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Simulation of Photovoltaic System as a Tool of a State's Energy Security

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ABSTRACT

This article is devoted to the photovoltaic system simulation. Photovoltaic systems operate in different conditions such as changing solar irradiance and environmental temperature. Analysis of the existing methods for photovoltaic system simulation was carried out in this paper. The formal model of the electricity consumption system was developed, which included the photovoltaic system and the electrical storage system. The expediency of using simulation modeling tools in the design of solar panel optimization tools was shown by application of maximum power point tracking methods. The developed software provides the ability to build current-voltage and high-voltage characteristics of solar cells at different values of the intensity of solar radiation and temperature.. The voltage and load current differ up to 50% from the voltage and current of the operating point of the solar panel, which is set to the optimal value using maximum power point tracker. The architecture of the software extends the capabilities of simulation modeling of systems based on solar panels. The optimizer model block along with the implementation of the maximum power point tracking algorithm can be further refined by using more sophisticated algorithms. The developments are innovative and their practical implementation will have a significant impact on the energy security of countries.

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NOMENCLATURE

P_{load}	Is the power consumption (W)	I_s	Is the reverse saturation current (A)
P_{max}	Is the maximum power of the photovoltaic system (W)	T	Is the absolute temperature of the p-n junction (K)
P_{lim}	Is the maximum power that can be taken from the external grid (W)	V_{oc0}	Is the open short circuit voltage under test conditions
P_1, P_2, P_3	Energy flows (W)	K_V	Is the temperature coefficient of the open circuit voltage
P_{3max}	Is the maximum energy due to capacity of the electrical storage system (W)	m	Is the diode ideality coefficient
N	Is the number of time intervals with constant load	I_{ph}	Is the photocurrent (A)
I_d	Is the current flowing through the diode (A)	**Greek Symbols**	
R_s	Is the serial resistance (Ω)	α_1, α_2, α_3	Are coefficients of the objective function
R_{sh}	Is the parallel resistance or shunt resistance (Ω)		

1. INTRODUCTION[1]

Solar energy is by far one of the most promising emerging sectors of renewable energy which become key factors of a state's energy security. Photovoltaic systems require an energy storage buffer to supply the loads when there is not enough solar energy. Lead acid batteries and super-high capacitors are typically used for this purpose [1-4]. High and fast energy (current) demands from the load can degrade the performances and lifetime of such batteries. Because of the output

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dependence on weather conditions, photovoltaic systems produce incomplete charge/discharge cycles, resulting in a low State of Charge (SOC). In these conditions, batteries cannot cope with fast and sudden energy demands from the load, as necessary for the applications such as motors and water pumps characterized by transients or start-ups with current requirements for a few seconds up to 6-8 times higher than the rated current. For this reason, the photovoltaic systems are not the best energy source to charge batteries [5-8].

The National Renewable Energy Laboratory (NREL, USA) is the main developer of free software for modeling solar power plants, offering two open source software packages online: PVWatts and System Advisor Model (SAM). Currently these software packages are widely used to simulate solar panels.

Helioscope is one of the most modern computing platforms allowed to model solar power plants with a capacity of up to 5 MW.

The software proposed in this article, in contrast to the existing one, will allow to simulate the operation of the solar panel and string in real time when changing the basic parameters of the panel. This software can optimize the process of studying the effective operation of the solar panel by selecting the maximum power point.

2. LITERATURE REVIEW

Smart grids are the next generation of electricity distribution networks. The development of smart grids is due to the emergence of new equipments for monitoring, automation and communication of generators and consumers of electricity. The use of smart grids can improve the quality of electricity, managing electricity prices, monitoring sources and demand for electricity [9-13].

The energy management system (EMS) of the electrical system for a luxury ship (yacht) is discribed in [14-17]. From the architectural side, a DC electrical distribution on-board has been adopted in place of the existing AC. Moreover, the DC micro-grid has been integrated with renewable energy sources (RES) based generators, as well as an energy storage system (ESS). The ESS compensates the power missing for the entire duration of the cold start up of the auxiliary generator. In case of big overload, the ESS provides the exceeding power with respect to the rated one, thus avoiding potential micro-grid instability problems.

In recent years, the management and operation of micro-grids are considered by many advanced societies with regard to the development of scattered energy resources [18-22]. The main goals that are paid attention in micro-grid management are the operation cost and pollution rate, which the aggregation of such contradictory goals in an optimization problem can provide an appropriate response to the management of the micro-grid.

Grid integration of photovoltaic (PV) system with a hybrid energy storage can help not only in increasing penetration of PV system into the network but also in improving the power system dynamics and control in addition to helping the demand side management [23-25]. The PV system with a hybrid energy storage including a battery array and a super capacitor bank is going to work as an active generator with innovative load management and power flow control strategies for managing the active power demand locally considering the grid constraints.

3. MATERIALS AND METHODS

3. 1. The Mathematical Model of Power Supply System

Let's consider the generalized power supply system, which consists of the electricity consumers, the external grid, the photovoltaic system and the electrical storage system [26-30].

The mathematical model of this power supply system is based on the condition of the electricity balance between the nodes of the system. The generalized power supply system block diagram is shown in Figure 1.

The electrical system balance is provided by the following equations:

$$\begin{cases} P_1 + P_2 = P_{load} \\ P_1 + P_3 \le P_{\max} \\ P_2 \le P_{\lim} \end{cases} \tag{1}$$

where, P_{load} is the power consumption; $P_{\max}$ is the maximum power of the photovoltaic system; $P_{\lim}$ is the maximum power that can be taken from the external grid.

The system from Equation (1) is a balance of electric energy over a period of time Δt during which P_{load} and $P_{\lim}$ can be considered as constant:

$$\begin{cases} P_{load}(t) = const \\ P_{\max}(t) = const \end{cases} \tag{2}$$

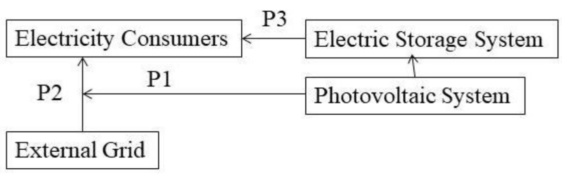

Figure 1. The generalized power supply system block diagram

The energy flows P_1 and P_2 are assumed to be positive.

$$\begin{cases} P_1 \geq 0 \\ P_2 \geq 0 \end{cases} \tag{3}$$

The energy flow P_3 is the energy that consumes the charge and discharge of the electrical storage system and it can be both positive and negative.

$$-P_{3\max} \leq P_3 \leq P_{3\max} \tag{4}$$

where, $P_{3\max}$ is the maximum energy due to capacity of the electrical storage system.

For each time interval Δt_i, if the conditions in Equation (2) are satisfied, we can write the system of Equations (1) and supplement it with the charge of the electrical storage system:

$$\sum_i^N \Delta t_i P_3 = 0 \tag{5}$$

where, N is the number of time intervals with constant load.

Let's introduce the objective function:

$$F = \sum_i^N \Delta t_i \left(\alpha_1 P_1^i + \alpha_2 P_2^i + \alpha_3 P_3^i \right) \tag{6}$$

where, α_1, α_2 and α_3 are coefficients of the objective function.

In the case of the objective function optimization by the criterion of minimum cost of energy resources, the coefficients of the objective function in Equation (6) are the corresponding tariffs for electricity and the cost of operating the photovoltaic system and the electrical storage system [31-36].

3. 2. The Linear Optimization Method The linear optimization methods are quite effective for solving this type of optimization problem. Under the condition in Equation (4) the variable P_3 can take negative values. Since a sign is not defined at the beginning of the problem-solving procedure, let's present it as a difference:

$$P_3 = x_1 - x_2 \tag{7}$$

where, $x_1 \geq 0$ and $x_2 \geq 0$ are the positive numbers.

We finally have the following system of linear constraints:

$$\begin{cases} P_1^i + P_2^i = P_{load}^i \\ P_1^i + x_1^i - x_2^i \leq P_{\max}^i \\ P_2^i \leq P_{\lim} \\ \sum_i^N \Delta t_i \left(x_1^i - x_2^i \right) \leq 0 \end{cases} \tag{8}$$

where, i takes values from 1 to N.

The last equality in system from Equation (8) was replaced by inequality in order for the system to be compatible and to have solutions.

The final expression for the objective function is:

$$G = \sum_i^N \Delta t_i \left(\alpha_1 P_1^i + \alpha_2 P_2^i + \alpha_3 \left(x_1^i - x_2^i \right) \right) \tag{9}$$

In Equation (9), the choice of the coefficients α_1, α_2 and α_3 depends on the optimization criteria. Thus, the formal problem is to find the optimal objective function using Equation (9) under the constraints in Equation (8).

4. EXPERIMENTAL RESULTS

Figure 2 shows a Simulink model for simulating the operation of a solar panel when changing the intensity of solar radiation using the maximum power point tracker (MPPT). This scheme involves measuring the values of current, voltage and power directly at the output of the solar panel and the external load.

The MPPT represented by the element "MPPT" takes the original values of current and voltage of the solar panel and returns the optimal value of the duty cycle D used to generate pulse width modulated (PWM) signal, which in turn controls the DC-DC converter. The latter thus adjusts the output voltage of the solar panel by setting it equal to the voltage at the MPPT.

Figure 3 shows the change in time of the solar radiation intensity during the simulation.

Figure 4 shows the current, voltage and power obtained from the simulation.

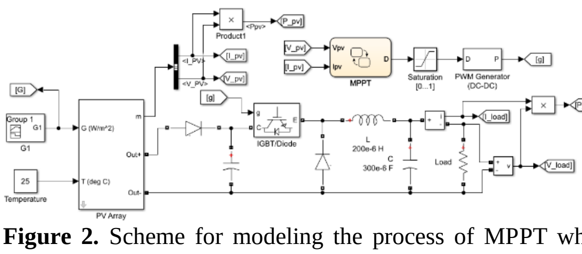

Figure 2. Scheme for modeling the process of MPPT when changing the intensity of solar radiation

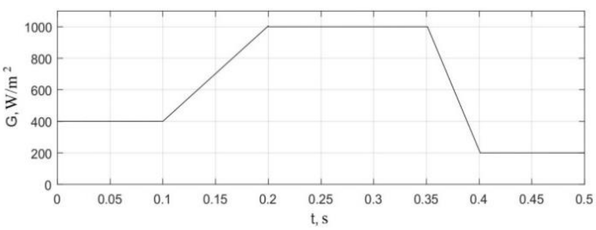

Figure 3. The changes of the solar radiation intensity

As can be seen from Figure 6, for a time period from 0 to 0.1 s, the solar radiation intensity is 400 W/m²; during the next 0.1 s, it increases linearly to a maximum value of 1000 W/m², and then falls again to a value of 200 W/m².

Figure 4 shows the dotted line current, voltage and power on the load; the corresponding values obtained directly at the load and the solid line corresponds to the solar panel. As can be seen from these diagrams, the voltage and load current differ from the voltage and current of the operating point of the solar panel, which is set to the optimal value using MPPT.

The Stateflow element was used to implement the incremental conductivity algorithm in the Matlab/Simulink environment. Stateflow is a graphical development tool that can be used to model simple logic problems and complex control system problems. It is easy to create and explore different behavioral scenarios of complex systems. The Stateflow element has been widely used in the modeling of embedded systems, human-machine interfaces, and hybrid systems [26].

Stateflow are based on finite automata. The transition from one state to another is determined by the condition of transition to this state.

The Stateflow diagram consists of the block sets that determine the possible states of the system and the conditional transition sets that specify the conditions for the transition of the system from one state to another.

Figure 5 shows the implementation of the incremental proficiency algorithm in the form of the Stateflow diagram.

As can be seen from Figure 5 the diagram consists of four main states, the transitions between which occur according to the algorithm.

The developed model is presented in the form of the subsystem PV Array, which takes as input the solar radiation G and temperature T. It has two electrical outputs ("Out+" and "Out-"), compatible with SimPowerSystems components and the output vector *m* of the measured values.

The PV Array subsystem requires the following parameters I_{sc0}, V_{oc0}, K_I, K_V, m, N_s, R_s and R_{sh} to be specified using the subsystem mask. A controlled current source was used to simulate the load, which simulates a linear increase in the load current.

The structure of the PV Array subsystem is shown in Figure 6. It includes internal subsystems for current simulation I_{ph}, I_s and I_d. The output current for the electrical output terminals is set by the controlled current source. The output vector *m* consists of the values of current and voltage at the output of the solar panel, the current value I_d, temperature value T and insolation G.

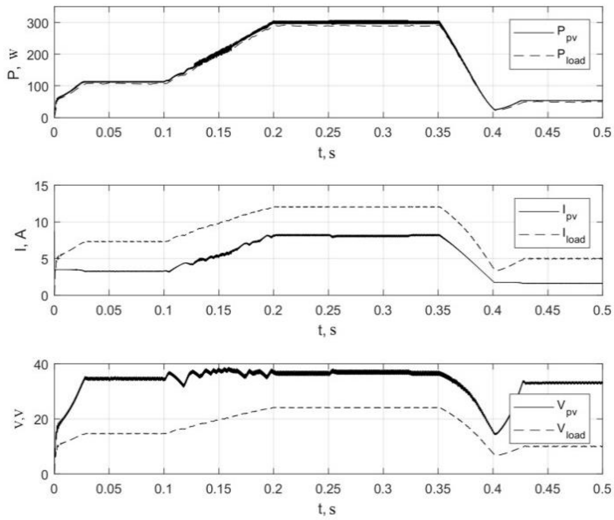

Figure 4. Power, current and voltage obtained from the simulation

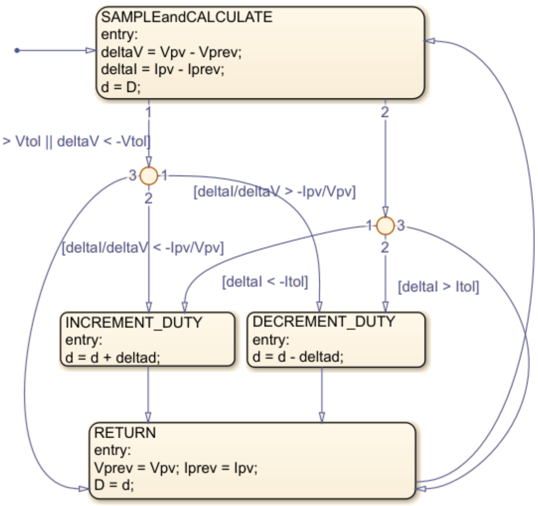

Figure 5. Implementation of the incremental conductivity algorithm as the Stateflow diagram

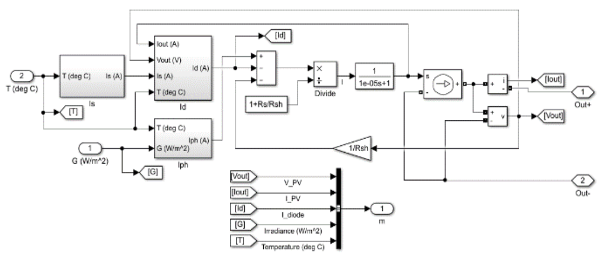

Figure 6. Internal structure of the PV Array subsystem

5. CONCLUSION

Considering the obtained results of the photovoltaic system simulation by means of the developed application, it can be concluded that this software shows adequate results and meets its requirements. The values of the maximum power point are obtained as a result of simulation under nominal conditions corresponding to the declared data sheet of the considered solar panels.

The architecture of the software application extends the capabilities of the photovoltaic system simulation. The block model of the optimizer with the implementation of the algorithm tracking the maximum power point can be further improved by using more sophisticated algorithms, and the interface of its interaction with other modules of the system will remain unchanged.

The simulation software supports the function of explicitly setting the operating point of the photovoltaic system simulation by changing the value of current or voltage. This module can be expanded by implementing the complex load model.

6. REFERENCES

1. Vdovin, O., Martynyuk, V. and Surdu, M., "A combined method for measuring super-high capacitors absorption characteristics", in Proc. Of the 11th IMEKO TC4 Symposium on “Trends in Electrical Measurements and Instrumentation” and 6th IMEKO TC4 Workshop on ADC Modelling and Testing, Lisbon, Portugal, 372-374, (2001). ISBN 972-98115-4-7
2. De Wildt, T. E., Chappin, E. J.L., van de Kaa, G., Herder, P. M. and van de Poel, I. R., "Conflicting values in the smart electricity grid a comprehensive overview", ***Renewable and Sustainable Energy Reviews***, Vol. 111, (2019), 184-196. https://doi.org/10.1016/j.rser.2019.05.005
3. Hosseini Rad, A., Ghadamian, H., Haghgou, H. R. and Sarhaddi, F., "Energy and Exergy Evaluation of Multi-channel Photovoltaic/Thermal Hybrid System; Simulation and Experiment", ***International Journal of Engineering, Transactions B: Applications***, Vol. 32, No. 11, (2019), 1665-1680. DOI: 10.5829/IJE.2019.32.11A.18
4. Accetta, A. and Pucci, M., "Energy Management System in DC Micro-Grids of Smart Ships: Main Gen-Set Fuel Consumption Minimization and Fault Compensation," ***IEEE Transactions on Industry Applications***, Vol. 55, No. 3, (2019), 3097-3113. DOI: 10.1109/TIA.2019.2896532
5. Aghajani, G. and Ghadimi, N., “Multi-objective energy management in a micro-grid”, ***Energy Reports***, Vol. 4, (2018), 218-225. https://doi.org/10.1016/j.egyr.2017.10.002
6. Konara, K. M.S.Y., Kolhe, M. and Sharma, A. “Power flow management controller within a grid connected photovoltaic based active generator as a finite state machine using hierarchical approach with droop characteristics”, ***Renewable Energy***, Vol. 155, (2020), 1021-1031. https://doi.org/10.1016/j.renene.2020.03.138
7. Boutabba, T., Drid, S., Chrifi-Alaoui, L. and Benbouzid, M. E., “A New Implementation of Maximum Power Point Tracking based on Fuzzy Logic Algorithm for Solar Photovoltaic System”, ***International Journal of Engineering, Transactions A: Basics***, Vol. 31, No. 4, (2018), 580-587. doi: 10.5829/ije.2018.31.04a.09
8. Sureshkumara, K. and Ponnusamyb V., “Power flow management in micro grid through renewable energy sources using a hybrid modified dragonfly algorithm with bat search algorithm”, ***Energy***, Vol 181, (2019), 1166-1178. https://doi.org/10.1016/j.energy.2019.06.029
9. Martynyuk, V., Vdovin, O., Boyko, J., and Vlasenko, N., “Super-high capacitor analyzer with compensation of common-mode error”, in Proc. of the 11th IMEKO TC-4 Symposium “Trends in electrical measurement and instrumentation”, Lisbon, Portugal, 340-343, (2001).
10. Martynyuk, V., Fedula, M., Ortigueira, M. and Savenko, O., “Methodology of Electrochemical Capacitor Quality Control with Fractional Order Model”, ***AEU - International Journal of Electronics and Communications***, Vol. 91, (2018), 118-124. https://doi.org/10.1016/j.aeue.2018.05.005
11. Hadi, A. A., Silva, C. A. S., Hossain, E. and Challoo, R., "Algorithm for Demand Response to Maximize the Penetration of Renewable Energy," ***IEEE Access***, vol. 8, (2020), 55279-55288. DOI: 10.1109/ACCESS.2020.2981877
12. Kalair, A. R., Abas, N., Hasan, Q. Ul, Seyedmahmoudian, M. and Khan, N. "Demand side management in hybrid rooftop photovoltaic integrated smart nano grid," ***Journal of Cleaner Production***, Volume 258, (2020), 120747. https://doi.org/10.1016/j.jclepro.2020.120747
13. Sagar, G. V. R. and Debela, T., “Implementation of Optimal Load Balancing Strategy for Hybrid Energy Management System in DC/AC Microgrid with PV and Battery Storage”, ***International Journal of Engineering, Transactions A: Basics***, Vol. 32, No. 10, (2019), 1437-1445. doi: 10.5829/ije.2019.32.10a.13
14. Nizami, M. S.H., Hossain, M. J., Haque, A. N.M.M. and Nguyen, P. H., “On the application of Home Energy Management Systems for power grid support”, ***Energy***, Vol. 188, (2019), 116104. https://doi.org/10.1016/j.energy.2019.116104
15. Rajeev K. C. and Kalpana C., “Building automation system for grid-connected home to optimize energy consumption and electricity bill”, ***Journal of Building Engineering***, Vol. 21, (2019), 409-420. https://doi.org/10.1016/j.jobe.2018.10.032
16. Garrab, A., Bouallegue, A. and Bouallegue, R., “An Agent Based Fuzzy Control for Smart Home Energy Management in Smart Grid Environment”, ***International Journal of Renewable Energy Research***, Vol. 7 No. 2, (2017), 599-612.
17. Dhass, A.D., Natarajan, E. and Lakshmi, P., “An Investigation of Temperature Effects on Solar Photovoltaic Cells and Modules”, ***International Journal of Engineering, Transactions B: Applications***, Vol. 27, No. 11, (2014), 1713-1722.
18. Ciupageanu, D., Barellia, L. and Lazaroiub G., “Real-time stochastic power management strategies in hybrid renewable energy systems: A review of key applications and perspectives”, ***Electric Power Systems Research***, Vol. 187, (2020), 106497. https://doi.org/10.1016/j.epsr.2020.106497
19. Kiran, A. and Arun, K. “Network selection criterion for ubiquitous communication provisioning in smart cities for smart energy system”, ***Journal of Network and Computer Applications***, Vol. 127, (2019), 82-91. https://doi.org/10.1016/j.jnca.2018.11.011
20. López-Ramosa, F., Nasini, S., H.Sayedd, M., “An integrated planning model in centralized power systems”, ***European Journal of Operational Research***, Vol. 287, Iss. 1, (2020), 361-377. https://doi.org/10.1016/j.ejor.2020.05.006
21. Simões D., Lau N., Reis L. P., “Multi-agent actor centralized-critic with communication”, ***Neurocomputing***, Vol. 390, (2020), 40-56. https://doi.org/10.1016/j.neucom.2020.01.079

22. Wang, Y., Nguyen T. L., Xu Y. and Shi, D. "Distributed control of heterogeneous energy storage systems in islanded microgrids: Finite-time approach and cyber-physical implementation", ***International Journal of Electrical Power & Energy Systems***, Vol. 119, (2020), 105898. https://doi.org/10.1016/j.ijepes.2020.105898
23. Khan, M. W., Wang, J., Ma, M., Xiong, L., Li, P, and Wu, F., "Optimal energy management and control aspects of distributed microgrid using multi-agent systems", ***Sustainable Cities and Society***, Vol.44, (2019), 855-870. https://doi.org/10.1016/j.scs.2018.11.009
24. Rahman, M.S. and Oo, A.M.T., "Distributed multi-agent based coordinated power management and control strategy for microgrids with distributed energy resources", ***Energy Conversion and Management***, Vol. 139, (2017), 20-32. https://doi.org/10.1016/j.enconman.2017.02.021
25. Sampaio F. C., Leão R. P.S., Sampaio R. F., Melo L S., and Barroso G. C., "A multi-agent-based integrated self-healing and adaptive protection system for power distribution systems with distributed generation", ***Electric Power Systems Research***, Vol. 188, (2020), 106525. https://doi.org/10.1016/j.epsr.2020.106525
26. Sovacool B. K. and Furszyfer Del Rio D. D. "Smart home technologies in Europe: A critical review of concepts, benefits, risks and policies", ***Renewable and Sustainable Energy Reviews***, Vol. 120, (2020), 109663. https://doi.org/10.1016/j.rser.2019.109663
27. Kolen, S., Molitor, C., Wagner, L. and Monti, A., "Two-level agent-based scheduling for a cluster of heating systems", ***Sustainable Cities and Society***, Vol. 30, (2017), 273-281. https://doi.org/10.1016/j.scs.2017.01.014
28. Davarzani, S., Granell, R., Taylor, G. A., Pisica, I. "Implementation of a novel multi-agent system for demand response management in low-voltage distribution networks", ***Applied Energy***, Vol. 253, (2019), 113516. https://doi.org/10.1016/j.apenergy.2019.113516
29. Santos A. Q., Monaro R. M., Coury D. V. and Oleskovicz M., "A new real-time multi-agent system for under frequency load shedding in a smart grid context", ***Electric Power Systems Research,*** Vol. 174, (2019), 105851. https://doi.org/10.1016/j.epsr.2019.04.029
30. Mokhtaraa, C., Negroua, B., Bouferrouk, A., Yao, Y., Settoua, N. and Ramadan, M., "Integrated supply–demand energy management for optimal design of off-grid hybrid renewable energy systems for residential electrification in arid climates", ***Energy Conversion and Management***, Vol. 221, (2020), 113192. https://doi.org/10.1016/j.enconman.2020.113192
31. Martynyuk, V., "Supercapacitor Data Acquisition Systems", in 4th IEEE Workshop on Intelligent Data Acquisition and Computing System: Technology and Applications IDAACS'2007, Dortmund, Germany,. 24-28, (2007). DOI: 10.1109/IDAACS.2007.4488365
32. Ogunjuyigbe, A. S., Ayodele, T. R. and Akinola, O. A., "User satisfaction-induced demand side load management in residential buildings with user budget constraint", ***Applied Energy***, Vol. 187, (2017), 352-366. https://doi.org/10.1016/j.apenergy.2016.11.071
33. Voynarenko, M., Dykha, M., Mykoliuk, O., Yemchuk, L. and Danilkova, A., "Assessment of an enterprise's energy security based on multi-criteria tasks modeling". ***Problems and Perspectives in Management***, Vol. 16, No. 4, (2018), 102-116.
34. Liu J., Chen X., Cao S., and Yang H. "Overview on hybrid solar photovoltaic-electrical energy storage technologies for power upply to buildings", ***Energy Conversion and Management***, Vol. 187, (2019), 103-121. https://doi.org/10.1016/j.enconman.2019.02.080
35. Confrey, J., Etemadi, A. H., Stuban, S. M. F. and Eveleigh, T. J., "Energy Storage Systems Architecture Optimization for Grid Resilience With High Penetration of Distributed Photovoltaic Generation," ***IEEE Systems Journal***, Vol. 14, No. 1, (2020), 1135-1146. DOI: 10.1109/JSYST.2019.2918273
36. Lingguo K., Jiamin Y. and Guowei C., "Modeling, control and simulation of a photovoltaic /hydrogen/ supercapacitor hybrid power generation system for grid-connected applications", ***International Journal of Hydrogen Energy***, Vol. 44, Iss. 46, (2019), 25129-25144. https://doi.org/10.1016/j.ijhydene.2019.05.097

Persian Abstract

این مقاله به شبیه سازی سیستم فتوولتائیک اختصاص دارد. سیستم های فتوولتائیک در شرایط مختلف مانند تغییر تابش خورشید و دمای محیط کار می کنند. تجزیه و تحلیل روش های موجود برای شبیه سازی سیستم فتوولتائیک در این مقاله انجام شده است. مدل رسمی سیستم مصرف برق ساخته شد که شامل سیستم فتوولتائیک و سیستم ذخیره برق بود. مصلحت استفاده از ابزار مدل سازی شبیه سازی در طراحی ابزارهای بهینه سازی صفحه خورشیدی با استفاده از روش های ردیابی حداکثر توان نشان داده شد. این نرم افزار توسعه یافته توانایی ایجاد خصوصیات ولتاژ جریان و ولتاژ بالا سلولهای خورشیدی را در مقادیر مختلف شدت تابش خورشید و دما فراهم می کند. ولتاژ و بار بار تا ۵۰٪ با ولتاژ و جریان کار متفاوت است نقطه پانل خورشیدی ، که با استفاده از ردیاب نقطه حداکثر قدرت روی مقدار مطلوب تنظیم می شود. معماری این نرم افزار قابلیت های شبیه سازی سیستم های مبتنی بر صفحات خورشیدی را گسترش می دهد. بلوک مدل بهینه ساز همراه با اجرای الگوریتم ردیابی نقطه حداکثر توان با استفاده از الگوریتم های پیچیده تر می تواند بیشتر اصلاح شود. این تحولات نوآورانه است و اجرای عملی آنها تأثیر بسزایی در امنیت انرژی کشورها خواهد داشت.