan of project aimed to generate about 3.2 giga watt in shakaya compound of renewable energy. The first step of project put the basics for energy in the future of Kuwait by installing large station of solar energy that has been started since September 2018. And farm of wind with about 10 mega watt that has been started since may 2017 (14).

C. How to install solar panels

The best place should be chosen on the roof, away from the shade of residential buildings or trees near the house or the facility for which the solar cells are to be installed.

➢ *Choosing the direction and angle of the solar panel:*

In most regions of the Arab world, which lie mainly north of the equator, it is preferable to direct the solar cells towards the sun in the south (15).

➢ *Choosing the angle of inclination of the solar panel:*

This depends a lot on the latitude in which we are located, as well as on the season of the year. The angle of inclination can be calculated according to the season of the year as follows:

- Spring and Autumn: The angle of inclination of the solar panel is equal to the degree of latitude of the site .
- Summer: the angle of inclination is 15 degrees less than the degree of latitude.
- In winter: the angle of inclination is greater than the angle of latitude by 15 degrees.

➢ *Installing panels in parallel or in series:*

Installing them in parallel leads to maintaining the voltage but increases the intensity of the current, while installing them in series increases the value of the voltage and leads to maintaining the stability of the current (16).

IV. LIMITATIONS

A. Electricity network impact

Within the increasing in levels of photovoltaic rooftop systems, flowing of energy is 2-way. When the consumed is less than the generation, electricity then travelled to the grid. However, the network of electric isn't formed to transfer the 2-way energy. Therefore, occurring of some issues technically may happen. As what happened in Australia specially Queensland, 30% or more of households used rooftop PV in the end of the year of 2017.

In 2020, the duck curve of California which is famous appeared many times for many communities from 2015. A problem of over-voltage may result as the flow of electric from households (PV) back again to the network. There are many solutions to handle this problem, like power factor PV regulation invertor, new -voltage and handle equipment of energy at the level of distribution of electricity, electricity wires re-conduction, require management, etc. Often costs and limitations related to these solutions are present. There is other limitation in management of electricity bill and energy investment (17).

V. CONCLUSION

Solar panel that known also as PV panels are important to change sunlight that contain energy particles "photons", into electric which used in powering the electrical loads. Development of solar energy return to 100 years ago. In leading days, using of it was rarely for production of steam which used then to machinery drive. Solar energy is represented in the radiant sunlight and its high heat, which is now exploited using a group of advanced technologies for the purposes of solar and photovoltaic heating, thermal energy applications and solar engineering, as well as in molten saline power plants and in artificial photosynthesis processes. The sun is an important source of renewable energy and its technologies are distinguished by their It is broadly defined as either passive or active energy depending on how that energy is used, distributed, or converted into other energy. Kuwait operates on electrical system about 230 Vas 50 Hz, and solar panels to attain emergency backup power. The

panel is nonpolluting energy, clean unlike fuel powered generators. They help people to achieve independency in energy while helping to decrease footprints of environment. Inverters also are very important in Kuwait like power inverters, and solar inverter charger that are here to give power. Kuwait institution for scientific researches has improved an important project that called “shakaya” project for wind energy. There are about 2 limitations for solar energy, they are in electricity network and management of electricity bill and energy investment.

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