

POSSIBILITIES OF USING ALTERNATIVE ENERGY SOURCES IN SLOVAKIA

Blanka GALBIČKOVÁ, Alica BARTOŠOVÁ, Maroš SOLDÁN

*Authors: Ing. Blanka Galbičková, Ing. Alica Bartošová,
Doc. Ing. Maroš Soldán, PhD.*
*Workplace: Slovak University of Technology in Bratislava,
Faculty of Materials Science and Technology in Trnava,
Institute of Safety and Environmental Engineering*
Address: Botanická 49, 917 24 Trnava, Slovak Republic

Abstract

Nowadays, alternative sources of energy are being more preferred. Traditional sources such as coal, nature gas and oil are limited. Using the atom splitting for generation of electricity has many disadvantages such as a huge amount of nuclear waste. There is also the threat of nuclear disaster, and therefore alternative sources of energy such as a clean energy are used increasingly. In this paper, alternative sources, that means solar energy, geothermal energy, wind energy and energy of biomass are discussed. On the base of legislative framework and possibilities of landscape, proposed are the ways of using these sources in more locations.

Key words

alternative energy sources, biomass, wind power, geothermal power, sun power

Introduction

In 2002, Slovakia ratified the Kyoto Convention, which is committed to reducing greenhouse gas emissions which are the main gases that cause global warming. For Slovakia, Appendix B of the Kyoto Protocol defined the reduction commitment for the period 2008 - 2012 in as a 5-fold 92 % of total national greenhouse gas emissions in 1990. In 1990, Slovakia issued the total of 72 107 million tons of greenhouse gases expressed as carbon dioxide equivalent. After deduction of 8 % Kyoto commitment is to SR 295,640 million tonnes in the years 2008 to 2012 (an average of 59,128 million tonnes per year) (1). Using renewable energy sources is one of the ways how to limit and also how to break the increasing dependency on traditional fossil fuels. The impact of energy on the environment is still interested in more prominent place in the way of management of the national economy in all developed countries.

Using renewable energy

It produces about 5.2 TWh per year of electricity, which is about 16 % of domestic electricity consumption. As reported in the energy policy of the Slovak Republic, the total exploitable potential of various types of renewable energy enables to increase their share of total electricity production to 24 % in 2030.

EXPLOITABLE POTENTIAL OF RENEWABLE SOURCES (2)

Table 1

Source	Exploitable potential	
	PJ[peta joule]	GWh
Water-energy	47.6	13222.222
Biomass	151.2	42 000
Biofuels	11.9	3305.556
Wind-energy	2.2	611.111
Geothermal-energy	22.7	6305.556
Sun-energy	18.7	5194.444
OVERALL	254.3	70638.889

BIOMASS

Biomass is one of the oldest sources of energy, especially in rural areas where it is often the only accessible and affordable source. It is a renewable energy source because its reserves are not limited. Currently, attention is being paid to other sources of exploitable biomass for energy purposes, for example duckweed biomass what is a plant with a high starch content which does not require such a complex process to convert cellulose biomass to ethanol (3). Biomass is the largest renewable sources of energy potential (in addition to solar energy). The total technical potential of renewable energy sources in Slovakia is 42 % biomass. Biomass can be used for energy purposes in several ways: a) direct combustion - waste, wood waste, agricultural waste; b) thermochemical processing to improve the quality of biofuels - pyrolysis, gasification; c) anaerobic fermentation or putrefaction - leading to the production of gaseous and liquid biofuels (bioethanol, biogas). The immediate product of these processes is heat, which can be used in the place of production or in its vicinity. The heat is used directly for production of hot water or steam, followed by electro-powered generator and produce electricity.



Fig. 1 Companies processing bioethanol in Slovakia (6)

Bioethanol has been produced in ENVIRAL, Leopoldov since 2007. It is the first producer of bioethanol in Slovakia. The annual production capacity of bioethanol is 120,000 m³, which is the largest production capacity of the new EU Member States. Another company in Leopoldov focusing on biofuels is MEROCO. Fatty acid methyl ester (FAME), also called biological diesel, is produced there. Biodiesel belongs to a category of fuels manufactured from renewable power sources. FAME is, in various proportions, folded into the diesel oil and this alone decreases the amount of CO₂ emissions released into the atmosphere. It is produced from agricultural products cultivated in the territory of the particular country, so its production decreases the dependence of the state economy on the import of fuels from abroad. (5) BGV, s.r.o in Hviezdne started its operation in 2008. Production capacity is 15 000 litres per day, the product is designed for petrochemical, industrial and technical sectors, where is required purity level. Ethanol concentration in the product is 94.0 % vol min.

In the past, biofuels were produced by such companies as Palma Group, where FAME production capacity of the company stood at 40,000 tonnes per year. Additional producers include FAME Slovakia Bio Plus, Agrochemix, EkoTips and several smaller manufacturers (6).

Biogas is generated from organic materials under anaerobic conditions. Feedstock for biogas generation includes cow dung, poultry droppings, pig manure, kitchen waste, grass faecal matter and algae. Biogas technology was introduced in Slovakia during the previous century, for the sanitary measures and also to reduce the volume and odour of increasing quantities of municipal waste.



Fig. 2 Companies processing biogas in Slovakia (6)

The Fig. 2 shows some companies processing biogas. For example, in Zvolen, biogas is produced from the operation of wastewater treatment plants for the production of electricity and heat. A company for biogas production from the operation of wastewater treatment plants is situated in Banká Bystrica, too. In 2003, biogas plant Kapušany near Prešov was opened; excrements of farm animals are used there as biomass for biogas production (6). In 2011, there were 30 biogas plants in Slovakia, and interest in the possibilities of biofuels production of keeps growing.

WIND

Wind energy is a form of solar energy produced by uneven heating of the earth's surface. The sun radiates energy towards the Earth equal to 1×10^{14} KWh. From this value, approximately 1 to 2 % is converted into wind energy (4).

The first wind park in Slovakia was put into operation in 2003 in the village of Cerová. Wind park Cerová consists of four Vestas V 47/660 wind turbines, each with an installed capacity of 0.66 MW, and a total power of 2.64 MW. Annual production is more than 5million kWh of electricity and the electricity consumption covers 1,200 households per year. Electricity generation in the wind park saves 3,500 tonnes of CO₂ per year. Wind park Myjava, Sharp Hill location, consists of a single Vestas V 39/500 wind turbine, with an installed capacity of 0.50 MW. Annual production is more than 1 million kWh of electricity. Electricity generation in the wind park saves 700 tons of CO₂ per year. Wind park Skalité, consists of four Vestas V 39/500 wind turbines, each with an installed capacity of 0.50 MW, and a total power of 2.00 MW. Annual production was more than 1.5 million kWh of electricity. Electricity generation in the wind park saved 1,050 tonnes of CO₂ per year. The wind farm was commissioned in 2004, and in 2008, the operation of wind turbines was completed (6).



Fig. 3 Map of wind parks in Slovakia (6)

Suitable sites for wind energy generation are also the areas where the average annual speed of wind is at least 60 meters measuring $6.0 \text{ m}\cdot\text{s}^{-1}$. Suitable locations for the installation of wind turbines are mountainous areas and lowlands or national parks. In Slovakia, there are several relatively suitable sites. It should be noted that, in addition to good wind conditions, a critical factor for building a wind farm is a connection to the distribution network, non-interference in protected natural areas and settlement division of the location. For the last 10 years wind power, in addition to natural gas, is the fastest growing energy source in the EU.

GEOHERMAL ENERGY

Geothermal energy uses the Earth's internal heat. Energy is produced when underground heat is transferred by water that is heated as it passes through hot rocks or shallow magma bodies located at depths of a few hundred meters to a few kilometres. The water is brought to the surface as hot water or steam through borewells drilled for the purpose. The water is often naturally occurring groundwater that seeps down along faults/fractures. In some cases, the water is artificially introduced by pumping down from the surface through borewells (7). Types of geothermal power systems are Dry Steam Power Plants, Flash Steam Power Plants and Binary-Cycle Power Plants (8). The Slovak Republic has a great potential for geothermal power, which on the basis of previous surveys and is provisionally estimated at 5,538 MWt (9).

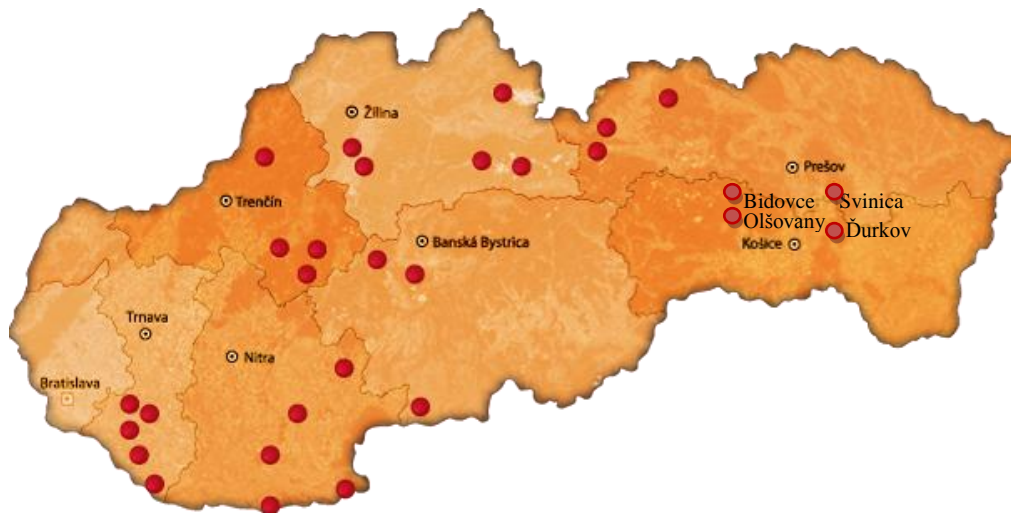


Fig. 4 Potential of geothermal energy in Slovakia (9)

At present, there are 26 geothermal areas, which take 27% of the Slovak surface area. Currently, 117 drill holes are registered in Slovakia, 5 of them being negative. Košická kotlina was proved the most prospective area for building a geothermal power plant. The first geothermal power plant will be building till the end of 2012 and will be located in Svinica-Ďurkov. An output is 3.5 MW. Total heat capacity in Bidovce, Svinica, Ďurkov and Olšovany is approximately 100 MW, which is the greatest source in the middle Europe. Geothermal energy in Košická kotlina will be used for supplying electricity to Košice (10).

SOLAR ENERGY

Photovoltaic (PV) is a technology which generates electricity directly from solar radiation by using semiconductor material. This conversion becomes directly without any emissions of greenhouse gases or any solid parts. The main part of solar system is a solar cell. Solar cells are composed of various semiconducting materials. Semiconductors are materials, which become electrically conductive when supplied with light or heat, but which operate as insulators at low temperatures (11). The essence of a solar cell is the flow of electric current (the creation of the electric field) between two interconnected semiconductor (the most common are silicon solar cells) (12). Although the sunshine conditions in Slovakia are better than in the Czech Republic or Germany, Slovakia is relatively backward in the construction of photovoltaic power plants. This is due to the fact that legislation to promote renewable energy sources in Slovakia was adopted recently (13).

Several photovoltaic power plants are being built in Slovakia now. The potential of solar power plants in Slovakia which depends on solar radiation is shown in Fig.4.

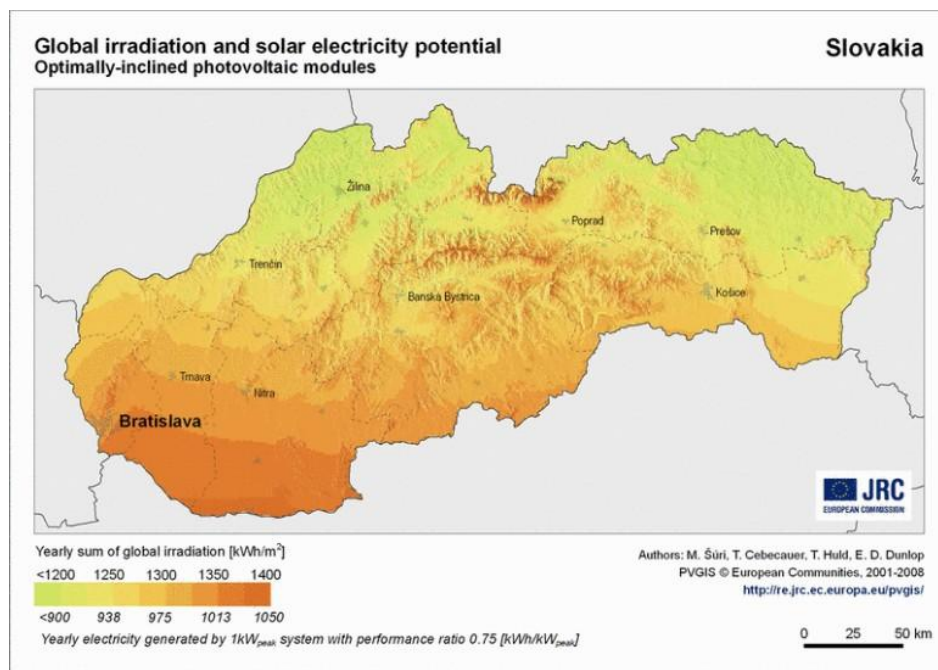


Fig. 5 Potential of solar power plants (14)

Until 30th June 2011, the total output of solar power plant was 480.35 MW. Since 1st July 2011, a new decree 7/2011 issued by the Regulatory Office for Network Industries determining the new purchase price has been in force. The prices of electricity are lower for the electricity produced by solar system. The current redemption price is set at € 259.17MWh (15).

Conclusions

The key criterion, besides continuity and long-term stability of any implemented policy for achieving an accelerated future renewable energy sources deployment in an effective and efficient manner, is the technology specification of the necessary support. This is reflected in Slovakia's current support for renewable electricity.

The support of electricity from renewable sources in 2009 was approved by Act No. 309/2009 Coll. of 19 June 2009 on the Promotion of Renewable Energy Sources and High-efficiency Cogeneration and on amendments to certain acts. The Act has improved the functioning of the electricity market in renewable energy and created a stable business environment. Ensure long-term guarantee of purchase prices for 15 years and also commissioned by the direction in the production of electricity from renewable energy sources, as favoured construction of small and decentralized.

Energy from biomass

Of the total area of Slovakia (4,903,423 hectares), agricultural land covers 49.7% and 40.84% of forest land. Disposals of agricultural land have been significant in recent years, but it is possible to observe changes of arable land to grassland. Biomass has great prospects for

heating in the form of wood pellets, chips and straw. It is essentially immediately available, but the least used. Forest biomass represents an annual value of 2.46 million tons with an energy equivalent of 26.8 PJ. Biomass is an important source of timber industry, which produces 1.84 million ton of wood waste per year. Another type of sources are the existing trees on non-forest vegetation land, waste from municipal sector, remains and excrement from animal farms and also the purpose-grown green. Biomass is a domestic resource that is easily accessible and practically independent from the energy policy of the state and the cheapest one compared to other renewable energy sources.

Wind energy

Theoretical estimation of maximum wind potential in Slovakia is around 3 billion KWh per year, but actually usable is about one third or 1 billion kWh per year. In Slovakia, there are approximately 4300 km² of suitable areas for the construction of wind farms, with an average wind speed of more than 4 m.s⁻¹ (less than 14.4 km.h⁻¹). For most mountainous area (altitude over 600 m) it is necessary to join wind farms to either local area.

And for larger plants would be necessary to allow the building itself as well as the construction of wind farms connected to either local consumption or to the public network. Many suitable sites are found in Podunajská nížina, where the air flow is more regular than in the hilly terrain. Locations with relatively good wind conditions are also found in the regions of Kysuce, Orava, Spiš and Malé Karpaty. Slovakia's accession to the EU has contributed to improving the access of government. ***Solar energy***

On the base of legislative background and solar irradiation conditions, there are many solar power plants in Slovakia. We can tell solar energy is quite popular in Slovakia. Solar energy is used in villages for electricity generation and for heating or heating water in households.

Geothermal energy

At present, in Slovakia, there are 26 geothermal areas defined, which take 27% of the Slovakia surface area. The most famous is Košická kotlina in which a geothermal power plant is being built. Total heat capacity in Bidovce, Svinica, Ďurkov and Olšovany is approximately 100 MW, which is the greatest source in the middle Europe. Geothermal energy in Košická kotlina will be used for supplying electricity to Košice. Other locations in which geothermal energy is used are Galanta and Podhájska. Galantaterm Ltd. in Galanta uses geothermal energy for heating buildings and water. In Galanta, one block of flats is heated by this company. In the village of Podhájska, geothermal energy is used for heating swimming pools. This area is famous for thermal spring.

This contribution was written with the support of the Research and Development Operational Programme for "Hybrid power source for technical and consulting laboratory use and promotion of renewable energy sources" project (ITMS 26220220056), financed from resources of the European Regional Development Fund.

References

1. Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
2. Kolektív autorov: *Polnohospodárska biomasa*. 2009, ISBN 978-80-968507-6-1

3. CHENG, J.J., STOPMP, A.M, *Production of high-starch duckweed and its conversion to bioethanol*. Biosystems engineering, 110, 2011.
4. Wind Force10, A blueprint to achieve 10% of the world's electricity from wind power by 2020, ISBN 1 871532 248 [online] <<http://www.inforse.dk/doc/Windforce10.pdf>>
5. MEROOCO, a.s., [online] <<http://www.meroco.sk/index.php?option=about-the-company&lang=en>>
6. Atlas obnoviteľných zdrojov energie, [online] <<http://www.atlasoze.sk/index.html>>
7. GUPTA, H., ROY. S, *Geothermal energy, An alternative resource for 21st century*, Elsevier, 2007. 9p. ISBN 978-0-444-52875-9
8. Geothermam power plant [online] <<http://www.geothermalpowerplant.com/>>
9. Geothermal energy in Slovakia [online] <<http://www.atlasoze.sk/geoterm.html>>
10. First geothermal power plant in Slovakia [online] <<http://www.skrea.sk/index.php?id=851>>
11. BOLEMAN, T., FIALA, J. *Obnoviteľné zdroje energie*. Trnava: Tlačové štúdio Váry, 2009. 21s. ISBN 978-80-89422-07-4
12. Photovoltaics principles [online] <<http://www.solarserver.com/knowledge/basic-knowledge/photovoltaics.html>>
13. HASELHUHN, R. *Budovy jako zdroj proudu*, HEL 2010, 17-21s. ISBN 978- 80- 86167-33-6
14. Photovoltaics in Slovakia [online] <<http://www.joyce-energie.cz/slovensko/fotovoltaika-na-slovensku/>>
15. Support of photovoltaics in Slovakia [online] <http://www.stavebne-forum.sk/events2009/prezentacie/1020_karaba.pdf>

Reviewers:

Prof. Ing. Peter Horbaj, PhD.

Doc. Ing. Jana Müllerová, PhD.