BUDOWNICTWO
CZASOPISMO TECHNICZNE
TECHNICAL TRANSACTIONS
CIVIL ENGINEERING
WYDAWNICTWO POLITECHNIKI KRAKOWSKIEJ
2-B/2010
ZESZYT 4
ROK 107
ISSUE 4
YEAR 107

MAREK KUŠNÍR, PETER KAPALO*

POWER PRODUCTION USING PHOTOVOLTAIC SYSTEM

PRODUKCJA ENERGII Z UŻYCIEM SYSTEMU OGNIW FOTOWOLTAICZNYCH

Odpowiedzialność za poprawność językową ponoszą autorzy

Abstract

The current economic crisis and energy crisis create a lot of anxieties, which increases people's awareness of the need to look for resources that would ensure their independence in the future. One way to secure this independence is renewable energy sources. The main reason of using these resources is their inexhaustibility, therefore unlimited supply of energy, which can be transformed to other types of usable energy. This group includes solar energy. One of several possible conversions of solar energy is conversion into electricity, obtained from photovoltaic panels.

Keywords: photovoltaic system, heat pump, energy production

Streszczenie

Obecnie kryzys gospodarczy i kryzys energetyczny niosą ze sobą wiele niepewności, stąd ludzie zaczynają powoli zwracać uwagę na zasoby, które zapewniłyby im niezależność w przyszłości. Jednym ze sposobów uwolnienia się od energetycznej zależności są odnawialne źródła energii. Głównym powodem zastosowania tych zasobów jest ich niewyczerpalność oraz nieograniczone dostawy energii, która może zostać przetworzona w inne typy stosowanej energii. Ta grupa obejmuje także energię słoneczną. Jednym z kilku możliwych przekształceń energii słonecznej jest energia elektryczna, uzyskiwana za pomocą ogniw fotowoltaicznych.

Słowa kluczowe: system ogniw fotowoltaicznych, pompa ciepła, produkcja energii

* Ing. Marek Kušnír; Ing. Peter Kapalo, PhD., Institute of Building and Environmental Engineering, Civil Engineering Faculty, Technical University of Košice, Slovakia.

Denotations

PV – photovoltaic
Wp – Watt peak

1. Introduction

The sun is an inevitable part of our everyday life. The sun is the source of all energy on Earth and is a practically inexhaustible source of clean energy. It is assumed that the sun has for burning hydrogen to helium supplies for the following 15 billion years. At the suns core thermonuclear reactions (fusions) are in progress. When these processes are releasing huge amounts of energy, which exceeds 11 000 times the current energy needs of mankind. The simplicity may be said, that the sun can emission energy during one hour, that humanity is able to consume over one year.

2. Description of the administrative building

Office building, where simulations were performed, is situated in Košice, Murgašova street near the centre of town. The building is also used as a laboratory centre building of the Civil Engineering Faculty of Technical University in Košice. The main entrance to the building is on the east side. The building has two main parts. Main section has 6 storeys and the other part has 2 upper floors, used for administrative purposes. The deployment of photovoltaic panels is almost the ideal building. The building has a flat roof with an area of 597.3 m^2 (Fig. 1).

Fig. 1. Flat roof

Rys. 1. Dach płaski

The south façade of the building are two areas on which it is possible to install photovoltaic panels, where the total area is 141.1 m^2 (Fig. 2).

Fig. 2. South façade

Rys. 2. Południowa fasada

3. Photovoltaic system proposal

Photovoltaic system was proposed using 130 pieces of photovoltaic panel using monocrystalline silicon. Maximum power per photovoltaic panel is 180 Wp. 60 pieces of panels will be installed on a flat roof. These panels are firmly placed in the aluminum frame at an angle of 30° and are oriented to the south (Fig. 3).

Fig. 3. Free standing PV system proposal

Rys. 3. Propozycja wolno stojących PV

The remaining 70 pieces of photovoltaic panels will be mounted directly on the external façade of the building structures using aluminum frames. Panels will be facing south at an angle of 90° (Fig. 4).

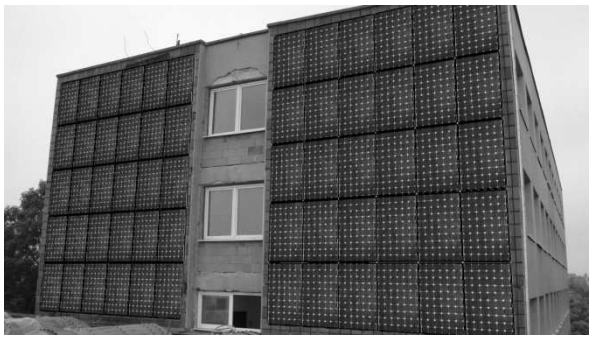

Fig. 4. PV system proposal on the façade

Rys. 4. Propozycja systemu PV na fasadzie

4. Solar potential in Košice

Photovoltaic systems are working well despite the weather (clouds), which uses the diffuse solar radiation. Also, the system is characterized by year round and daily volatility of the intensity of solar radiation. Simulating the conditions chosen for office building situated in Košice is calculated the most favorable inclination of 30° to install PV system, with southern orientation to maximize the potential of solar radiation (Fig. 5). In addition of the optimal inclination, PV systems are also installed in the horizontal and vertical position [1].

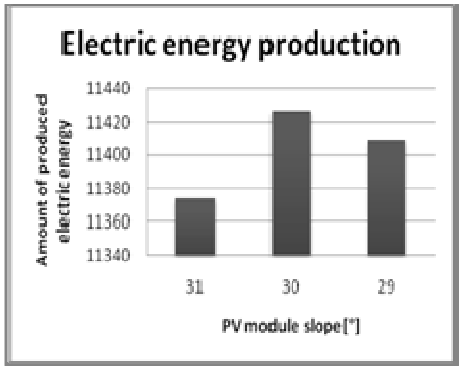

Fig. 5. Optimal PV panel slope

Rys. 5. Optymalne nachylenie paneli PV

The following table (Tab. 1) indicated the amount of solar energy (kWh), which falls on 1 m^2 each month for the city of Košice. The following table describes the amount of incident diffuse and global solar radiation of 1 m^2 area of PV panel. The last column is the average outdoor temperature for each month of the year.

Table 1

The amount of solar radiation and average outdoor temperature

	G [kWh/m^2]	*D* [kWh/m^2]	*T* [°C]
January	29,65	23,18	–2,6
February	46,85	30,40	–0,7
March	90,13	49,00	3,8
April	126,62	61,74	10,2
May	171,17	75,19	15,6
June	179,08	78,99	18,4
July	179,85	77,20	19,8
August	153,62	71,41	19,7
September	107,82	55,00	14,3
October	69,07	38,10	9,4
November	33,69	25,24	4,2
December	23,58	19,29	–1,9

G – global solar radiation

D – diffuse solar radiation

T – average outdoor temperature

5. Simulation of the photovoltaic system

After specifying exact weather and solar condition in the regional conditions into the specialized simulation program, electric energy production is simulated. There are simulated two types of photovoltaic system. The first type is free standing system with 30°

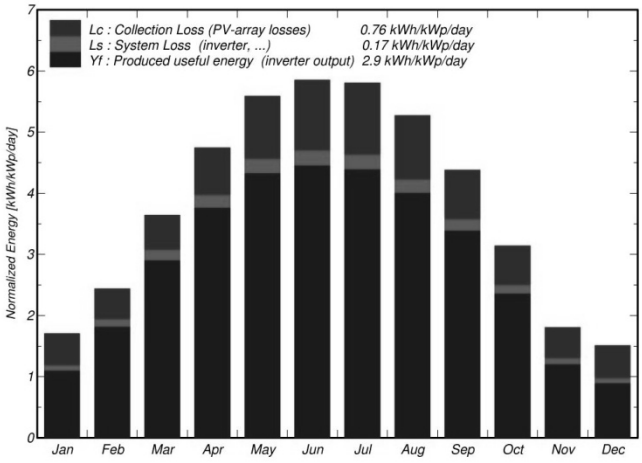

Fig. 6. Produced electric energy with 30° module slope

Rys. 6. Produkcja energii elektrycznej przy nachyleniu modułu 30°

slope (Fig. 6) and the second is 90° slope, that is connected on the façade of the building (Fig. 7).

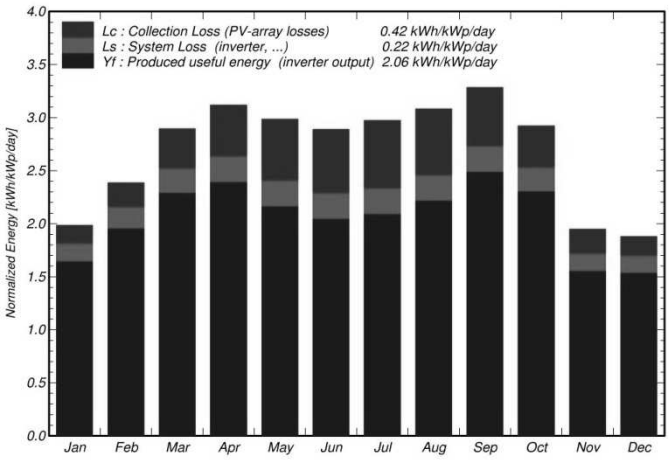

Fig. 7. Produced electric energy with 90° module slope

Rys. 7. Produkcja energii elektrycznej przy nachyleniu modułu 90°

6. Conclusions

Examined office building has measured power consumption values for individual sampling points within a year 2009. The building shows the total electricity consumption during the past year 197 436 kWh/year. When it has produced 20 910 kWh of electricity per year using photovoltaic panels is expected the following percentages covering, which is further described in the following table (Tab. 2) [2].

Table 2

Percentage cover of electricity needs

Coverage of electricity needs	[%]
Building without heat pump	17,8
Heat pump	26,1
Overall	10,6

References

[1] Slovak Renewable Energy Agency, http://www.skrea.sk/index.php?id=177.
[2] Výnos Úradu pre reguláciu sieťových odvetví z 9. septembra 2009 č. 7/2009, ktorým sa ustanovuje regulácia cien v elektroenergetike, http://www.urso.gov.sk/sk/legislativa/vynosy.

This article was created by the project VEGA 1/0079/10 "Smart administrative buildings and related progressive indoor technologies in combination with low greenhouse gases level renewable energy sources".