What about further development of geothermal energy use in agriculture in Europe? Problems and possibilities.

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Summary

Agricultural uses of geothermal energy have been under center of attention during the initial period of introduction of direct application in Europe. Characteristical are the cases with Hungary, Macedonia, Bulgaria, Serbia, etc. However, now-a-days, it looks that the attention is paid only to the district heating systems, integrated systems, large balneological/tourist centers, etc.

Problems, connected to the development of agricultural uses in different regions of Europe are analyzed in the paper, the need and possibilities to accelerate it. By the analysis of situation in Europe and three characteristical countries (Hungary, Macedonia and Greece), different needs and possibilities, different combinations of influencing factors, and need for different development strategies are identified.

Final result of the analysis is that agricultural uses of geothermal energy are not in collision with the "modern" trends of direct application development in Europe. In opposite, they are improving the possibilities for composition of economical exploitation of any district heating or integrated system by the offer of excellent possibilities for cascade use of the geothermal water temperatures on disposal and combinations of users with different diagrams of day/night and seasonal heat use.

INTRODUCTION

Europe is definitely the "most geothermal" continent in the world (Fig.1), at least when direct application is in question. About 45% of total flow, 40% of the total installed capacity and 50% of the annual utilization (Lund, 2000) are located in 29 European countries. However, distribution of the "know-how" and experience is very uneven (Fig.2). Heat pumps are mostly used in North and West European countries, where geothermal energy is mainly used for space heating purposes. Balneology is characteristical for the central part of the continent. Agricultural and industrial uses are spread off in the Southern and Eastern countries. Iceland is an exception. There, nearly all the known types of direct utilization can be found.

When agricultural uses are in question, it's necessary to underline that practically all the known technologies have been developed here, and then spread off all around the world. Still, the biggest geothermally heated greenhouse complexes in the world are in the South European countries. During the seventies and eighties of the past century, this type of use has been the direct application promotor in many European countries, much more than the space heating or balneology, etc.

However, during the recent decade, characteristics and composition of geothermal energy users slowly changed due to the change of influencing factors. A strong development of the space heating , balneological and heat pumps use can be identified (Fig.4). a much slower development of agricultural and complete stagnation of other types of uses.

It's interesting to analyze the reasons which caused the change and to try to find where is the position of agricultural uses in the further geothermal development process in Europe.

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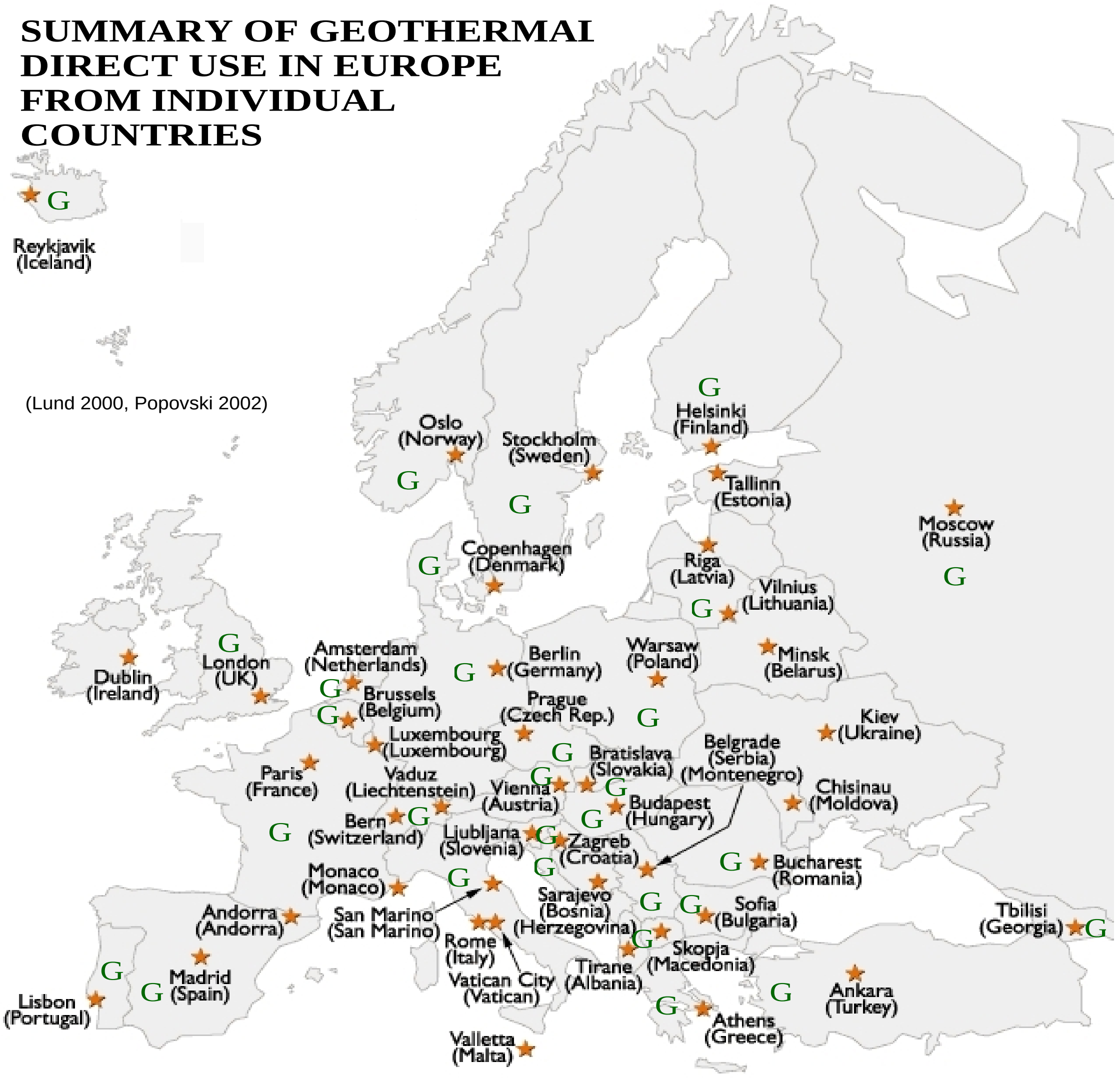


COUNTRY	FLOW l/s	CAPACITY MWt	ANNUAL U GWh/yr
Austria	210	255.3	447
Belgium	58	3.9	30
Bulgaria	1,690	107.2	455
Croatia	927	113.9	154
Czech Rep.		12.5	36
Denmark	44	7.4	21
Finland		80.5	134
France	2,793	326.0	1,360
Georgia	894	250.0	1,752
Germany	371	397.0	436
Greece	258	57.1	107
Hungary	677	328.3	785
Iceland	7,619	1,469.0	5,603
Italy	1,656	325.8	1,048
Lithuania	13	21.0	166

COUNTRY	FLOW l/s	CAPACITY MWt	ANNUAL U GWh/yr
Macedonia	761	81.2	142
Netherlands		10.8	16
Norway		6.0	9
Poland	242	68.5	76
Portugal	49	5.5	10
Romania	890	152.4	797
Russia	1,466	307.0	1,703
Serbia	827	80.0	660
Slovak Rep.	623	132.3	588
Slovenia	656	42.0	196
Sweden	455	377.0	1,147
Switzerland	120	547.3	663
Turkey	700	820.0	4,377
United Kingdom	25	2.9	6

(Missing information for Spain, Latvia and Estonia)

TOTAL:			
Europe	**Flow 24,324 l/s**	**Capacity 6,388 MWt**	**Annual utilization 22,914 GWh/**
World	**54,416 l/s**	**16,210 MWt**	**45,006 GWh/yr**
	44.70 %	**39.41 %**	**50.91 %**

Fig.1


EUROPE
AGRICULTURAL GEOTHERMAL EXPERIENCE IN EUROPEAN COUNTRIES
ICELAND
NORWAY
SWEDEN
FINLAND
RUSSIA
ESTONIA
LATVIA
LITHUANIA
BELARUS
UNITED KINGDOM
IRELAND
DENMARK
POLAND
GERMANY
NETH.
BEL.
LUX.
CZECH REPUBLIC
SLOVAKIA
UKRAINE
MOLDOVA
FRANCE
SWITZ.
AUSTRIA
SLOVENIA
CROATIA
BOSNIA AND HERZEGOVINA
ROMANIA
YUGOSLAVIA
BULGARIA
MACEDONIA
ALB.
GREECE
TURKEY
ITALY
SPAIN
PORTUGAL
MOROCCO
ALGERIA
TUNISIA
MALTA
Scale 1: 19,500,000
Lambert Conformal Conic Projection, standard parallels 40°N and 56°N
802789AI (R01083) 4-01
LEGEND
Heating greenhouses
Space heating
Drying
Electricity production
Open fields heating
Irrigation
Aquaculture

Fig.2

1. AGRICULTURAL GEOTHERMAL DEVELOPMENT FROM 1995 TO 2000

Precise orientation about the real geothermal agricultural development in Europe from 1995 to 2000 is not on disposal. Available data (Lund, Freeston, 2000) are not precise and do not allow orientation about development status because development rates are influenced of the different number of countries and mode of estimation of composition of direct uses.

Anyhow, some conclusions can be extracted. First of all, we have rough estimation for composition of direct uses at world level, both for 1995 and 2000 (Fig.3), and rates of development (Fig.4).

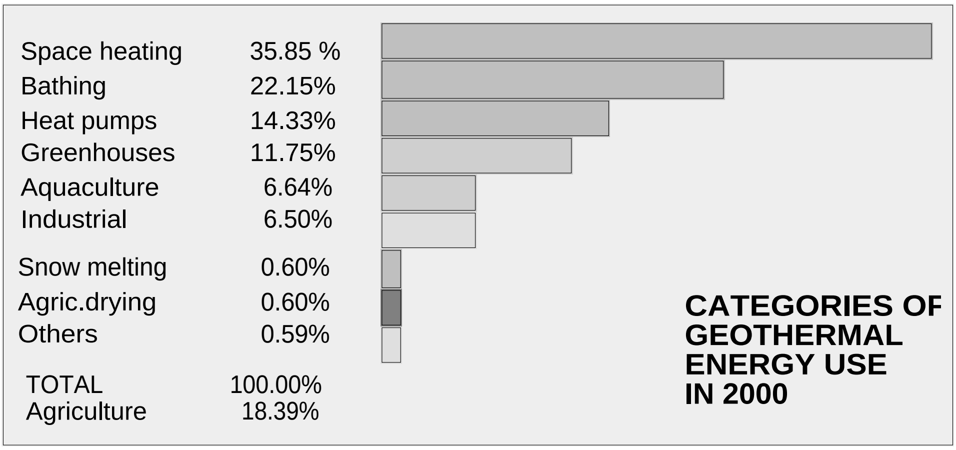


Fig.3

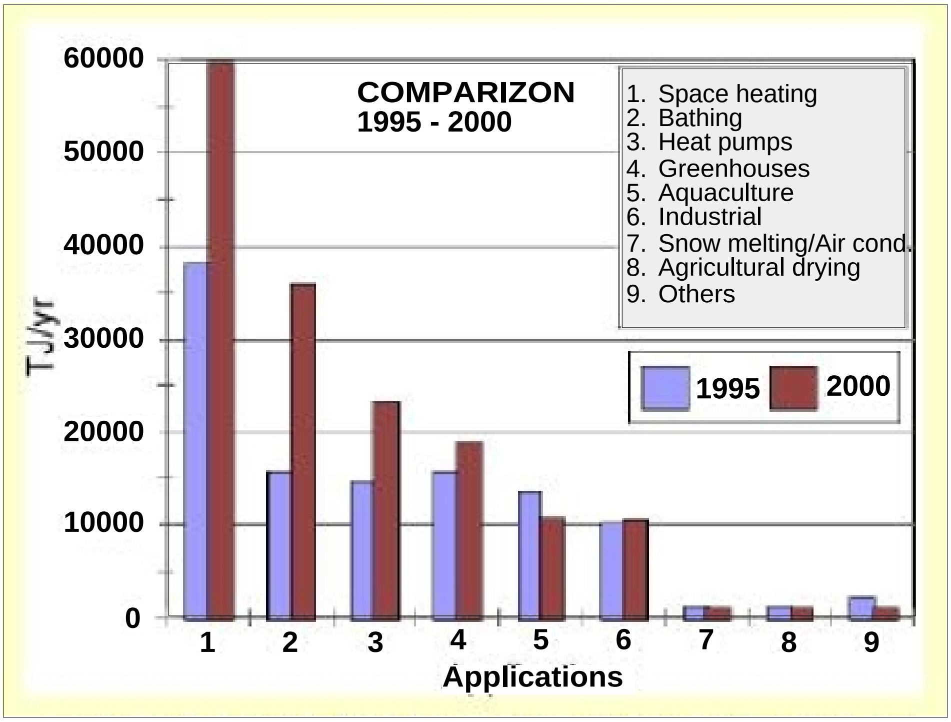
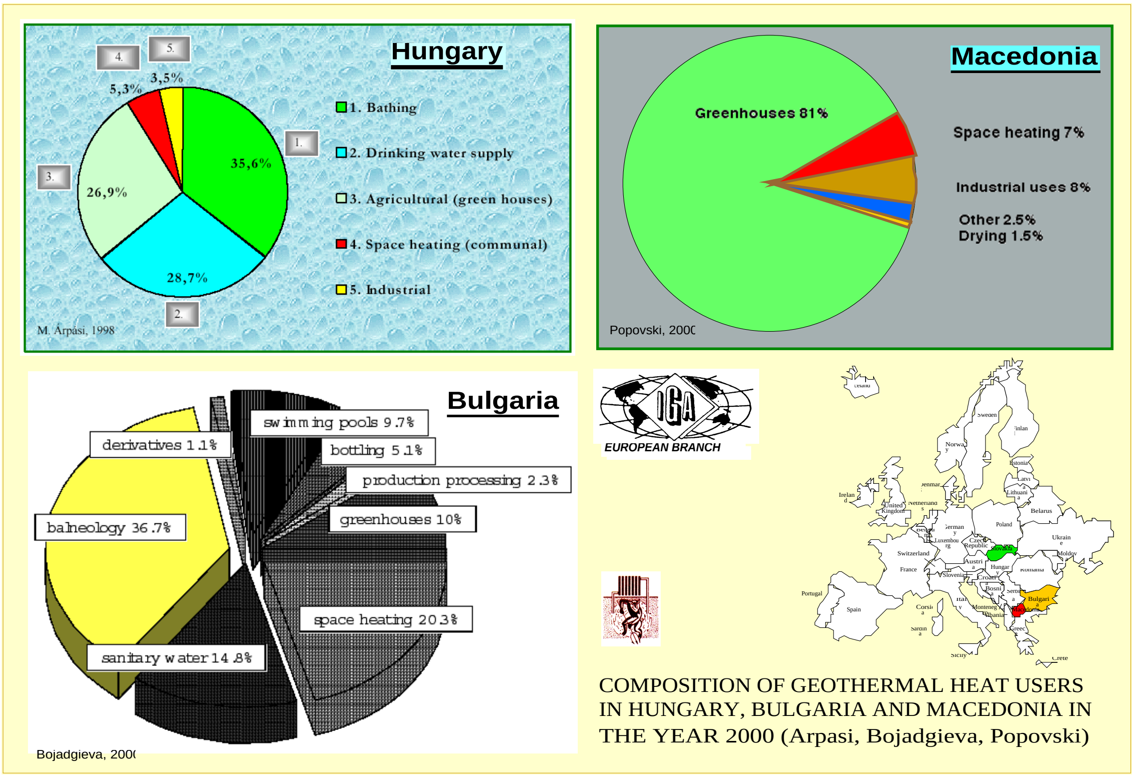


Fig.4

When geothermal energy use in agriculture is in question, some facts are immediately evident, i.e.:

- Geothermal application in agriculture lost its importance in comparison with 1995 and particularly with 1990; and
- Except for heating greenhouses (due to the introduction of data from new countries), in all the other agricultural sectors we have stagnation and not increase of use.
- Stagnation in all the categories of agricultural uses is present in Europe due to the abandoning of some bigger projects in Italy and CE European countries in transition.

2. BULGARIAN, HUNGARIAN AND MACEDONIAN CASES



COMPOSITION OF GEOTHERMAL HEAT USERS IN HUNGARY, BULGARIA AND MACEDONIA IN THE YEAR 2000 (Arpasi, Bojadgieva, Popovski)

Fig.5

Most characteristical are the cases of the countries, previously known as the ones with most developed agricultural uses of geothermal energy, i.e. Hungary, Macedonia and Bulgaria (Fig.5).

About 64% (Arpasi, 2000) of the geothermal energy use in Hungary is for heating greenhouses. They are mostly small projects spread in 48 different locations. Some of them have been abandoned during the recent years but also some new installations have been completed. Transition process of the country didn’t influenced significantly their work because privatization has been possible without big stresses and with rather small new investments. Situation is rather stabile and new development is planned, with an orientation towards bigger geothermal systems with introduction of cascade use of available temperatures.

Macedonia has been the first country in the world where economic feasibility of geothermal heating of big greenhouse complexes has been proved during the eighties of last century. Still, about 80% of the geothermal energy use in the country is for heating greenhouses (Popovski, 2000). Practically, only they survived the bad period of embargoes by Greece to Macedonia and NATO to Serbia.. However, later on, some of them have been abandoned due to the problems of privatization of big complexes. Now-a-days, only a part of the greenhouse complex in Vinica (6 ha privatized by a Dutch company) works without problem and 12 ha in Kotchany are still "surviving". Rice drying plant and 6 ha greenhouses in Kotchany, 3.2 ha in Bansko and 22.5 ha in Gevgelia are not working anymore. However, small growers around the Bansko increased their geothermally heated surface for more than 100% (about 1.5 ha in total).

In Bulgaria, no investment in geothermal agricultural uses have been realized during the recent period of 10 years. In opposite, main part of previous uses is abandoned or shall be abandoned soon. Again, the reason is not that installations are not competitive to the ones using fossil fuels but the problems with privatization and the crisis of agricultural sector in the country.

If the situation in Romania is similar to the one in Bulgaria and Macedonia, in Italy one new big greenhouse complex has been completed but also one lost, in Turkey there is still no significant development in agricultural sector, in Slovakia and Greece it is at the beginning phase, and … that's practically all what happened in Europe during the past 10 years. Conclusion: development of agricultural use of geothermal energy in Europe is stopped. Conditions for development are not good in countries where already technically and economically proven, and there is no interest in the others.

3. ARE THERE CHANCES FOR POSITIVE CHANGES?

Chances exist because:

- Geothermal energy use in agriculture is already practically proven in Europe as technically and economically feasible;
- Geothermal energy is a "green" energy, i.e. doesn't have negative impact to the environment, when used in correct way; and
- Agricultural uses "fits" excellent in composition of large district heating schemes.

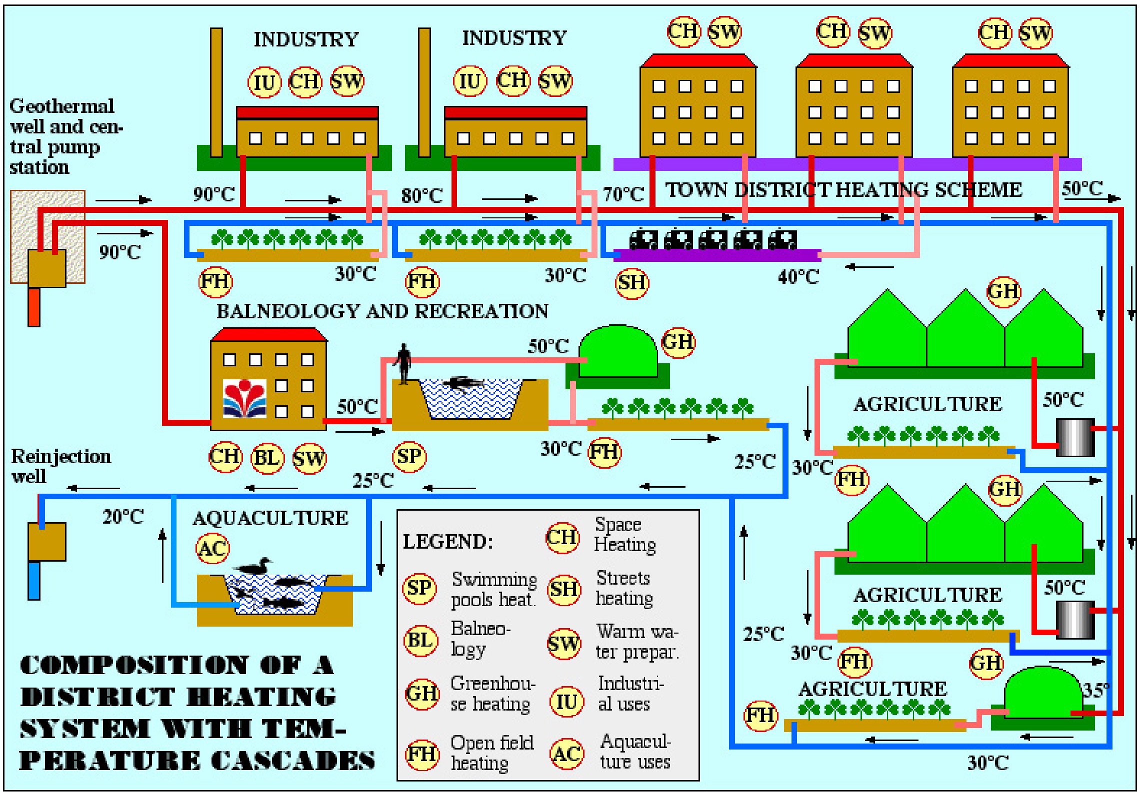


Fig.6

Presently, the problem is above listed facts are known only between geothermal specialists and not between the decision makers and normal people. Even more, there where it was already known, it has been “forgotten” during the period of last ten years.

Best chances for change of the present public opinion is to demonstrate the advantages of geothermal energy use in agriculture there where it was already proven as a good technical and economical solution at a larger scale, and where possibilities for further quicker development are the best. According to the numerous studies and investigations (Popovski, 2000), the real market for development during the coming decade is the wider region of CE and South European countries, i.e. Poland, Slovakia, Hungary, Russia, Romania, Croatia, Serbia, Bulgaria, Macedonia, Greece, Turkey and, probably, Italy Spain and Portugal.

4. TECHNICAL AND TECHNOLOGICAL IMPROVEMENTS

Depending on locally influencing factors, different development strategies should be defined for each country or region. However, collected experience during the recent years enables to extract some common elements which should be taken into account, i.e.:

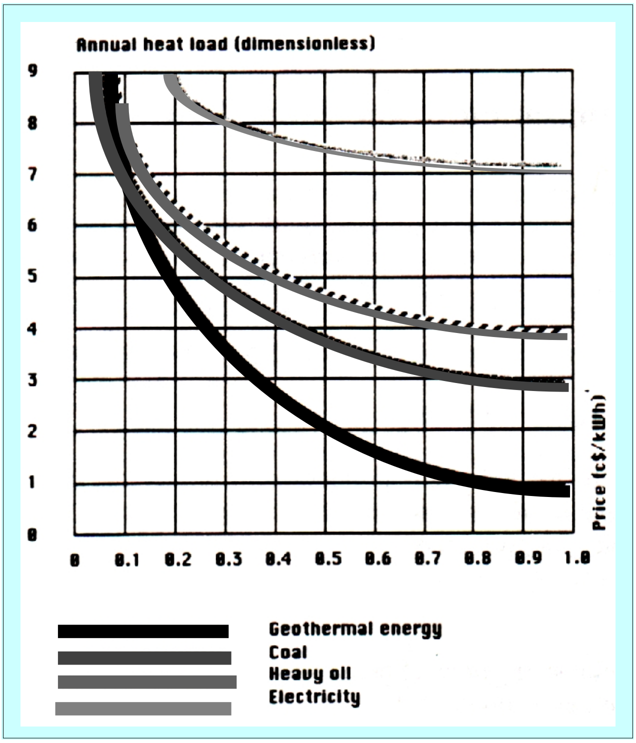


Fig.7

- Small agricultural projects do not “provoke” a real development. Economy is doubtful and to much exploitation problems appear due to the lack of knowledge of users;
- Final users should be “free” of the problems of reservoir management, scaling or corrosion problems, treatment of effluent water, etc. They should have on disposal a connection point, where to take hot water when needing it, under defined technical and economical conditions; and
- Final users should be free of any risk of irregular heat supply and changeable temperature conditions of the energent.

- Final user should have a good technical support for proper design of (combination) of heating installations which should enable him the most economical use of the energy on disposal.

Real technically and technologically justified answer to the listed requests are the district heating schemes (Fig.6) because offering the possibilities for:

- Increasing the value of annual heat loading factor and, with that, decreasing the price of used heat by minimizing the influence of investment costs (Fig.7);
- Composition of users with different temperature levels (Fig.8), i.e. cascade use of available temperature differences. It's important to realize that temperature requests of many agricultural uses are much lower than for other heating purposes;

TEMPERATURE LEVELS OF DIFFERENT AGRICULTURAL HEAT USERS

1.	Soil heating	20-35 ºC
2.	Heating greenhouses	35-95 ºC
3.	Food processing	35-95 ºC
4.	Aquaculture	20-40 ºC
5.	Biogas processing	35-50 ºC
6.	Mushrooms cultivation	45-65 ºC
7.	Drying fruits and vegetables	65-95 ºC
8.	Pasterization	50-70 ºC
9.	Beat sugar extraction	60-85 ºC
10.	Blanching and cooking	70-100 ºC
11.	Sugar pulp drying	110-125 ºC

Fig.8

- Composition of internal cascades, too.
- Centralized government of the problems with reservoir engineering, scaling, corrosion, etc.
- "Clean" connection point with possibilities for manual or automatic heat supply, depending on the changeable requests of each user; and
- Payment of the used heat, exactly as used by the final consumer.

Competitiveness to the other (fossil) energy sources depends mainly on the composition of heat users, i.e. reached value of the annual heat loading factor. Careful study of daily and annual changes of heat consumption of each type of heat consumer (Fig.9) should be made in order to get maximally possible value. Peak loading should be covered, where possible, by the use of accumulating tanks (enabling additional "ironing" of the daily curve of heat use) or, where not possible, by the use of cheap boilerhouses, using fossil fuels.

Positive influence to the used heat price is clearly demonstrated at the Fig.7 (made 1982 when first promotions of the need for introduction of district heating technology in agriculture has been made).

5. DEMONSTRATION PROJECTS?

As already mentioned, it's necessary to complete several demonstration projects, big enough and carefully designed to illustrate the advantages of geothermal energy use in comparison with fossil fuels. Presently, the best possibilities for such projects are in the listed three countries, i.e. Macedonia, Hungary and Bulgaria, plus probably Romania. By the reconstruction and re-completion of existing systems, it is possible to get large projects with minimal investments.

As initial example, the project in Vinica (Macedonia) can be taken. 6 ha glasshouse project has been abandoned until Austrian government gave a grant for reconstruction of the geothermal heat source . 3 submersible Pleuger pumps, 3 circulation pumps, full automatic regulation of pumping,, reconstruction of the 3.5 km connection line, plate heat exchanger complete, four heat distribution stations and low temperature heating system made of corrugated plastic pipes have been installed. Additionally, a Dutch firm privatized the greenhouse complex and installed heating system for the benches for flowers cultivation, reconstructed the existing steel pipe aerial heating system and connected all the systems in logical cascades. Together with the reconstruction of one of the heavy oil boilers for covering the peak demands, all the investment reached about 500,000 Euro, enabling covering 95% of the total annual heat consumption, i.e. substitution of about 1,200 tons of heavy oil per year.

The same can be made in Kocani (3 x 6 ha glasshouses), Gevgelia (22,5 ha glasshouses) and Bansko (3.2 ha). The example in Kocani is even better because enabling connection of the town district heating system and introduction of industrial consumers.

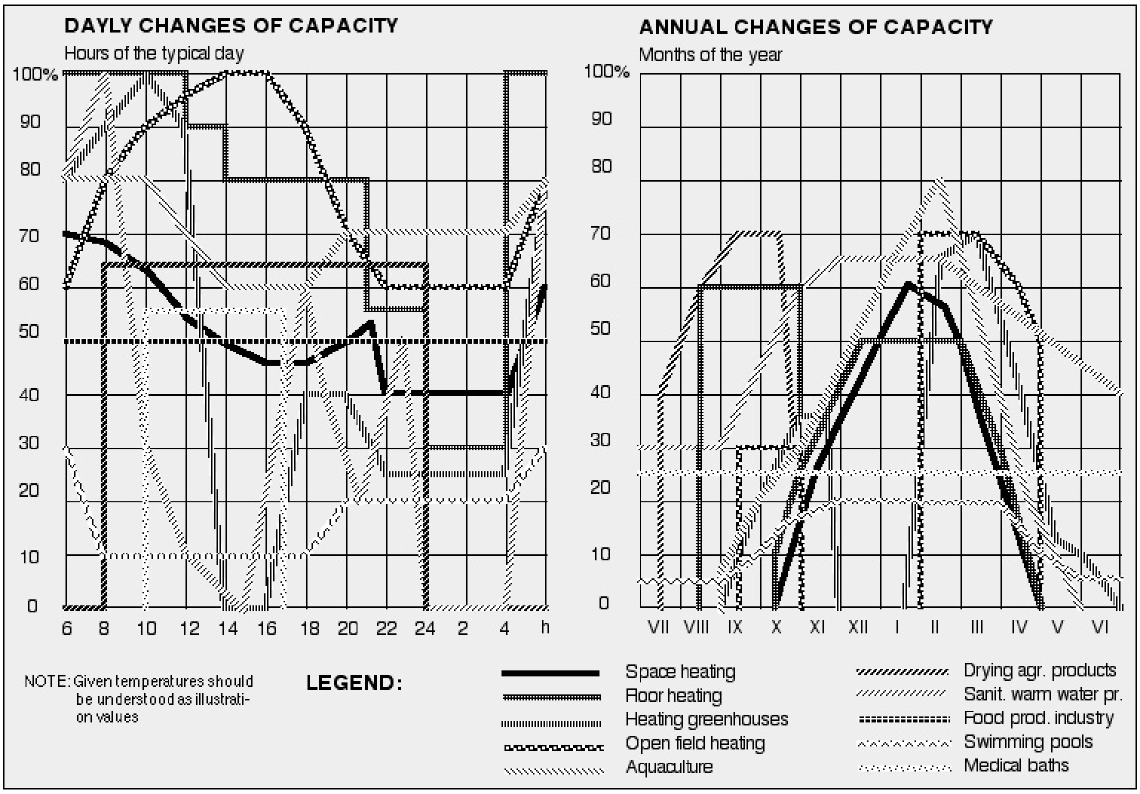


Fig.9

Similar is the situation in Bulgaria (18 ha greenhouses) and Romania (12 ha). In addition, in Hungary, connection of existing or new greenhouse projects to district heating schemes in development is possible. Beside the low investment costs and resulting very low price of used heat, such interventions offer experienced teams for exploitation of the projects and removal of initial mistakes of development which can disturb the positive image of the interventions.

Completion of such large demonstration projects and, what's probably more important, their intensive and aggressive promotion can open the markets in the countries in question and surrounding ones, estimated to about 1,000 ha in next 10 years, plus about the same of heated open fields, hundreds drying units and aquaculture plants. It's for sure that such positive orientation shall have stimulative influence to the development process in other EC countries, too.

6. CONCLUSIONS

Different reasons influenced negatively the process of development of geothermal energy use in agriculture in Europe. On the other side, development in space heating sector and geothermal heat pumps use is in process of acceleration, at least in the richer and more developed EC countries.

Taking into account that some of the main constraints (political and economy transition process in countries with developed agricultural geothermal sector), it's necessary to re-define the development strategy and to introduce a stronger promotion activity in order to stimulate a quicker development. Technical and economical feasibility can be proved in most of the European countries but the most secure for completion of good demonstration projects are the countries where experience in development and exploitation of agricultural geothermal projects exists, like it is Hungary, Macedonia or Bulgaria. Another advantage of projects in these countries is that by reconstruction and re-completion of existing large projects with minimal investments, it's possible to compose large district heating schemes with cascade use of geothermal heat. In that way, very competitive price of used heat can be reached and justifiable-ness, technical and economical feasibility of incorporation of agricultural sector in development of geothermal district heating schemes, which is now in trend in Europe.

Demonstration of benefits of large projects are important in order to prevent initial orientation to small demonstration and commercial projects in many countries, resulting with poor economy and weak maintenance, i.e. demonstrating more negative than positive sides of geothermal energy application in comparison with fossil fuels use.

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