On the conversion and application of solar energy in the technological process

A I Kanareykin

Sergo Ordzhonikidze Russian State University for Geological Prospecting, 23, Miklouho-Maclay St., Moscow, 117997, Russia

E-mail: kanareykins@mail.ru

Abstract. The work is devoted to one of the possibilities of converting and using solar energy generated by solar panels. The issue of implementing the technological process directly from the panels themselves without converters is considered. The article considered the pros and cons of such an implementation, the result obtained can be applied both in industry and in private.

1. Introduction
As you know, the Sun is the source of life of the planet Earth. To date, one of the promising areas of energy supply to consumers is the development and introduction of renewable sources of electricity [1-2]. Therefore, there are many works devoted to the development and improvement of solar panels, as well as increasing their efficiency [3-18].

In this paper, another possibility of converting and using solar energy generated by solar panels is considered. The issue of implementing the welding process directly from the panels themselves without converters is considered. In favor of how much welding from the sun is possible, an example can be given that, in case of urgent need, several batteries connected to 24 or 36 volts can be used for welding work. Only in this case it is possible to use the energy of the sun, converted into electrical energy by means of solar panels and supplied by thick-section wires to the part being welded. Thereby bypassing electronic converters.

2. Materials and methods
Numerical methods are used in the work.

3. Results
In welding theory, an electric welding arc is considered as a plasma jet. The most important property of plasma is the ability to transfer charged particles under the action of an electric field. When an electric field is applied, forces arise that cause electrons to drift - to move along the field lines of force. Since an arc discharge usually exists in a mixture of gases and vapors at high temperature, it is necessary to have an effective ionization potential. Figure 1 shows its current–voltage characteristic in favor of arc discharge by a solar cell [19-20].
Figure 1. Current–voltage characteristic of a solar cell.

From the above characteristics it can be seen that when the contacts are shorted in the circuit, there will be a short-circuit current $I_{sc}$. Therefore, the presence of a certain potential difference will be a necessary condition for the occurrence of an arc. To achieve the desired value, it is enough to connect an array of panels together using connectors (figure 2).

Figure 2. Connecting panels using connectors.

Taking everything into account, the following (figure 3) shows the implementation of a welding machine on solar panels.
Figure 3. Implementation of a welding machine on solar panels.

The more panels in the battery, the greater the arc current and voltage values will be. The voltage of the arc itself is equal to:

\[ U = nU_{mpp} \]  

(1)

Where \( U_{mpp} \) is the voltage at the point of maximum power, V; \( n \) is the number of panels connected in series in the battery. In this case, the welding current can be found by the formula:

\[ I = mI_{sc} \]  

(2)

Where \( m \) is the number of panels connected in parallel.

Also, by the value of the arc voltage, its temperature can be determined:

\[ T \approx 800U \]  

(3)

In order to ensure the safety of the welding process, as well as in order to reduce heat losses, it is necessary to choose the right cable cross-section for welding. There are several ways to do this. At the same time, the calculation of the current section is the simplest and fastest way. It allows you to choose the best option of the conductor. Under certain assumptions, the cross section of the copper wire is equal to:

\[ S = 0.1I \]  

(4)

Also, another important criterion that directly affects the quality of the weld being welded is the length of the supply wires. Since a voltage drop occurs with an increase in the length of the welding cable, it is necessary to take this feature into account. The permissible length of the welding cable at a current greater than 200 A can be calculated using the following formula

\[ L_{\text{max}} = 0.5S \]  

(5)

At currents less than 200 A, the formula will take a rough form

\[ L_{\text{max}} = 0.01I \]  

(6)
4. Discussion
As you can see, the resulting welding machine itself is very simple, since it lacks automation and control elements. And, therefore, it is reliable in terms of breakage. The main disadvantage is the direct dependence of the current strength on the intensity of solar radiation. In order to cook in case of a decrease in the power of solar panels, you will have to use thinner electrodes. It should also be noted that in order to obtain a stronger arc, you can connect more solar panels in series, but such a connection is already more dangerous, since there is a possibility of electric shock damage.

5. Conclusion
Thus, the paper considered the implementation of a simple welding machine. Which can be useful for those who are building a house away from electrical networks and use energy from solar panels as an alternative network. The disadvantage of this connection is, of course, binding to the sun. Welding will have to be done during the day in sunny weather. The process of conversion and use of solar energy considered in the article can be applied both in production and in everyday life.

References
[1] Correa-Betanzo C, Calleja H and De León-Aldaco S 2018 Module temperature models assessment of photovoltaic seasonal energy yield. Sustain. Energy Technol 27 9–16
[2] Ranjeva M and Kulkarni A K Design 2012 Optimization of Hybrid, Small, Decentralized Power Plant for Remote/Rural Areas. Energy Procedia 20 258–270
[3] Steingrube S, Breitenstein O, Ramspeck K and Glunz S 2011 Explanation of commonly observed shunt currents in c-Si solar cells by means of recombination statistics beyond the Shockley-Read-Hall approximation. J. Appl. Phys 110 014515
[4] Greulich J, Glatthaar M and Rein S 2010 Fill factor analysis of solar cells' current–voltage curves. Prog. Photovolt. Res. Appl. 18 511–515
[5] Hoenig R, Glatthaar M, Clement F and Greulich J 2011 New measurement method for the investigation of space charge region recombination losses induced by the metallization of silicon solar cells. Energy Procedia 8 694–699
[6] Khanna A, Mueller T and Hoex B 2013 A fill factor loss analysis method for silicon wafer solar cells. IEEE J. Photovolt 3 1170–1177
[7] Babaa S, Armstrong M and Pickert V 2014 Overview of maximum power point tracking control methods for PV systems. Journal of Power and Energy Engineering 2 59–72
[8] McIntosh K 2001 Lumps, humps and bumps: Three detrimental effects in the current–voltage curve of silicon solar cells, in: Centre for Photovoltaic Engineering. Univ. N. S. W. Aust. 171
[9] Djeghloud H, Guellout O, Larakeb M, Bouteldja O, Boukebous S and Bentounsi A 2014 Practical study of a laboratory undersized grid-connected PV system. IEEE Innovative Smart Grid Technologies 618–623
[10] Engelhart P 2009 Laser processing for high-efficiency silicon solar cells. In Proceedings of Laser-based Micro/nanoPackaging and Assembly III 28-29
[11] Breitenstein O, Rakotoniaina J, Al Rifai M H and Werner M 2004 Shunt types in crystalline silicon solar cells. Prog. Photovolt. Res. Appl. 12 529–538
[12] Elgendy M A, Zahawi B and Atkinson D J 2012 Assessment of perturb and observe MPPT algorithm implementation techniques for PV pumping applications. IEEE Transactions on Sustainable Energy 3 21–33
[13] Esram T and Chapman P L 2007 Comparison of photovoltaic array maximum power point tracking techniques. IEEE Transactions on Energy Conversion 22 439–449
[14] Femia N, Granozio D, Petrone G, Spaguolo G and Vitelli M 2006 Optimized one-cycle control in photovoltaic grid connected applications. IEEE Trans. Aerosp. Electron. Syst. 42 954–972
[15] Babaa S, Armstrong M and Pickert V 2014 Overview of maximum power point tracking control methods for PV systems. Journal of Power and Energy Engineering 2 59–72
[16] Djeghloud H, Guellout O, Larakeb M, Bouteldja O, Boukebous S and Bentounsi A 2014

4
Practical study of a laboratory undersized grid-connected PV system. *IEEE Innovative Smart Grid Technologies* 618–623

[17] Dolara A, Faranda R and Leva S 2009 Energy comparison of seven MPPT techniques for PV systems. *J. Electromagnetic Analysis & Applications* 3 152–162

[18] Glunz S W 2007 High-efficiency crystalline silicon solar cells. *Adv. Optoelectron* 1–15

[19] Kanareykin A I 2021 On the correctness of calculating the Fill Factor of the solar module. *IOP Conf. Series: Earth and Environmental Science* 808 012018

[20] Kanareykin A I 2022 Determination of the shunt resistance of a solar cell from its light volt-ampere characteristic. *IOP Conf. Series: Earth and Environmental Science* 979 012185