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Solar Energy Conversion Methods*

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Abstract

This article presents the characteristics of three basic methods of solar energy conversion: thermal energy – photothermal conversion, electrical energy – photovoltaic conversion, energy related to chemical processes – photochemical conversion. The paper addresses some aspects of the primary goals of EU climate and energy policy, as well as the benefits of passive building constructions.

Keywords: solar energy conversion, energy policy, education

Wstęp

The primary goals of EU climate and energy policy are improving energy efficiency and increasing the share of renewable energy in the total energy balance of the European Union. Every country's energy policy is based on the strategy of balancing the safety of energy materials supply, effectiveness of economic processes and environmental protection.

Solar energy is an energy source for the beings living on Earth. The sun produces vast amounts of energy in a form of radiation. Only a small portion of this radiation reaches Earth, yet it is still 15 times more than is demanded. This source has one disadvantage though – it produces low-density energy which makes its conversion problematic (Ostrowska, Sobczyk, Pawul, 2013). The intensity of solar radiation varies across different regions.

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There are many ways of making use of solar energy reaching the Earth surface. However, three basic methods of solar energy conversion are practicable:

– thermal energy – photothermal conversion
– electrical energy – photovoltaic conversion
– energy related to chemical processes – photochemical conversion (Sobczyk, Pelc, Kowal, Ranosz, 2017).

Thermal energy – photothermal conversion

Production of hot water is the simplest, most available and efficient method of using solar energy. Efficiency of energy conversion in solar collectors designed to convert solar energy into thermal energy may amount to as much as 90%. Also, the structure and operation of such devices are relatively uncomplicated. However, favourable climate conditions are required; therefore the expected results will not be achieved everywhere. Solar collectors enable photothermal conversion of solar radiation in order to heat spaces and tap water, to produce electrical energy and to conduct chemical processes. Solar collectors require a carrier to transport and transfer heat. The temperature of working substance at the device outlet determines the design of the collector, which can be of low-, medium- and high-temperature type. Collectors can also be classified based on the type of working substance, namely liquid and vacuum. The basic element of a collector is the absorber, i.e. a plate coated with a thin layer of black nickel, copper and other material.

The absorber boasts a high coefficient of solar radiation absorption and low coefficient of thermal radiation emission. The flow-through part of the collector is insulated with a material that has a low thermal conductivity coefficient (mineral wool, polyurethane foam). Transparent covers – such as glass panes or transparent insulation – are used for sealing the surface of the collector. Such elements minimize heat loss from the surface of the absorber by convection.

Electrical energy – photovoltaic conversion

The most convenient way to obtain energy is, undeniably, generating it in an electrical form. There are also methods of obtaining electricity from the energy carried by solar radiation – e.g. photovoltaics produce direct current that is usually converted into alternating current. However, it is only profitable to build and install the required devices in highly-insolated areas, where the sun shines for 1800–2000 hours per year on average.

A photovoltaic cell is a semiconductor which converts solar energy into electricity. A typical photovoltaic cell is a plate made of crystalline or polycrystalline silicon where a barrier for electric potential is formed. The sunlight that reaches a photovoltaic cell generates pairs of electric energy mediums (electrons and positive holes). Under the influence of the electric field, they are scattered,

resulting in a potential difference, i.e. PV voltage. When a connection with the receiver of electricity is made, the flow of electric current commences. The thickness of the plates is in the range of 200–400 micrometres. A single cell produces 1–2 watts of power. To provide higher voltages or currents photovoltaic cells are connected in series or parallel forming photovoltaic modules.

Energy related to chemical processes – photochemical conversion

This type of solar energy conversion is mainly used in agriculture (photosynthesis). Solar energy is transformed into usable energy by recuperation of the energy from organic matter by way of combustion or through other decomposition process. Approximately 3% of solar energy can be extracted, but the process itself is complicated and costly.

Passive building construction

Passive solar systems can use some elements of the building (e.g. glazing) to accumulate heat. No intermediate medium is used for heat transport and transfer. Sun rays in the form of visible and infrared waves penetrate into the rooms, being accumulated in walls, floors and ceilings. The elements heat up and emit thermal radiation, producing the greenhouse effect (http://www.passivesolarenergy.info).

Passive heating methods are effective only for buildings with a low unit energy demand for heating purposes. They may also be an auxiliary source of heat in conventional buildings.

Modern construction industry offers increasingly airtight and warm houses and it pays much attention to the selection of materials which would ensure the lowest energy losses. Warm and airtight windows, modern building materials, minimizing the number of thermal bridges and lowering the heat transfer coefficient due to the excellent insulating materials and their proper installation are all elements significantly affecting the energy demand of a building. Since 2009 all new buildings need to obtain certificates to determine their energy efficiency (Wielewska, Sobczyk, Gliniak, 2017).

Passive building construction is a sector of the construction industry that has extremely low demand for the energy for heating house interiors. A passive house requires a small amount of energy to provide thermal comfort, but it requires proper systems (HRU, heat pumps, solar collectors) to accomplish that effect.

Modification of a traditional building into a passive building is quite expensive and requires a large amount of work (capital-intensive investment). It is much easier to build a passive house from scratch, which reduces costs and allows for much greater freedom in terms of design. In both cases, subsidies can be obtained for installations that use alternative energy sources.

Summary

Environmental education of the society in the use of alternative solutions of building thermoregulation is a key to environmental and power policies of the state (Bogoliubov, Nagorniuk, Sobczyk, 2016). Raising awareness among the society of the advantages of applying unconventional solutions in residential buildings may bring great environmental and social gains.

REFERENCES

Bogoliubov, V.M., Nagorniuk, O.M., Sobczyk, W. (2016). Providing Environmental Training in the Context of Ukraine's Transition to Sustainable Development. *Annals of Agrarian Science, Ecological Agricultural and Nature Conservation*, *14* (4), 292–294.

http://www.passivesolarenergy.info (27.12.2017).

Ostrowska, A., Sobczyk, W., Pawul, M. (2013). Evaluation of Economic and Ecological Effects of Solar Energy on the Example of a Single-family House. *Annual Set The Environment Protection*, *15*, 2697–2710.

Sobczyk, W., Pelc, P., Kowal, B., Ranosz, R. (2017). Ecological and Economical Aspects of Solar Energy Use. *E3S Web of Conferences, 14, 01011*, 1–8.

Wielewska, I., Sobczyk, W., Gliniak, M. (2017). Energia z OZE jako dobrobyt społeczny w opinii polskich rolników. *Folia Pomer. Univ. Technol. Stetin., Oeconomica*, *333* (86) 1, 91–100.