SOLAR THERMAL ENERGY USE IN BULGARIA

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Introduction

Bulgaria is a sunny country and the solar energy has been used for ages, mostly for drying of agricultural products and for hot water production. The traditional Bulgarian architecture benefited of the advantages of the passive solar air condition for hundreds of years.

Fig. 1 presents the total annual solar radiation (kWh/m^2)

The theoretical and technical potential of RES in Bulgaria is among the greatest in Europe (Table 1).

RES	Theoretical potential 10^3 toe/year	Technically feasible potential (2010) 10^3 toe/year	Utilised potential (1997)	Usage
Solar	13x10^6	246	50000 m^2 solar collectors	Domestic hot water
Biomass	3608	380	n.a.	Heating, cooking, industrial needs
Hydro-power	2276	428	2432 MW installed capacity in HPPs	Electricity generation
Geothermal	482	95	32642 toe/year	Green-houses, health care, domestic heating
Wind	75000	31.5	n.a.	Water pumping for irrigation

Table 1. Bulgarian Theoretical and Technical Potential of RES

The technical potential of solar energy is distributed as follows:

	10^3 toe/year	%
Photo voltaic panels	52	21
Active solar thermal energy systems	161	66
Passive solar thermal energy systems	33	13
Total	**246**	**100**

Current status of solar thermal installations in Bulgaria

It is evident that 66 % of technical solar potential belong to the active solar thermal energy systems, which are mostly applied until now; therefore only these will be considered in the present report. It should be mentioned that PV modules are, so to say, symbolic. Bulgaria was the leader in Eastern Europe in design and production of solar thermal installations. The first Bulgarian solar thermal collectors have been of panel type radiators with area of 2 m^2, next step of design was the flat plate collectors with area of 1,46 and 1,76 m^2. The first Bulgarian solar collector was designed and produced in 1977. The state enterprise "New Energy Sources" (NES) was in a position to solve technical problems related to research, design, testing, manufacturing and assembling of solar thermal installations. NES implemented a large-scale governmental programme for designing, the manufacture and installation of 50 000 m^2 solar collectors. These collectors were installed during 1977-90 mainly in the tourist facilities for hot water supply at the Black Sea coast. Fig. 2 presents the regional distribution of these solar thermal installations.

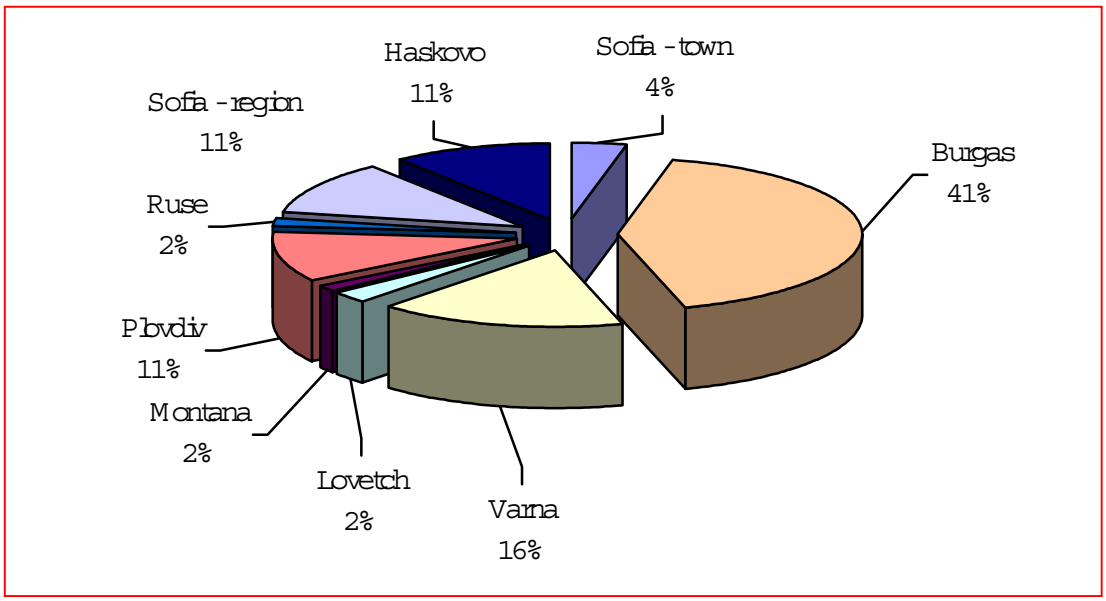

Fig. 2

Most of the collectors installed comprise of steel absorbers, black coating, single glass cover and galvanized steel collector surrounding. The pipes for installations are 99 % from steel.

Arbeitsgemeinschaft ERNEUERBARE ENERGIE – AEE, supported by the Austrian Ministry of Environment and Youth, implemented in 1998-99 the project "Statistic evaluation and analysis of large-scale Bulgarian solar

installations". The report overviews in detail the situation of large-scale solar installation in three regions of Bulgaria – Burgas, Plovdiv and Sofia. Detailed surveys had been done, reviewing the present condition of the various elements of solar collectors and installations. The main conclusions are very characteristic and significant for the solar thermal installations market in the country and also review the main factors influencing it.

- The installation of 50 000 m^2 solar collectors for the period 1977-90 was made in the framework of a governmental programme and was financed by the government, local authorities, etc.
- This policy was not related with the market penetration of solar thermal installations for households, small hotels, etc.
- The low energy prices of the fuels and electricity at that time and incompetitiveness of the price of a solar energy
- Since 1990, Bulgaria is in transition and major part of the tourism facilities and industrial enterprises have been privatized or undergoing this procedure. This is one of the reasons for the poor maintenance, leading to the present bad status of the installations.

  54 % of the installations in the tourist facilities are still operational, but for the industrial sector – these are only 8 %.
- Major part of the existing installations require repair. The main problems are the corrosion of steel collector surrounding and the absorber coatings, lack of frost protection; broken glasses, etc.

During the last 10 years, the prices of the energy carriers (electricity, heat, liquid fuels, etc.), have been many times increased and are closer now to those of the European market. Thus, the main barrier – low energy prices – has been eliminated. The new private companies and the population start investigating the possibility of energy efficiency and utilisation of new energy sources and mainly solar energy.

During the last years, many demonstration projects have been implemented under various programmes on solar thermal utilisation in Bulgaria.

Sofia Energy Centre took part in the implementation of energy efficient solar system in the kindergarten "Alen Mak" in the town of Veliko Turnovo (1998), for domestic hot water production and hot water supply for the swimming pool.

The solar collectors manufactured by Kaloria S.A. – Greece, have been installed into 2 systems, each with 8 collectors featuring effective area of 15,44 m^2. Each system is connected with a boiler ISOTHERM, 800 l, with a special construction of 2 serpentines. The system is characterized of combined cycle of operation – making use of solar energy, heat energy and electricity. The heat carrier of the cycle solar collector – boiler, is antifreeze. Thus the installation can be used during the whole year period. The antifreeze circulation is a closed cycle and driven by a pump with electronic programming device. The second serpentine heats the water in the boiler through the hot water derived from the heat exchanger of the district heating system. The water may also be heated by a 4 kW electric heater.

Another demonstration project – Solar thermal installations for various types of buildings (blocks of flats, houses, restaurants, pizzerias, etc.) has been realised by Sofia Energy Centre in 1996. The solar collectors have also been manufactured in Greece.

Within the PHARE programme, different solar thermal demo projects have been implemented. Table 2 presents technical data and financial and ecological benefits of 3 projects in hospitals in Southern Bulgaria.

No	Parameters	Measure	Stara Zagora	Radnevo	Krumovgrad
1.	Investments	EUR	116970	62190	34005
2.	Fuel savings – oil gas	t/year	38.0	19.1	10.5
3.	Cost savings	EUR/year	7994	4750	2973
4.	Simple pay-back period	Years	16.4	15.9	16.0
5.	Solar collectors – area	m^2	405	210	110
6.	Accumulation volume	l	7000	5000	3500
7.	Hot water consumption incl. distribution losses	MWh/y	352	198	92
8.	Measured production	KWh/m^2/y	501	550	572
9.	Measured production	MWh/y	203	116	62
10.	SC cover summer/winter	%	100/25	100/25	100/32
11.	Reduced CO_2 emissions	t/year	71.01	40.44	22.03
12.	Reduced SO_2 emissions	t/year	0.48	0.27	0.15
13.	Reduced NO_x emissions	t/year	1.44	0.82	0.45
14.	Particles	t/year	0.10	0.05	0.03

Table 2. Financial, technical and ecological data and results

Table 3 presents 5 solar thermal demo-projects in Northern Bulgaria. The first three of them were of plate solar water collectors (made in Bulgaria) – bivalent installation for hot water with driven circulation.

For the ZEMUS enterprise, two bivalent solar systems have been designed, each one comprising of 2 groups of four modules. Each module comprised of a solar collector and a boiler, working in a gravitation regime.

The fifth project is solar dryer for the wood processing enterprise and is integrated in the roof.

No	Parameter	Measure	Kindergarten "Eugenia Kissimova", Veliko Turnovo*	"ELIOT" Ltd, Veliko Turnovo*	Sanatorium in Ovcha mogila village*	Zemus Ltd.*	EMOS – Solar Dryer*
1.	Investments	EUR	5561	5561	4661	5702	5000**
2.	Fuel savings	t/year	1.6	1.8	1.1	1.2	6.5
3.	Cost savings	EUR/year	411	444	282	304	1625***
4.	Simple pay-back period	Years	13.5	12.5	16.5	19.0	3.1**
5.	Solar collectors area	m^2	21	21	15	13	100
6.	Accumulation volume	l	1500	1500	1200	640	-
7.	Measured production	KWh/m^2/y	400****	432	401	462	-
8.	Measured production	MWh/y	8410	9065	6008	6007	-
9.	SC cover summer/winter	%	54/0	56/0	52/0	34/0	100/0

Table 3 Financial and technical data for the 5 projects

* *The savings are for the session April – October instead of a whole year*

** *The total investments are 36840 EUR for the whole construction of the solar dryers. The investment only for the transparent part and its construction, i.e. the solar part is 5000 EUR.*

*** *The measured cost savings is 1625 EUR/year. The theoretical cost saving is 1960 EUR/year*

**** *The production, i.e. the efficiency is less than projected because of trees shadowing.*

Besides the projects implemented under various programmes, demonstration projects on large-scale solar installations, there are some solar collectors installed in private hotels and new houses. Part of them is produced in Bulgaria, but the rest are imported from different EU countries (Greece, France, Germany, etc.)

Bulgarian solar thermal market

The majority of installed solar collectors during the last years in public buildings and in industrial enterprises are implemented under different programmes. The annual market of solar collectors for household systems is rather low, because a great part of the population currently faces enormous financial problems and the people being worried about their energy bills do not dispose of finance to invest in solar systems. 90 % of the sales of solar collectors belong to those who are building new houses or new private hotels.

The technologies applied for solar thermal energy conversion are the same as the ones applied in other European countries.

The solar thermal installations are mainly for:

- hot water in public buildings (hospital, kindergarten, etc.) in domestic and tourist sectors;
- solar dryers in the wood processing and agricultural products industries.

The estimated market potential at present is around 5000 m^2 of collectors per year. The cost of the Bulgarian solar collectors is only 100-150 $/$m^2$ and 250-290 $/$m^2$ for the entire systems.

There are five bigger enterprises in Bulgaria, which produce solar collectors. There are a number of small and medium-sized companies producing solar collectors but these are not equipped with technological lines, and most of the solar collectors feature various design defects. It would be more beneficial to import at least the absorbers and the rest to be produced and assembled in Bulgaria.

It must be noted that there is no laboratory in Bulgaria for testing solar collectors, therefore no quality certificate can be granted for collectors made in Bulgaria.

There are also many distributors of different types of solar collectors (Greek, German, French, etc.).

Barriers for implementation of solar thermal installations

In conclusion it may be summarised that Bulgaria has a substantial solar potential and a limited scope of its utilisation. To a great extend it is due to the fact that for a long period between 1944-90 the state policy applied symbolic prices of the energy sources (electricity, heat, etc.) and the development of RES utilisation and therefore – of the RES industry, did not meet the required fundament to begin. The demonstration projects implemented during the last years, undoubtedly, contribute to the solar thermal applications development, but at the present moment RES hardly form 0,4% of the national energy balance. The solar collectors share in RES is only 4,5 % installed capacity and 2,1 % generated energy. The barriers for development of RES and especially for solar thermal installations are as follows:

1. Institutional barriers:

- Lack of a national programme for the development of renewable energy sources and the related technologies.
- The various state institutions, although having a positive attitude towards renewables, still do not pay the necessary attention to these energy sources.
- Lack of regional and municipal structures, dealing with energy planning and utilization of RES.
- Lack of related codes and standards covering the technical requirements of the equipment and installations.
- There are no authorised laboratories for quality control of the produced equipment.

2. Financial barriers:

- There are no state funds in Bulgaria for the development of RES utilisation and technologies. Such a fund would support to a greater extend the implementation of various RES projects, including solar thermal installations.
- The Bulgarian commercial banks have very prudent crediting policy – high interest rate (usually over 15 %) and credit guarantee more than 125 %. They abstain from granting long-term credits. Currently this burdens the small and medium size enterprises in producing solar collectors and solar thermal installations.
- In some cases the renewable energy is still more expensive than the consumer price of heat and electricity. The pay-back period for solar thermal installations is more than 10 years.

3. Legal framework

The new Energy and Energy Efficiency Law (1999) treats only generally RES. Renewables are still not considered a priority in legislation and there are no incentives for their utilisation, including solar thermal installations as well.

Opportunities assisting RES (including solar energy)

- The prices of conventional energy have increased many times. Nevertheless, the energy market is still not liberalized. Under the international pressure for liberalization of the energy sector, the energy prices soon will be in line with the international levels and RES will be more competitive.
- Environmental awareness is growing and RES are seen as a clean future source of energy
- Decentralisation of the state regulation and the larger autonomy of the local and regional authorities leads to development of their natural resources as they see triple dividends: environmental improvement, economic development and increased employment.

Conclusions

The prospects for development of solar thermal installations in Bulgaria by the year 2010 are to increase to 300 000 m^2 solar collectors. The investments required are 26 million EURO at payback period between 7 and 10 years. To achieve these prospects, the following should be underlined:

- The development and admission of a National Strategy and Programme on renewables, including on solar thermal implementation in Bulgaria is imperious in view to assist the investment process.
- The government should assist the investment for solar installations by discharging the taxes on RES projects and thus reducing the cost of the installations.
- Low interest rates, grants and other financial schemes are equally important to activate the investments for solar applications.
- Joint venture companies establishment in Bulgaria and application of the newest technologies for modern solar collectors production is also very important.
- Establishment of a testing laboratory for solar collectors in Bulgaria. This will facilitate the quality certification of the Bulgarian solar collectors and will help further promotion of these not only to the Bulgarian market, but also will facilitate their export.
- The RES utilisation is a new philosophy in our country, and requires a new way of thinking and new approach for RES development. Joint efforts are necessary, both on the part of state with its regulatory functions, and on the part of the entrepreneurs and financing institutions. Regional and national information campaigns are needed, showing the advantages of RES utilisation for the energy saving and for the environment.