

Michal Kolcun, Dušan Medved', Jaroslav Petráš, Rastislav Stolárik, Štefan Vaško
Technical University of Košice, Department of Electric Power Engineering, Faculty of
Electrical Engineering and Informatics
VÁDIUM s.r.o., Plzenská 2, 080 01 Prešov, Slovenská republika

THE INFLUENCE OF PHOTOVOLTAIC PANEL CONSTRUCTION ON EFFECTIVITY OF SOLAR SYSTEMS

Abstract: This paper describes the influences of photovoltaic panel construction and positioning in solar system on system's effectivity.

Keywords: solar system; photovoltaic panel

Introduction

In the framework of project „Photovoltaic component parameters research for effective design of solar systems“, we prepared an experiment with different types of photovoltaic panels that are used as components of solar systems. We had samples of photovoltaic panels manufactured by different manufacturers for this purpose. These panels are positioned and oriented in different directions and have different construction.

There are 30 photovoltaic panels installed for this experiment. A group of 6 panels have sun tracking system installed with tracking heads, other groups of 6 panels have fixed orientation in directions: horizontally positioned, facing southwards, westwards and eastwards.

This paper describes the influence of various panel positioning on their ability to supply as much as energy as possible to the solar system in which panels are installed.

Photovoltaic panels and components and their positioning

For experimental purposes we have chosen into our laboratory various types of panels which differed in manufacturer, manufacturing technology, construction and positioning, as can be seen on Fig. 1 and 2. The manufacturers are Nova, Sanyo, Solarsys and Trina.

See below for model and type of selected photovoltaic panels:

- PV Solarsys PM245-BB panel with mono-crystal manufacturing technology and with 60 cells, 245W power, there are 10 pieces installed in our laboratory,
- Thinfilm Nova T-series 80W with thinfilm manufacturing technology of photovoltaic cells, power rate of individual panels is 80W, there are 5 pieces installed in our laboratory,
- Sanyo HIT214 with hybrid manufacturing technology of photovoltaic panels, power rate 214W, 5 pieces of installed panels in our laboratory,
- Trina TSM-PC05 235W with power rate 235W, 10 pieces of installed panels with poly-crystal technology of manufacturing.



Fig.1 Installation of photovoltaic panels in external part of our laboratory



Fig.2 Installation of photovoltaic panels in external part of our laboratory – front view

Each of these panel types was positioned in all direction mentioned above, i.e. at least one of them is positioned in direction horizontally, southwards, westwards and eastwards (Fig. 3) and at least one of them has sun tracking system installed (Fig. 4).



Fig.3 Positions of photovoltaic panels in directions horizontally, southwards, westwards and eastwards



Fig.4 Photovoltaic panel installation with sun tracking system

Solar Tracking System is a sun tracking device and system which changes the direction of photovoltaic panel to face the current sun position in the sky during the day. There are different types of such systems, most used are one axis and two axis systems which enable to position the panel as precise as possible.

Parameters measured on installed photovoltaic panels

There is a continual measurement of temperature, voltage and (on selected SANYO panels) also power measured by pyranometer. Measured parameter values are concentrated by data concentrator into one file per hour and recorder on data server.

Measured data are continually measured, recorded and archived for later evaluation and for displaying them as a daily graph for selected day.

Graphical user interface for archived date display enables to select for display data from maximum 7 panels at the same time for data and graph comparison. This is useful when we compare graphs form panels of different manufacturer made by different manufacturing technology and when comparing different panel positioning.

Measured data evaluation

As there is a big amount of data measured each hour and day for every of 30 panels, system records every hour data amount which is hard to evaluate and display. Therefore we used data approximation techniques such as under sampling and averaging.

Daily graphs of temperature, voltage and power can be seen on Fig. 5, 6 and 7 respectively, as well as daily data values can be seen in tables 1, 2 and 3 respectively. These data were measured on 2nd of August 2014 (a sunny day in the location of panel installation with day air temperature max. 32 °C and minimal night air temperature 18 °C). Graph is created from points of average values for selected parameter calculated for one particular hour.

parameter TEPLOTA																								
	00h	01h	02h	03h	04h	05h	06h	07h	08h	09h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
Sanyo tracker	25.17	26.47	26.09	25.56	25.06	25.06	26.17	29.2	30.13	32.25	35.66	38.77	40.89	40.68	47.13	52.68	48.9	35.24	30.69	31.86	28.64	27	26.16	25.42
Sanyo vodorovne	26.68	26.44	25.96	25.25	24.95	25.87	27.87	34.37	39.26	45.17	46.56	48.2	43.86	40.24	41.2	40.68	45.75	35.69	31.51	31.05	29.17	27.22	26.29	25.22
Sanyo západ	31.19	31.18	30.38	29.54	29.45	29.28	30.26	41.93	47.75	51.79	54.94	57.74	55.19	55.32	44.84	46.06	49.83	39.33	35.22	33.73	33.1	31.46	30.39	29.6
Sanyo východ	26.33	25.93	25.62	25.28	25.06	24.87	25.45	23.79	28.34	31.8	32.95	38.27	42.66	41.59	49.09	51.64	49.05	35	30.3	31.44	28.1	26.49	25.64	25.2
Sanyo juh	25.76	25.44	25.16	24.17	23.66	23.69	25.25	29.83	36.01	44.33	45.14	42.87	43.43	45.92	44.77	45.7	45.12	34.01	29.46	29.53	27.21	25.82	24.9	23.94

Tab. 1 Temperature on SANYO panels on 2nd of August 2014 in °C, Sanyo tracker, horizontal, westwards, eastwards and southwards

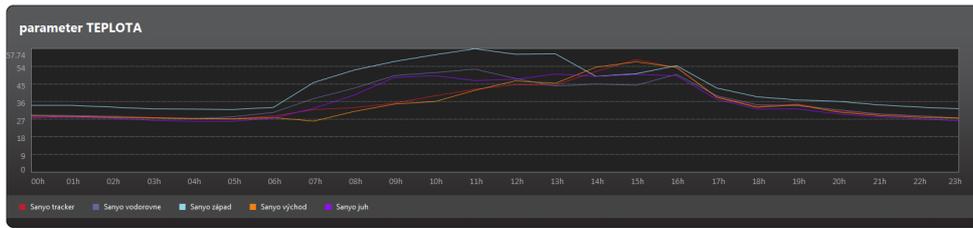


Fig.5 Graph of temperature on Sanyo panels on 2nd of August 2014 in °C, Sanyo tracker, horizontal, westwards, eastwards and southwards

parameter Napätie

	00h	01h	02h	03h	04h	05h	06h	07h	08h	09h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
Sanyo tracker	0	0	0	0	0.03	1.61	17.03	29.34	36.93	39.17	38.16	34.11	25.64	14.39	5.39	5.35	4.11	0.83	1.37	0.5	0.03	0	0	0
Sanyo vodorovne	0	0	0	0	0.02	1.07	2.57	3.29	3.5	3.81	10.36	20.04	29.56	37.57	40.87	41.54	8.07	1.24	2.63	0.63	0.04	0	0	0
Sanyo západ	0	0	0	0	0.02	0.79	2.19	2.9	2.97	2.93	2.86	2.87	3.05	5.41	13.55	21.7	4.62	0.65	1.93	0.49	0.03	0	0	0
Sanyo východ	0	0	0	0	0.02	1.13	3.18	27.33	33.39	33.04	27.41	18.56	8.4	3.84	3.49	4.4	2.82	0.51	0.99	0.37	0.02	0	0	0
Sanyo juh	0	0	0	0	0.02	0.88	2.44	3.13	3.29	3.41	5.85	13.71	21.68	27.06	26.2	24.73	4.57	0.84	1.14	0.71	0.04	0	0	0

Tab. 2 Voltage values on Sanyo panels on 2nd of August 2014 in Volts, Sanyo tracker, horizontal, westwards, eastwards and southwards

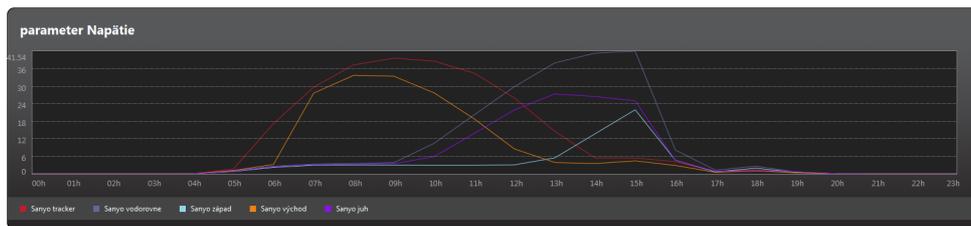


Fig.6 Graph of voltage values on Sanyo panels on 2nd of August 2014 in Volts, Sanyo tracker, horizontal, westwards, eastwards and southwards

		parameter Výkon																							
		00h	01h	02h	03h	04h	05h	06h	07h	08h	09h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
Sanyo	tracker	0.02	0.02	0.02	0.02	0.02	0.48	2.88	4.85	6.16	6.79	6.61	5.81	4.6	3.01	1.6	1.23	0.76	0.18	0.26	0.11	0.03	0.02	0.02	0.02
Sanyo	vodorovne	0.03	0.03	0.03	0.03	0.03	0.26	0.57	0.76	0.91	1.13	2.18	3.62	5.06	6.21	6.92	7.21	1.48	0.25	0.61	0.4	0.05	0.03	0.03	0.03
Sanyo	západ	0.04	0.05	0.05	0.05	0.05	0.15	0.38	0.47	0.5	0.5	0.54	0.6	0.73	1.38	2.61	4.01	0.71	0.12	0.17	0.58	0.08	0.05	0.04	0.04
Sanyo	východ	0.02	0.02	0.02	0.02	0.02	0.16	0.41	3.88	5.2	5.18	4.37	3.63	1.83	0.91	0.71	0.79	0.41	0.1	0.17	0.07	0.02	0.02	0.02	0.02
Sanyo	juh	0.03	0.03	0.02	0.02	0.02	0.17	0.38	0.56	0.7	0.85	1.38	2.46	3.54	4.34	4.72	4.66	0.79	0.15	0.19	0.18	0.04	0.03	0.03	0.03

Tab. 3 Power values on Sanyo panels on 2nd of August 2014 in Watt, Sanyo tracker, horizontal, westwards, eastwards and southwards

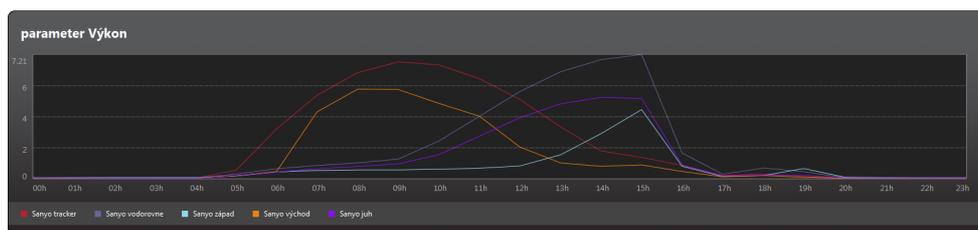


Fig.7 Graph of power values on Sanyo panels on 2nd of August 2014 in, Sanyo tracker, horizontal, westwards, eastwards and southwards

Conclusion

In our laboratory of photovoltaics we have installed different models and types of photovoltaic panels with different technical parameters and different manufacturing technology.

A set of 30 photovoltaic panels was used for our experiments for research and evaluate the effectivity of photovoltaic panels and their construction in the dependence of manufacturing technology used, construction used (static fixed direction or tracking system).

Highest daily values were achieved by panels with sun tracking system installed, although such construction of solar systems is much more expensive. Other panels in our experiment were static, had fixed position and also showed smaller daily power values than panels with tracking system and same manufacturer and manufacturing technology.

For horizontally positioned panel we had in average 16% lower parameter values, for panels facing westwards 60% lower, for panels facing east 40% lower and for south facing panels we had 50% lower values than for panel with sun tracking system installed.

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