SOLAR ENERGY

Matúš Katin, Vladimír Krištof, Stanislav Kušnír, Ľudovít Csányi, Martin Marci

ABSTRACT

This article deals with the renewable energy sources. More concretely it deals with the solar energy and photovoltaic cells. The article describes inclusive flash history and distribution of solar devices. The principle of photovoltaic cell function and constructions is mentioned marginally.

.

1. INTRODUCTION

Presently the Slovakian energy supply depends for more than 70% on import of fossil fuels. As Slovakia only has limited natural fossil energy resources a transmission towards renewable energy supply is important to guaranty a long term energy and therewith political independence. Furthermore, the EU directive on the promotion of electricity produced from renewable energy sources sets a target that by 2010 31 % of the overall Slovak electricity consumption should come from renewable electricity production plants. Given the geographical and geological situation, four renewable electricity production technologies appear to be most applicable for Slovakia: 1) Hydropower, 2) Photo-Voltaic solar energy, 3) Wind and 4) Biomass.

2. HISTORY OF SOLAR CELLS

PV was first commercially applied in space travel in 1957. At that time PV was extremely expensive ($ 300, - per Watt) while the efficiencies did not exceed 9%. The high cost of fuel transport into space however made PV competitive for that specific niche market. In 1970, with a module price of $ 100, - per Watt [2], the price of solar electricity was still more than 100 times the price of electricity generated by fossil fuel fired power plants. Since 1970 however the price of modules has come down dramatically to $ 5,- per Watt (€ 3,- per Watt) and the end of the price reduction is not yet in sight. The first cells, used in the Vanguard satellite were silicon solar cells. Since that time many new cell concepts have been developed. They include new materials, new structures, new processes, etc. While for space travel the ratio of Watt per kg was the leading criteria, for terrestrial applications the cost per Watt is far more important. The new developments are therefore aiming at reduction of cost per Watt through either improvement of efficiency or reduction of cost. They could be divided into two groups, with a comparable cost per Watt objective:

1. low efficiency low cost cells and
2. high efficiency, high cost cells.

The first group is more suitable for regions where surface area is amply available and mounting constructions can be cheap (deserts, factory roofs, etc.), the second group is more interesting in situations where one is looking for a high energy production per m2, which is when surface area is scares and mounting constructions are expensive (domestic rooftops, facades, spacecrafts).

3. WHERE SOLAR IS FOUND

Solar energy is everywhere the sun shines. Solar energy is by far the Earth's most available energy source. Solar power is capable of providing many times the total current energy demand. But it is an intermittent energy source, meaning that it is not available at all times. However, it can be supplemented by thermal energy storage or another energy source, such as natural gas or hydropower. According to the energy budget, our earth is able to receive around 51% of the sun’s solar energy. The rest is either absorbed by clouds and the atmosphere or radiated back into space.

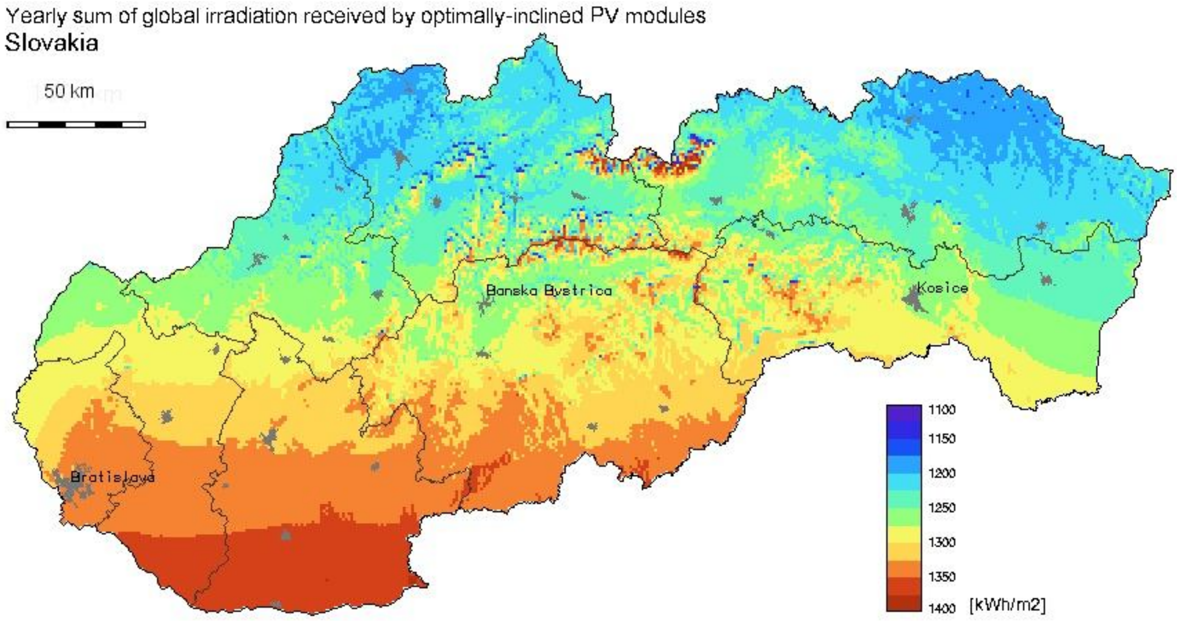

Figure 1 - Slovakia horizontal irradiation at the optimum angle.

4. SOLAR PHOTOVOLTAIC CELL

A photovoltaic cell, commonly called a solar cell or PV, is the technology used to convert solar energy directly into electrical power. A photovoltaic cell is a nonmechanical device usually made from silicon alloys. Sunlight is composed of photons, or particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity. When enough sunlight (energy) is absorbed by the material (a semiconductor), electrons are dislodged from the material's atoms. Special treatment of the material surface during manufacturing makes the front surface of the cell more receptive to free electrons, so the electrons naturally migrate to the surface.

When the electrons leave their position, holes are formed. When many electrons, each carrying a negative charge, travel toward the front surface of the cell, the resulting imbalance of charge between the cell's front and back surfaces creates a voltage potential like the negative and positive terminals of a battery. When the two surfaces are connected through an external load, such as an appliance, electricity flows.

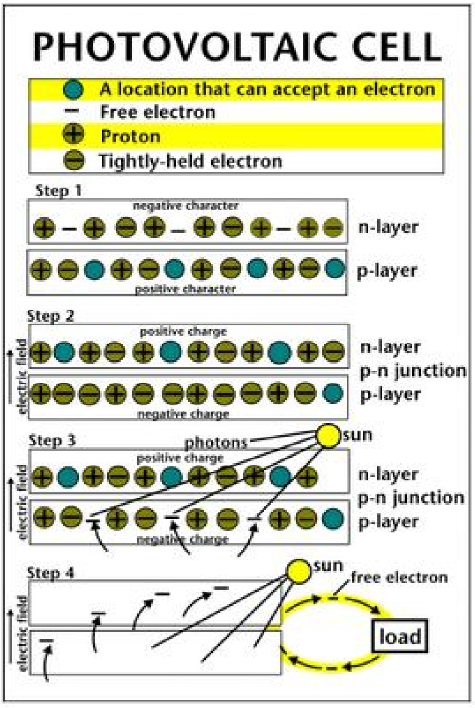

Figure 2 - Photovoltaic cell construction

4.1. How photovoltaic systems operate

The photovoltaic cell is the basic building block of a photovoltaic system. Individual cells can vary in size from about 0.5 inches to about 4 inches across. However, one cell only produces 1 or 2 watts, which isn't enough power for most applications. To increase power output, cells are electrically connected into a packaged weather-tight module. Modules can be further connected to form an array. The term array refers to the entire generating plant, whether it is made up of one or several thousand modules. The number of modules connected together in an array depends on the amount of power output needed.

The performance of a photovoltaic array is dependent upon sunlight. Climate conditions (such as clouds or fog) have a significant effect on the amount of solar energy received by a photovoltaic array and, in turn, its performance. Most modern modules are about 10% efficient in converting sunlight. Further research is being conducted to raise this efficiency to 20%.

The success of PV in outer space first generated commercial applications for this technology. The simplest photovoltaic systems power many of the small calculators and wrist watches used every day. More complicated systems provide electricity to pump water, power communications equipment, and even provide electricity to our homes.

Photovoltaic cells, like batteries, generate direct current (DC), which is generally used for small loads (electronic equipment). When DC from photovoltaic cells is used for commercial applications or sold to electric utilities using the electric grid, it must be converted to alternating current (AC) using inverters, solid state devices that convert DC power to AC.

5. CONCLUSIONS

In these days topic about renewable energy sources is most actual and discussed. As we are getting out of fossil fuels, we need to find new sources of electricity. When our country joined the EU we pledge to produce 20% of electricity from the renewable sources by 2020 . As Slovak republic has only few stores of fossil fuels question about renewable energy sources is the most important. Finally, there is the need for reducing the emissions and cutting-down environmental pollution. Solar energy is one of the ways how we can reach this aim.

REFERENCES

[1] Solar Basic. Available on internet < http://www.eia.doe.gov/kids/energy.cfm?page=solar_home-basics> 2006

[2] *Kolcun, M. – Mešter, M.- Chladný, V. – Cimbala, R.– Rusnák, J. – Tkáč, J. – Hvizdoš, M.:*.Elektrárne, TUKE 2006, ISBN 80-8073-704-5

[3] *European communities:* Solar radiation and PV maps Europe 2007. Available on internet: < http://re.jrc.ec.europa.eu/pvgis/countries/europe.htm> 2007

AUTHORS:

Ing. Matúš Katin
Technical University in Košice
Department of Electric Power Engineering
Mäsiarská 74, 041 20 Košice, Slovak Republic
E-mail: matus.katin@tuke.sk
Tel: + 421 55 602 3566

Ing. Vladimír Krištof
Technical University in Košice
Department of Electric Power Engineering
Mäsiarská 74, 041 20 Košice, Slovak Republic
E-mail: vladimir.kristof@tuke.sk
Tel: + 421 55 602 3566

Ing. Stanislav Kušnír
Technical University in Košice
Department of Electric Power Engineering
Mäsiarská 74, 041 20 Košice, Slovak Republic
E-mail: stanislav.kusnir@tuke.sk
Tel: + 421 55 602 3566

Ing. Ľudovít Csányi
Technical University in Košice
Department of Electric Power Engineering
Mäsiarská 74, 041 20 Košice, Slovak Republic
E-mail: ludovit.csanyi@tuke.sk
Tel: + 421 55 602 3566

Ing. Martin Marci
Technical University in Košice
Department of Electric Power Engineering
Mäsiarská 74, 041 20 Košice, Slovak Republic
E-mail: martin.marci@tuke.sk
Tel: + 421 55 602 3566