Modeling and simulation of a photovoltaic module

WAEL Z. ELSAYAD

Assistant Professor
Division of Construction Engineering,
Umm Al-Qura University, College of Engineering at Al-Qunfudah, P.O. BOX 288, Al-Qunfudah 21912, Saudi Arabia

***Abstract*: The material in this article is based on a detailed analysis of the characteristics and parameters that must be taken into account for modeling the photovoltaic module. The effects of various environmental conditions were also taken into account. In connection with the expansion of the field of application of solar PV modules, in some cases there is a need to accurately determine their parameters and characteristics. The analysis and information on the use of "green energy" in different parts of the world.**

***Index Terms*: Modeling, modeling of the photovoltaic module, network inverters, photovoltaic systems, "green energy"**

I. INTRODUCTION

All manuscripts must be in English. These guidelines include complete descriptions of the fonts, spacing, and related The development of society and the standard of living of the population of any country are associated with the provision of energy. Energy is a basic industry, the state of which determines the volume of industrial and agricultural production, providing the country's population with products, maintaining a high standard of living, transport and communications.

Currently, most of the produced electric and thermal energy is generated at fossil fuels operating on fossil fuels. The production of electricity is accompanied not only by chemical pollution of the environment and the depletion of limited natural resources, but also leads to laquo-thermal pollution raquo- Earth.

It is believed that in order to avoid irreversible climate changes, the total energy production on Earth should not exceed 1% of the total energy coming to the Earth from the Sun (about 1. 5-1024 J per year) [1,2]. The use of nuclear power plants is associated with the problem of processing radioactive waste and the danger of radiation contamination. All this leads to the need to revise the prospects for the development of energy in the new millennium.

Recent studies have shown that the use of renewable energy sources is promising for solving the problems that have arisen. These include natural cycles and processes: solar radiation, wind, wave and river energy, geothermal energy. All of them have the advantage that they are practically inexhaustible, do not pollute the environment and do not require the cost of their production.

At the heart of almost all types of renewable energy sources is the energy of solar radiation. The contribution of the Sun to the energy balance of the Earth is several thousand times greater than the contribution of all other sources. Thanks to it, all energy-accumulating processes on Earth occur, but even so, no more than 1% of the energy that comes to Earth is accumulated. The rest of 99% is converted into heat or radiated back into space [7,10].

II. HISTORICAL VIEW

It took Austria more than 30 years to become a leader in the share of electricity production from renewable sources among EU countries, bringing it to 65.5%. At the same time, the cost of green energy in Australia has become cheaper than in traditional energy. This information was voiced by the Director of the Australian Agency Ivor Frishknecht. According to him, alternative energy simply displaces traditional from the market.

Historically, when investing in projects in the field of renewable energy, companies chose wind energy instead of solar energy. Apple's investment has been a positive step for First Solar and the solar industry, which has affected other companies, forcing them to choose solar sources. This choice was also facilitated by the fall in prices for photovoltaic cells [11].

Google now uses wind and solar power, while Microsoft has signed a 25-year contract to purchase electricity from a 20 MW solar energy project in Virginia. In 2016, Amazon invested in solar panel projects. These companies are part of the S&P 500.

Solar panels use thermal energy from the sun to convert solar cells into sunlight. Consider the history of solar cells:

1839 - French physicist Edmond Becquerel discovered the photovoltaic effect.

1883 - an electrician from New York, Charles Fritts made solar cells from selenium, which convert light in the visible spectrum into electricity and have an efficiency of 1-2%. (photosensitive elements for cameras are still made from selenium).

1950 - the Czochralski method was invented, which is used to grow crystalline silicon.

1954 - a silicone photovoltaic cell with an efficiency of 4% was synthesized in the Bell Telephone laboratory; in the future, the efficiency reached 11%.

1958 - Solar cells became the main power source for satellites in low Earth orbit. For example, small (less than 1 watt) photovoltaic batteries powered the avant-garde American space satellite radio transmitter.

1973 - launched the program for the use of solar cells, there was an installation of 3100 photovoltaic systems only in the United States. Many of them are still in operation.

1980 - installation of photocells in devices: from watches to calculators to musical equipment [6].

1990 is a year of progress. Photovoltaic plants pump water, provide night illumination, charge batteries, supply electricity to the general power system, etc. They work in any weather. With variable cloud cover - 80% of its potential productivity; in foggy weather - about 50%, and with continuous cloudiness - up to 30% of energy.

III. Comparison between the advantages and disadvantages of solar cells

The benefits of solar cells

1. long period of operation - about 25 years;
2. ease of installation;
3. environmentally friendly installations;
4. high payback ratio;
5. modular layout.

The disadvantages of solar cells:

1. occupy a fairly large area for installation
2. does not generate energy at night and in the evening;
3. photocells contain toxic substances, such as lead, cadmium, gallium, arsenic, etc.
4. solar panels become very hot [8].

IV. The efforts of countries towards solar energy

Thus, the market for solar cells already occupies a significant niche in the global economy. And it continues to grow stably, especially in those market segments where solar cells are competitive, for example, in stand-alone systems, in the construction of solar power plants.

According to EPIA, the volume of installations in 2015 reached a record level of 16.6 GW, and the total fund of all types of batteries installed in the world is about 39.5 GW. According to Solarbuzz, the installation market in 2016 was 18.2 GW.

The current state of the market for solar cells is characterized by rapid growth, the average annual growth rate (CAGR) of new battery installations in the world over the past 10 years amounted to 50.4%, and this is against the background of a protracted crisis. The increase in the consumption of solar panels occurs with a parallel decrease in prices for solar modules.

According to Solarbuzz, the average retail cost of solar modules has declined from $ 5.5 / watt at the end of 2010 to $ 3.1 / watt by June 2017. The minimum cost of single-crystal modules is 1.8 $ / W; polycrystalline –1.74 $ / W; thin-film modules - $ 1.37 / W. However, the kilowatt-hour of electricity generated by the photovoltaic system is still 3-10 times more expensive than traditional electricity (depending on the specific location and type of system).

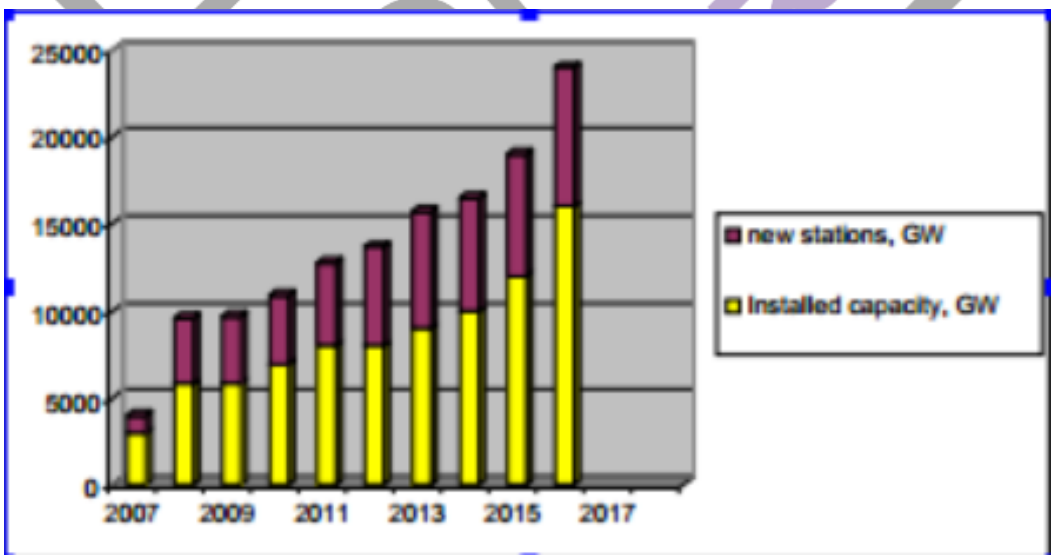

Diagram 1 - Fund and new stations in the world in the period 2006-2017.

In many regions of the world, progress is very tangible, and state programs will contribute to the additional development of the photovoltaic market. So, in Germany, the goal is to reach the level of 51.8 GW of installed capacity by 2020, in Spain - 8.4 GW, in China - 5.0 GW by 2018, in India –22.0 GW by 2022. The impetus for this is the need for energy independence and environmental considerations.

These programs, combined with environmental concerns - such as climate change - can significantly accelerate industry development.

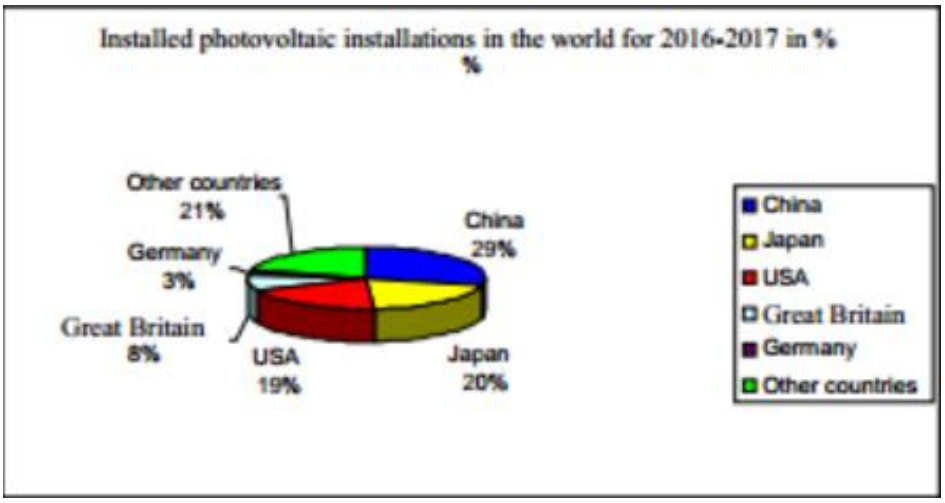

Diagram 2 - Installed photovoltaic installations in the world in the period 2016-2017.

In March 2018, a 13.7 MW station will open in Japan. 180 thousand square meters annually meters of solar modules will generate 16,170 MW * h - this energy will be enough to equip 5,000 houses. A large area for floating solar panels is also being built in Singapore [7].

Consulting firm Grand View Research suggests that floating solar farms will become widespread in the next 8 years, they predict the growth of the market for floating solar panels will grow from $ 19.8 million in 2018 to $ 5.7 billion in 2025. In the next 3 years, annual revenue growth will amount to 50%. The most active market will grow in Japan, the UK, China and Brazil.

And the forecasts can be justified, since China plans to build not only facilities for collecting solar energy on water, but also nuclear power plants in the South China Sea in the next 5 years. For China, the development of alternative energy is a necessary measure. Almost 50% of the global carbon dioxide emissions from thermal power plants are in China. The country's authorities have already closed 97 coal-fired power plants.

In 2012, in the village of Sogra, Ust-Kamenogorsk, construction began on a plant for the production of photovoltaic modules for solar panels. Kazakhstan is the fifth country in the world after the USA, Japan, Canada and China, where production will be created from the extraction of silicon to the production of solar panels.

V. Classifications of photovoltaic cells

Photovoltaic systems are used to convert sunlight to electricity, which are safe, reliable and cost-effective to install. Currently, there are serious problems faced by the rapidly growing market for photovoltaic systems.

Based on connectivity, the market for solar PV modules is segmented into and out of the grid. On-grid accounted for more than 55% of the market share of solar PV modules in 2016. Current electrification programs, along with favorable government initiatives related to the connection to the power grid, will stimulate business [8].

Based on the installation, the market for solar PV modules is segmented into a ground, top roof and so on. Based on the application, the market for the solar PV module is segmented into commercial, residential, utility and industrial, and so on. Based on geography, the market for solar PV modules is segmented in North America, Europe, Asia Pacific, Latin America and the Middle East and Africa.

VI. Leading companies in the field of solar photovoltaic industry

The market share of the solar PV system in the United States in the coming years will increase by more than 6%. Growing investments in energy optimization, coupled with stringent regulations for GHG emissions, will contribute to industry growth. Ongoing deployment of the microgrid with growing focus on adopting sustainable energy will drive business growth.

The Chinese solar photovoltaic module industry accounted for more than 60% of the share of the Asia-Pacific region in 2016. Increased investment in renewable integration along with an ongoing electrification program will complement business growth. Key players in the solar PV industry are Jinko Solar, First Solar, Canadian Solar, Sharp, Suntech Power Holdings, Trina Solar, Yingli Solar, JA Solar Co. Ltd., Hanwha Q-Cell, SFCE, ReneSola, SunPower, Vikram Solar, Lanco, Su Kam, GCL, Moser Baer, Shine Solar, Motech Solar, Kaneka Corporation, Kyocera Corporation, Mitsubishi Electric Corporation, Sharp Corporation, Panasonic Corporation and Hareon.

VII. Conclusions

A further increase in the use of photovoltaic stations contributes to the overall development of industry.

It can be concluded that solar energy can become a commonplace from fiction, as, indeed, all other renewable energy sources. By 2020, it is only planned to launch 1,600 new green energy facilities with a total capacity of about 26,100 megawatts.

The Association of Solar Energy Enterprises also said that a rise in prices for solar energy is expected if fines are introduced. This will lead to a decrease in demand. Many companies are also concerned about rising prices if imports are banned, as this may affect current and future projects.

REFERENCES

[1] A. Marti, A. Luque, "Next generation photovoltaics", — B&Ph.: Institute of physics publishing, 2014. — p 344.
[2] S. A. Ayvazyan, M. Yu. Afanasyev, "Modeling production potential based on the concept of stochastic frontier": Methodology, results of empirical analysis. Assessment of intelligence. Moscow: Krasand 2015.-p 352.
[3] A. A. Akayev, "From the era of great divergence to the era of great convergence": Mathematical modeling and long-term forecasting. technological and economical development – Moscow, Lenand, 2015 .-p 352.
[4] V. M.Andreev, V. A. Griliches, V. D. Rumyantsev, "Photoelectric conversion of concentrated solar radiation" - L .: Nauka, 1989. p 310 - ISBN 5-02-024384-1
[5] A. V. Kozlov, A. V. Yurchenko, D. A. Pestunov, "The influence of atmospheric parameters on the energy characteristics of a silicon solar battery", Optics of the atmosphere and ocean. 2015.Vol. 18. No. 8. pp. 731-734.
[6] A. V. Kozlov, "Control of the influence of atmospheric parameters on the energy characteristics of a silicon solar battery", Tomsk, 2017 – p. 110.
[7] N. A. Nefyodov, "Assessment of geoecological risks: safety modeling of tourist and recreational areas",– Moscow/ Finance and Statistics, 2009. p. 336.
[8] B. Needles et al., "Assessment of geoecological risks: modeling the safety of tourist and recreational areas", - Moscow/ Finance and Statistics, 2009. p 336.
[9] A. V. Ohorzina, M. V. Kitaeva, A. V. Yurchenko, A. V. Skorokhodov, "Sun tracking systems using FED", Polzunovsky Bulletin. 2015. No. 2-1. pp. 213-217 .
[10] B. Ya. Sovetov, S. A. Yakovlev, "Modeling systems: Textbook for academic undergraduate", Lyubertsy: Yurayt, 2016 .p 343.
[11] A. V. Yurchenko, A. V. Kozlov, "Mobile station for monitoring the operation of solar panels in natural conditions", Sensor and systems, 2016.-№9.-pp. 64-67. 6.