Scientific quarterly journal ISNN 1429-7264

Agricultural Engineering

2014: 4(152):165-173

Homepage: http://ir.ptir.org

DOI: http://dx.medra.org/10.14654/ir.2014.152.091

PROSPECTS OF SOLAR ENERGY USE IN UKRAINE

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ARTICLE INFO

Article history:
Received: February 2014
Received in the revised form:
April 2014
Accepted: May 2014

Keywords:
policy of solar energy sources
energy safety

ABSTRACT

The object of the research is to analyze the politics and economics of the solar energy sources in Ukraine. Application of alternative energy sources in Ukraine, especially solar energy, is extremely promising. The adopted strategy of power by 2020 assumes that Ukraine should play an important role. The methods of analysis, comparison and synthesis were used to assess the level of theoretical studies. The analysis of solar energy enabled to get the result of historical research and forecasting functional areas for possible development paths. The advantages and disadvantages of solar energy were posted. Fundamental directions and applied research in Ukraine related to the development of solar energy. The dynamics of the solar industry in Ukraine was posted. Practically in almost all regions of Ukraine, the investment projects aimed at creating plants that run on solar energy are implemented actively. At various stages of implementation in Ukraine there are more than 100 solar power projects with the total capacity of over 1380 MW in all regions of the country.

Introduction

The main driving mechanism of mankind's scientific and technological progress is energy. At present we get 90% of the energy through the consumption of fossil fuels (oil, coal, gas), the world's reserves of which deplete in this century. It should be noted that the current traditional sources of fuel are actually irreplaceable and extraction and processing of raw materials includes human pressure on the environment. Therefore, the world began to increasingly give preference to renewable energy, especially solar energy. Industry which associated with the use of solar radiation began to develop in the late 20th century and in 2012 the world energy market produced this type of energy industry accounted for almost 2% (fig. 1).

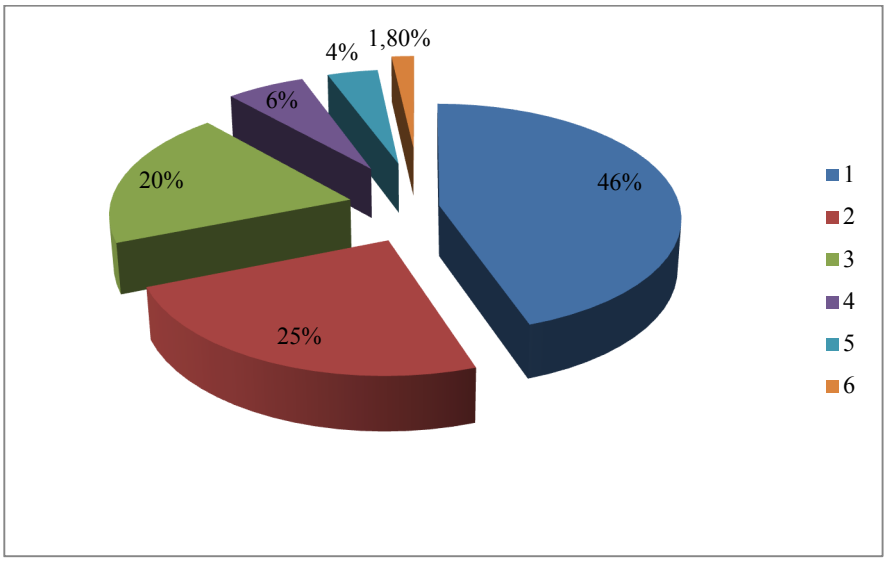


Figure 1. Distribution of solar energy among traditional sources of energy: 1 – oil; 2 – coal; 3 – natural gas; 4 – nuclear energy; 5 – hydropower; 6 – solar energy (by IEA – World Energy Outlook, 2014)

By different estimates the processing of solar energy in the world is growing rapidly. For comparison, the growth rate of solar cells' production annually accounted for more than 30% in the period of 1994-2005. Since the 2000s the average annual dynamics of growth was 37%. In 2006-2009, the figure rose more than threefold.

The object and subject of the research. The article considers the prospects of the development of solar energy sources in Ukraine.

The research methods are analyzing the development of solar energy, including potential sources of solar energy and synthesis of the results of studies in historical and functional areas.

The objective consists in the evaluation of the advantages and disadvantages of solar energy and the prospects for its use in Ukraine.

The main part

The largest percentage of the world market of solar energy falls on the European market. According to the European photovoltaic industry association, now in Europe more than 3 million buildings are provided with electricity entirely or partially by solar modules (Hybylysko, 2010). In 2010, the total installed solar capacity in Europe grew to 16 GW, but only in the world – nearly 40 GW (fig. 2). Is expected that in 2020 it will reach 430 GW.

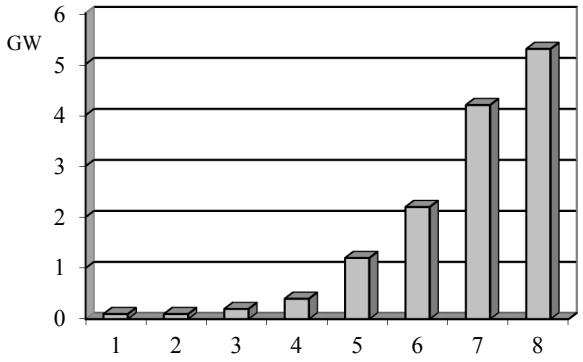
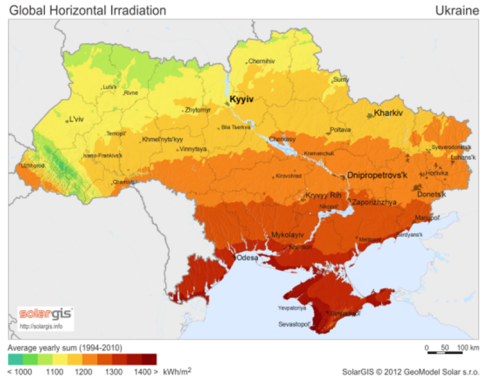


Figure 2. Distribution of the total capacity of solar power in the world: 1 – France; 2 – India; 3 – China 4 – Korea; 5 – USA; 6 – Japan; 7 – Spain; 8 – Germany (by Hybylysko)

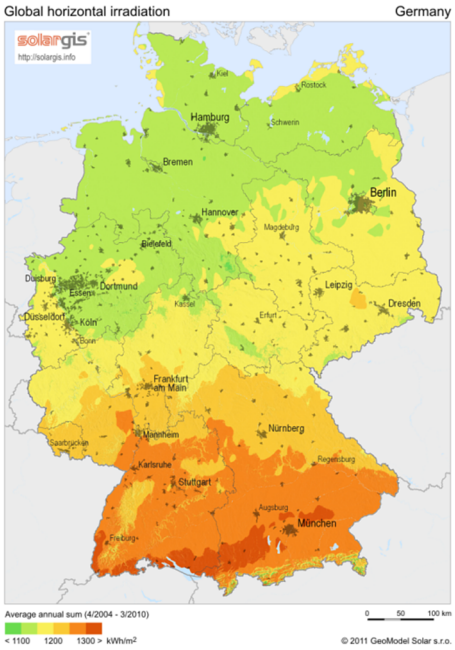
Germany (8,000 MW) and Italy (1500 MW) are the leaders in the consumption of solar energy among the European countries (Scheer, 2002). Leaders in the manufacture of solar modules are Chinese and Taiwanese manufacturers.

The most promising regions of the country for the development of solar energy is the Crimean peninsula and Steppe Ukraine. Today in Ukraine the largest helioelectrostation is in Ohotnikov (Saki District ARC). In the end of 2012 its capacity has reached 80 MW. Dimensions of the helioelectrostation are equivalent to 207 football fields. After the completion the facility is equipped with 360 thousand terrestrial modules. Solar park in Ohotnikov district is the fourth power of PV-installation in the world and third in Europe. Much research is devoted to effectiveness and efficiency of solar energy in Ukraine (Wozniak, 2010; Lyashkov, 2004). Significant results were obtained at the Institute of Semiconductor Physics and Institute of Electrodynamics of NAS of Ukraine, Shevchenko Kyiv National University, Yuriy Fedkovych Chernivtsi National University, National Technical University "KPI", Lviv Polytechnic National University, some industrial enterprises ("Pillar", "Quasar") and other Ukrainian laboratories. The scientific research showed that the cost of solar cells has decreased to 0.5-1.1 euro per watt of power. Thus over the past quarter century it decreased 20 times (as compared to the first sample of 1950-1000!) In principle, it is not so far from the characteristics of the gas and gasoline engines: 0.1-0.15 euros per watt.

The using in Ukraine of alternative energy sources, primarily solar energy is very promising. The average potential of solar energy in Ukraine (1235 $kWh \cdot m^{-2}$) (fig. 3a) is quite high and much higher than in Germany for example W – 1000 $kWh \cdot m^{-2}$ (fig. 3b) or even in Poland – 1080 $kWh \cdot m^{-2}$ (fig. 3c).



a)



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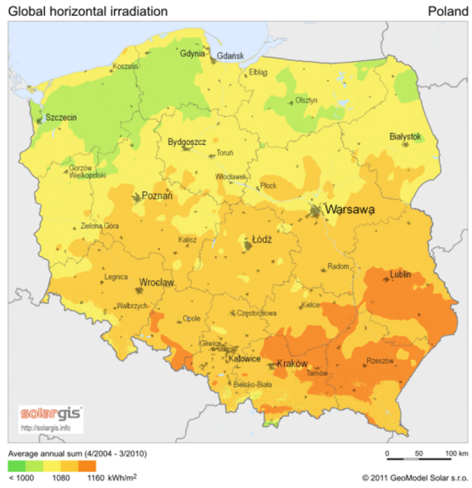

c)

Figure 3. Annual average potential of solar energy in Ukraine (a) Germany – (b), in Poland (c) (by Stryczewska)

Therefore, we have good opportunities for effective use of thermal power equipment in Ukraine. The term "effective using" means that a helioplant can work with efficiency of 50% or more, which is 9 months in the southern regions of Ukraine (from March to November), and 7 months – in the northern region (from April to October). Winter performance decreases, but does not disappear.

Consequently in our climate conditions the solar systems work all year round only with variable efficiency. Therefore it is necessary to consider the total annual potential of solar energy in Ukraine.

Regarding the use of solar radiation to produce energy, it is technically permissible potential of solar energy roof housing Ukraine today is 26-37 TWh·year^{-1}, which is in cash (at the present value of 1 kWh = 0.05 euros): 1.3-1.8 billion per year. The using and development of alternative energy sources leads to a unique new technology. An example is the use of solar energy in the domestic aviation. Ukraine has its own aircraft engineering industry (State Aircraft Manufacturing Concern "Antonov" and State Concern "Aviation of Ukraine") and inherited third space potential of the former USSR ("National Space Agency of Ukraine"), which in turn is the basis to enter into the life of the pilot project (Pohrebennyk, 2013).

Advantages of Solar Energy: Solar energy is inexhaustible and accessible; it is safe for the environment.

Disadvantages: Depending on the weather conditions; depending on the day and night; it should be able to accumulate energy; quite expensive is the construction of power plants of this type; it should periodically clean the surface of cells from dirt and dust; atmosphere over power pretty hot.

In the developed countries the strong investments are made in new research and development, the main purpose of these are to reduce the cost of solar energy and new consumption markets is going to form. It suffices to recall the program "Million Solar Roofs" in the United States, "100,000 solar roofs" in Germany and Italy, and others. The governments of the USA, Japan and Western Europe encourage the consumption of solar energy of the population, primarily because this energy is environmentally friendly and saves limited resources of fossil fuels. To do so interest-free long-term loans allot to people for the purchase of solar panels, free servicing carried these (Oksanich, 2010; Oszczak, 2012).

The areas of the research in Ukraine

Fundamental research

Through theoretical limitations in converting into useful energy range (about 30%) very large plots of land must take for solar power plants based on solar cells first and second generations. Thus, for plant of capacity 1 GW the plot area of several dozen square kilometers may need (while in the hydropower, at these same facilities, it is necessary to withdraw the use of even much larger land). Construction of the helioelectrostations the same capacity can cause climate change around the station. Thus, usually the solar power built by capacity of 1-2 MW, which is located not too far from direct consumers. Also the individual or mobile installations are constructed. Panels on the large power plants are installed at a height of 1.8-2.5 meters above the ground, so you can use the land under the power plant for agriculture production for example, for grazing. This problem is solved if applicable Balloon solar station. They can be located both on land and at sea and in the air.

The flow of solar energy that falls on the set at the optimum angle photocell depends on the latitude, season and climate and can vary twofold in the populated parts of the land. An atmospheric phenomenon (clouds, mist, dust, etc.) not only change the range and intensity

of incident solar radiation the Earth's surface but also changes the ratio between direct and diffuse radiation, which greatly affects to the certain types of solar power plants, such as hubs or on elements of a wide range of conversion.

Applied research

Photoelectrical cells work during day and with low returns in the morning and evening hours. In this case, the peak electricity consumption is in the evening. In addition, the electricity that they produce can vary dramatically and unpredictably change according to the weather. To reduce this dependence the rechargeable batteries (but in this case they are quite expensive) are used on helioelectrostations. It is possible to convert energy into another form, for example, sometimes pumped storage station was build, which can take up quite a large area and it is possible to implement the projects which are based on the concept of hydrogen energy or now it is currently still not cost effective. The problem is resolved by creation of uniform grids that redistribute generated and power consumption. The problem of the specific power solar power dependence on time of a day and the weather conditions is also solved by means of balloon solar plants.

After 30 years the use performance elements gradually decreases. Sometimes the solar cells contain Cadmium. The problem of their disposal appears.

June 3, 2011 the American magazine "Research and development" has published an annual list of the winners of the prestigious competition "100 R & D world," including the development of the Taiwan Textile Research Institute (TTDI) "Fully flexible fabric supercapacitor" in the "Electrical Appliances". This super-capacitor was invented and designed by TTDI team of scientists from the National University "Lviv Polytechnic" (Il'chuk, 2011). The newspaper "Chicago Tribune» (The Chicago Tribune) calls this the "Oscar among inventions."

Environmental problems

The level of polution in the solar cells manufacture does not exceed the permitted level for companies' microelectronic industry. PV cells are 30-50 years old. The use of cadmium compounds in the manufacture of certain types of solar cells raises the question of their disposal. Although these items are not very common, in addition to compounds of cadmium on modern production of solar panels they have already found a replacement. Now more and more common thin-film solar cells are containing only about 1% of the total weight of silicon. Due to the low cost of materials, thin-film silicon solar cells are much cheaper, but they are less effective, and most lose their properties. Now more and more active production is developing in other semiconductor materials, particularly in the CIS and CIGS. They can be serious competitors to silicon. So in 2005 the company «Shell» decided to concentrate on producing only the thin film elements and get rid of its business of producing monocrystalline silicon photovoltaic cells.

Prospects for solar energy

According to the estimates of the International Energy Agency (IEA) energy which will be produced by solar energy by 2050 could provide 20-25% of the energy demand of man-

kind that is after 40 years solar energy can produce about 9 000 terawatt hours. This will reduce carbon dioxide emissions by 6 billion tons annually.

In 2001 the price of energy, which is obtained by means of solar collectors was $ 0.09 - $ 0.12 per kW·hour^{-1}. The USA Department of Energy predicts that to 2015-2020 years the price of energy generated by solar concentrators will drop to $ 0.04-0.05. In Ukraine the "green" tariff for electricity which was generated by private households is relatively high. The households that install installation prior to 1 January 2015 will be eligible to sell electricity at a price of 4.67 €·kWh^{-1} VAT) or about 36.2 cents·kWh^{-1}. This compared with Germany, where the "green" tariff is 19.5 cents·kWh^{-1}, looks very attractive. In early 2010, the total global capacity of solar thermal energy (solar concentrator plants) reached one gigawatts.

Production facilities only such giants microelectronics, industrial associations as "Quasar", "IRVA" (Kyiv), "graviton" (Chernivtsi), "Hartron" (Kharkiv), "Gamma" and "Elektroavtomatika" (Zaporozhye), "Dnepr" (Kherson), "Positron" (Ivano-Frankivsk) allow full technological cycle of solar cells. Ukraine has highly qualified scientific potential in this area.

More than 100 solar power projects are in all regions of Ukraine which have the total capacity of over 1380 MW at various stages of implementation. In Ukraine the solar stations are also building in addition to local companies the enterprises from Portugal, Germany, France, Austria, Czech Republic and Israel.

Other applications of solar energy are: telecommunications systems and services (repeaters, telemetry); providing power for navigation lights, buoys, traffic signs, road lighting at night; corrosion protection of metal structures and pipelines; remote and not electrified dwellings to power household appliances; in burglar alarm systems; agriculture and arid areas for mining and water supply; creating a network of automatic stations equipped with various sensors for environmental monitoring and so on. Finally, the solar cells play a crucial role in the spacecraft and artificial satellites as power systems on-board equipment (Afonin et al., 2014).

Thus, the use of the alternative energy sources in Ukraine primarily solar energy will benefit undoubtedly. On the other hand, the economy of Ukraine has sufficient capacity for the production of the necessary components and creation of infrastructure of such power. According to the Ministry of Energy and Coal Industry of Ukraine 2013 the alternative energy produced 1,247 billion kilowatt-hours of electricity which is doubled (or over 608,4 million kWh) more than in 2012. In this case the total share of electricity production from RES (renewable energy sources) also doubled – up to 0.64% – down from 0.32% in 2012. In 2013 it was put into operation 539 MW of new capacity of RES. Showed the largest increase of wind and solar energy, as well as the installation of biomass processing.

According to the Energy Strategy of Ukraine to 2020 the share of renewable energy should be 11% of the total energy produced by Ukraine. This corresponds to the commitment of Ukraine to the European Energy Community, of which Ukraine is a party. 11% – is 12 000 MW, of which 6,800 MW would account for a large share of hydro power plants (HPP and PSP) and 5200 MW – the share of small hydropower, wind power, solar power and biomass and biogas. According to the annual commissioning for 500-700 MW of new renewable energy capacity by 2020 Ukraine will meet its obligations.

Conclusions

Solar power is a cheap, independent source of inexhaustible energy that has great prospects in all areas of industry in Ukraine and the home. The reasons for these are:

– in Ukraine the average potential of solar energy is much higher than in Germany and Poland;
– Ukraine has concentrated 10 percent of the global production of silicon; it can place the country at the leading place in the world with regard to production of silicon solar cells and electronics;
– the Ukrainian manufacturing capabilities allow enterprises to conduct the full technological cycle of solar cells. Ukraine has highly qualified scientific potential in this area;
– creating positive dynamics of solar power capacity – 8.1 MW in 2010 and 746.9 MW in 2013 – said that Ukraine can provide until 2020 up to 11% of electricity from renewable energy sources;
– relatively high "green" electricity tariff favors the investments in Ukraine.

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PERSPEKTYWY ENERGETYKI SŁONECZNEJ NA UKRAINIE

Streszczenie. Celem badań była analiza polityki i gospodarki źródłami energii słonecznej na Ukrainie. Zastosowanie na Ukrainie alternatywnych źródeł energii, w szczególności energii słonecznej, jest bardzo obiecujące. Przyjęta strategia do 2020 roku przewiduje, że Ukraina powinna odgrywać istotną rolę na tym polu. Aby ocenić poziom studiów teoretycznych zastosowano metody analizy, porównania i syntezy. Analiza energii słonecznej pozwoliła uzyskać wynik badań historycznych oraz prognozowanie obszarów funkcjonalnych dla możliwych ścieżek rozwoju. Przedstawiono zalety i wady energii słonecznej oraz kierunki badań podstawowych i stosowanych na Ukrainie związanych z rozwojem energii słonecznej. Praktycznie prawie wszystkie regiony Ukrainy aktywnie realizowały projekty inwestycyjne mające na celu stworzenie elektrowni, które działają w oparciu o energię słoneczną. Na Ukrainie działa ponad 100 projektów energii słonecznej o łącznej mocy mocy ponad 1380 MW we wszystkich regionach kraju.

Słowa kluczowe: energia słoneczna, bezpieczeństwo energetyczne