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SUMMARY OF EXPLORATION AND DEVELOPMENT OF GEOTHERMAL RESOURCES IN ECA REGION COUNTRIES

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SUMMARY

Summary of the situation with exploration and development of geothermal resources in ECA Region countries illustrates that this renewable energy resource is generally neglected with exception probably only in Turkey and Russia. Present changes of the world energy market, in combination with previous positive experience and obvious positive possibilities for development in large areas and regions, confirms the need to change the approach and to define development strategies to widely introduce this energy sources. Existing constraints for development are identified and necessary measures to overcome them are recommended.

INTRODUCTION

ECA Region Countries[3] compose a very complex and interesting part of the world. A large number of nations with different origin, long and rich history live under very different climate conditions, with big differences in natural resources and with different level of development. When geothermal energy, or more precise hydrogeothermal resources, is in question, the situation is similar, i.e. there are large concentrations in the region but very irregularly distributed and with very different characteristics. History of its use is long and rich but, again, irregularly distributed and different in kind, intensity and reached technology level. Unfortunately, due to the lack of attention, not all the data and information are collected and systematized in the way to enable real orientation about the shape and characteristics of this renewable energy resource and, in that way, to get a base for evaluation of its possibilities as possible future energy source.

This summary is based on the available information, get through the regular collection of data by IGA. For the countries which are not included in this data base, data collected by EBRD has been used. Unfortunately, there are still several countries for which no data is available.

In order to enable more detailed overview for the situation in each of the consisted countries, a collection of „country update" IGA and EBRD papers are given in the annex of this paper (links to the reference list).

The aim of this summary is to try to get necessary information, enabling more precise composition of a strategy for geothermal energy use development in the ECA Region, needed by the WB and its GeoFund program.

1. GEOTHERMAL ENERGY RESOURCE

ECA Region (Fig.1) is composed of 21 countries, spread over two continents and one sub-continent (Turkey). Geothermal „rings of fire" (Fig.2) touch it at the far East and at the South West borders, resulting with high temperature appearances and possibilities for electricity production.

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[3] The expression ECA Region Countries covers group of countries of South East Europe and Central Asia. Grouping has neither geographical nor historical or even purely economic background. Mostly the strategic reasons put together countries with different geographical characteristics, different climatology, origin, history, religion, political and economic systems and organization. On the other hand, historically, there was a continual inter-influence between them, which lasts until today.

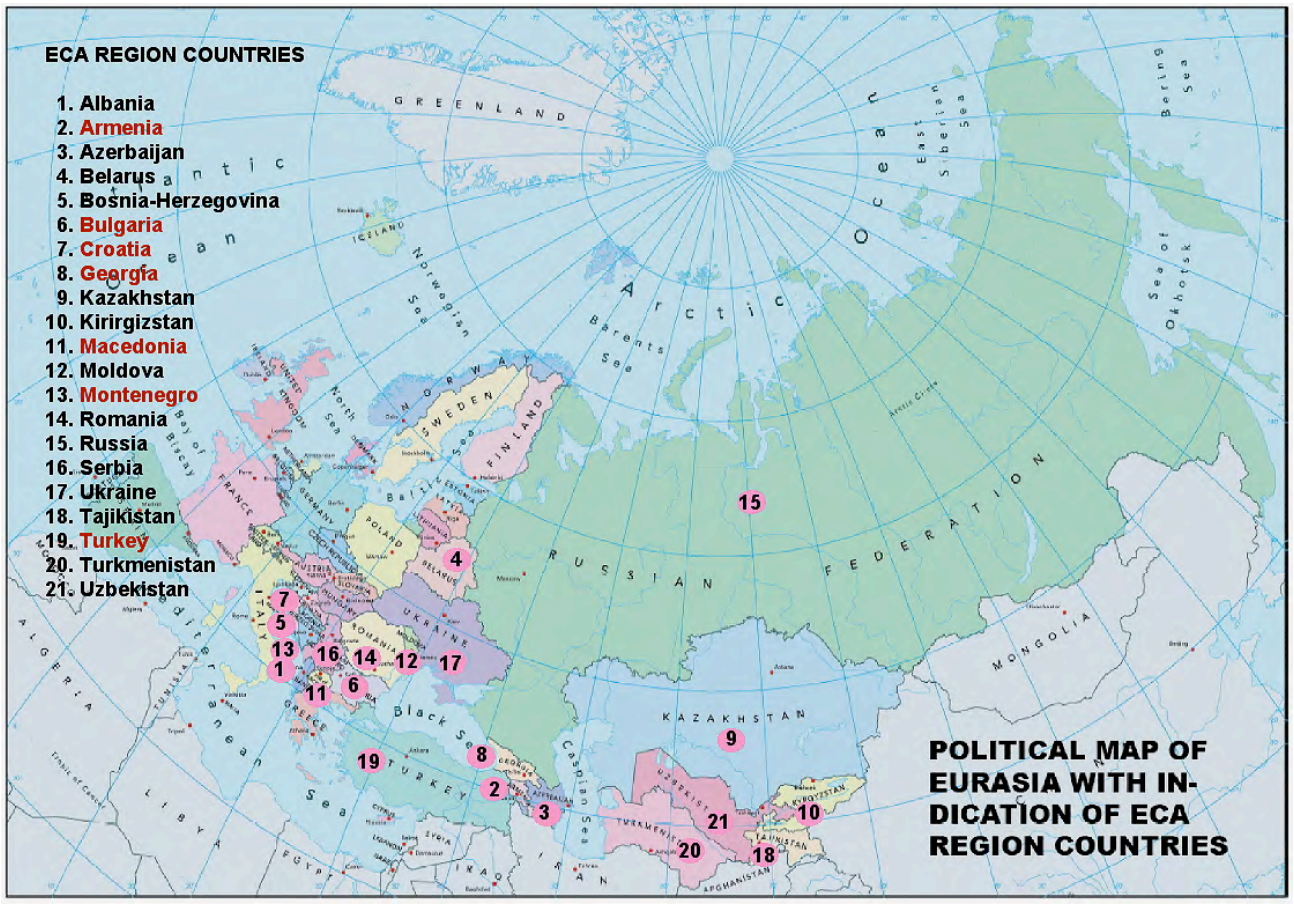

Fig.1. ECA Region countries

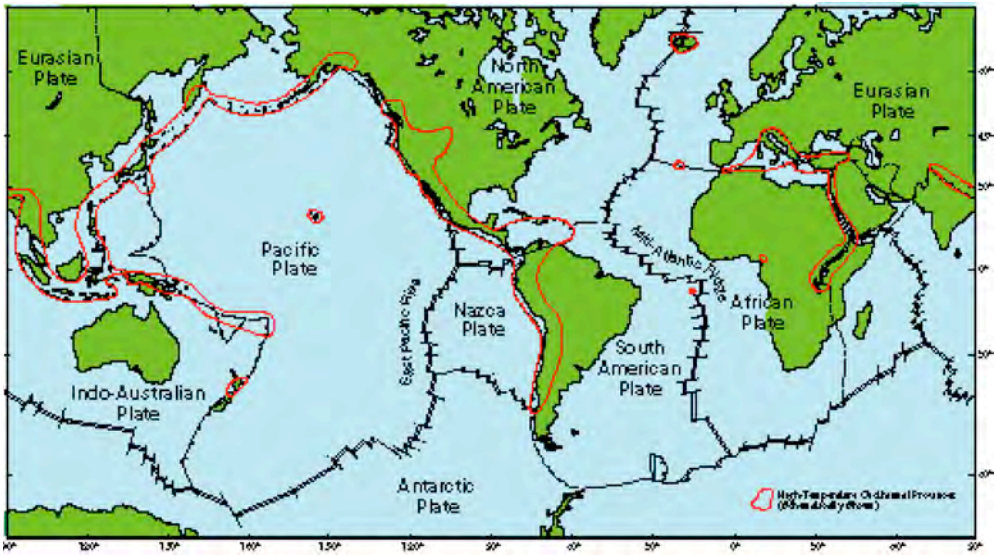

Fig.2. Geothermal „Ring of Fire“ with location of high temperature geothermal resources

Numerous middle and low temperature resources are irregularly distributed all over its teritory, mostly out of larger urban and industrial concentrations. In Russian Federation (Fig.3) most promissing are the regions of Tchukotka (far Nord East), Jakutia and Kamtchatka (Far East), Baykal Region (South East), West Siberia Region (Central part) and Kaukaus region (South West). Explorations and investigations made illustrate existence of enormous large energy resources, however additional efforts are necessary to enable their practical development (Povarov, Kononov, 2005).

European part of the region (Fig.4) is characterized only by lower and very few middle temperature reservoirs. Generally, level of explorations and investigations is very poor and dates form the period of 20 years ago. Anyhow, they confirm existence of rather large reserves with characteristics enabling wide use for numerous applications, already proven in local r world practice (Popovski, 2005).

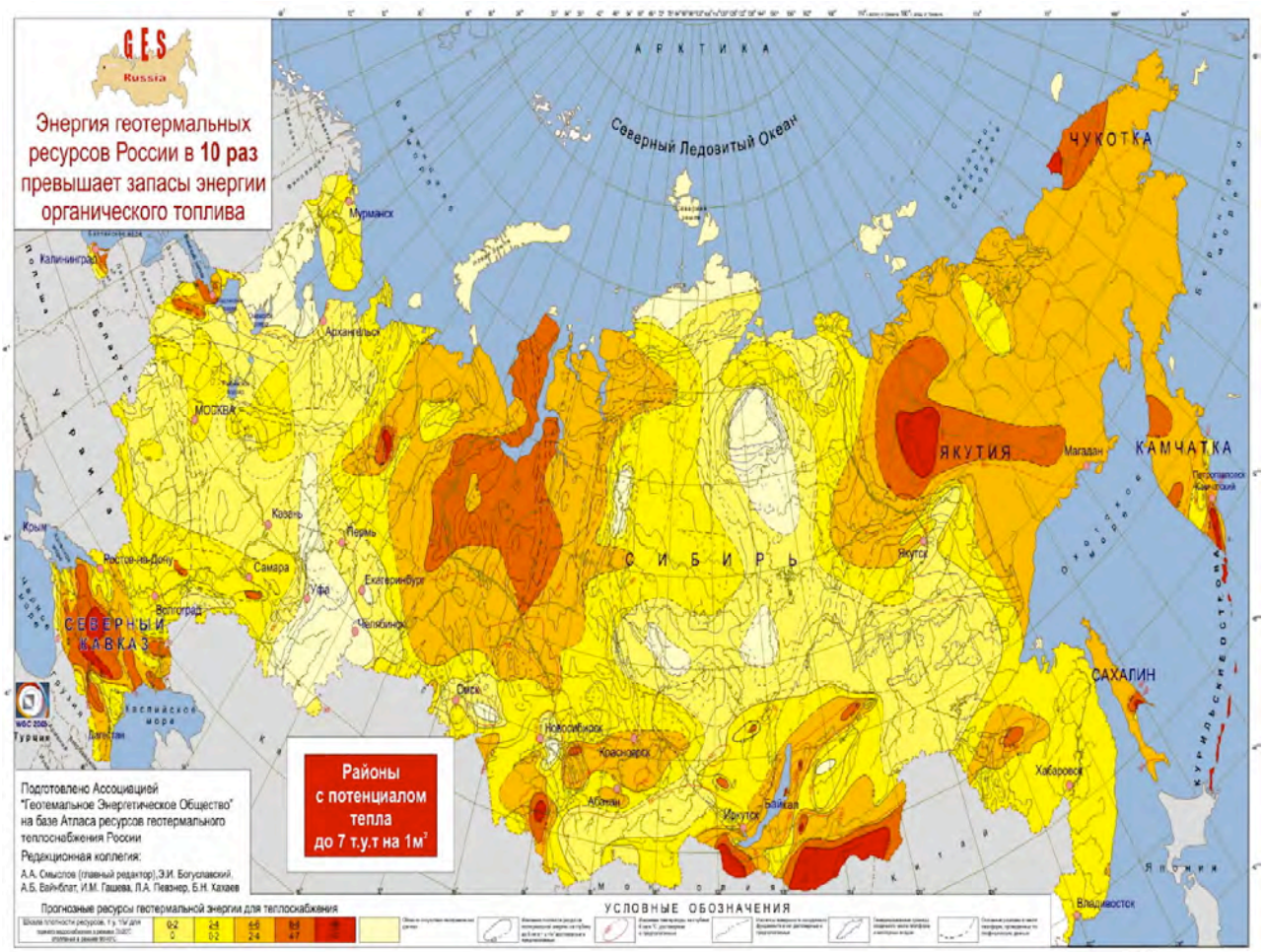

Fig.3. Location of geothermal provinces in Russia

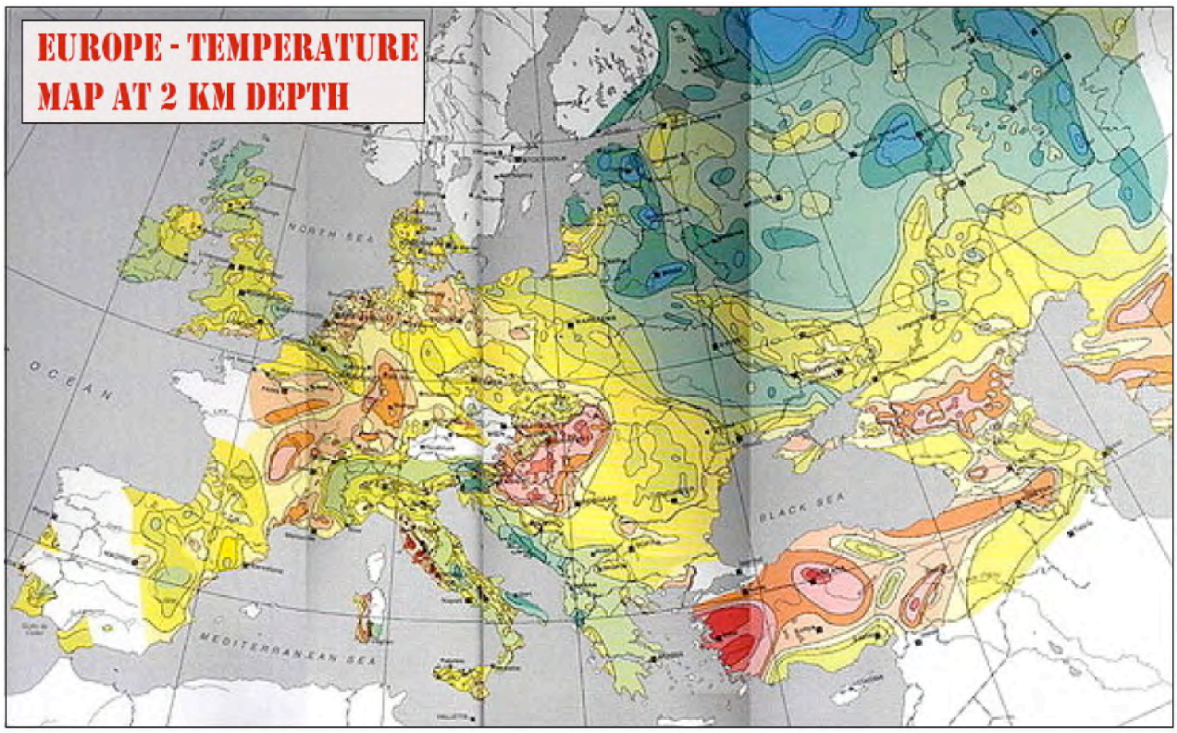

Fig.4. Location of geothermal provinces in Europe

Turkey is a special case (Fig.5). Large number of geothermal fields are spread all over the country, mostly with very convenient middle temperature but also some with high characteristics. Level of explorations and investigations is probably the best in whole the ECA Region (Simsek et al, 2005).

Fig.5. Location of geothermal provinces in Turkey (Simsek, 2001)

Table 1. Known hydrogeothermal resources and their application in ECA Region countries

		Known geohydrothermal resource			*Present energy application*		
	Country	**Tempe-ratures**	**Flow rate**	**Heat power**	**Used flow**	**Capacity**	**Produced energy**
		ºC	**l/s**	**MW**	**l/s**	**MW**	**TJ/yr**
01	Albania	21-65	˜ 120	ND	54.8	9.59	8.59
02	Belarus	ND	ND	ND	ND	ND	ND
03	Bulgaria	20,5-95.0	2,896.8	315.73	836.63	109.7	1,671.49
04	Croatia	34-105	ND	ND	927.0	113.94	681.68
05	Georgia	ND	ND	ND	1,569.4	307.1	458.4
06	Macedonia	20-78	˜1,000	125	641	62.4	598.62
07	Romania	40-115	ND	480	889	156.6	2,840
08	Russia	12,5-220	ND	ND	1,466	307	6,182
09	Turkey	30-250	ND	31,500	6,845	1,077	19,623
10	Serbia	22-96	ND	ND	845	82.80	2,375
11	Ukraine	ND	ND	ND	3,472	200	5,000
12	Azerbaijan	35-110	ND	700	ND	ND	ND
13	Armenia	43-99	270	ND	ND	ND	ND
14	Tajikistan	<90	280	ND	ND	ND	ND
15	Kazkhsyan	45-170	ND	ND	ND	ND	ND
16	Turkmenistan	<80	ND	6,600	ND	ND	ND
17	Moldova	<50	ND	ND	ND	ND	ND
18	Uzbekistan	<120	>1,800	>1,150	ND	ND	ND
19	Montenegro	ND	ND	ND	ND	ND	ND
20	B & H	ND	ND	ND	ND	ND	ND

Source of data: Country updates of IGA (2005) and EBRD study (2007)

In summary (Table 1), it can be stated that existence of geothermal energy resource is proven in nearly all the countries of the region. However, available data are far of satisfactory to generally characterize how big and with what characteristics it is. The level of explorations and investigations made is absolutely to low to offer any reliable figure, even for the countries where they have been more intensive (Turkey, Russian Federation, Bulgaria, Romania). That's limiting possibilities to define acceptable and sustainable strategies for development of the resource. Probably, only Turkey and partially Russian Federation have on disposal quantity and quality of data enabling at least to compose some kind of initial strategy of development, guaranteeing future significant role in the state (Turkey) or larger regions (Russia) energy balance.

2. PREVIOUS EXPERIENCE

Not in all of the countries, but previous (somewhere very long) experience with geothermal energy use exists. Some of it is unique and interesting also for other parts of the world.

Fig.6. Mutnovskaya power plant in Kamtchatka (Russia)

Fig.7. District heating system in Balçova (Turkey)

Fig.8. Large geothermally heated greenhouse complex in Kocani (Macedonia)

Fig.9. Spirulina production in Roupite (Bu;garia)

Fig.10. Fish ponds for all year around production

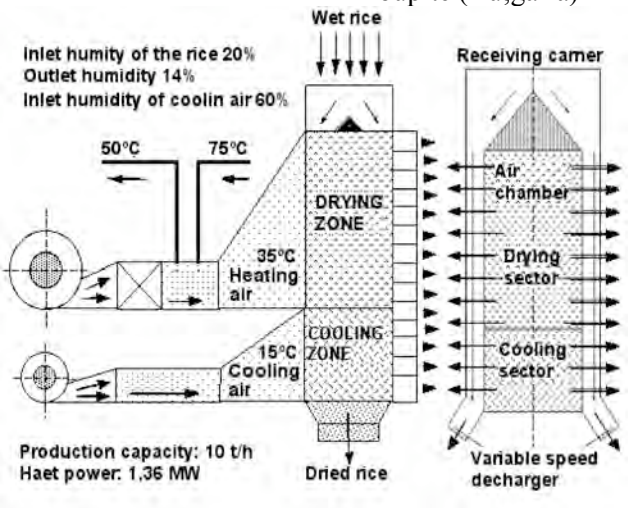

Fig.11. Rice drying unit in Kocani (Macedonia)

Four countries use or are begining to apply geothermal electricity production. In Russia it's located at the Kamchatka region and Kurils Islands. Alltogether 77 MW are already installed and new 100 MW in development (Povarov, Kononov, 2005). In Turkey, based on the positive experience with the first 20,4 MW power plant in Kizildere, a new one in Germencik is completed, and 30 ones are planned for near future (Simsek, 2005). Romania experimented with a small unit in Oradea but didn't followed the development (Rosca et al, 2005). In opposite, Ukraine, in Sivashkaya, recently experimented with a small 0.8 MW unit (Khvorov et all, 2005). Particularly is interesting the Russian experience, where own advanced technological solutions have been developped.

Fig.12. Large spa center in Sandanski (Bulgaria)

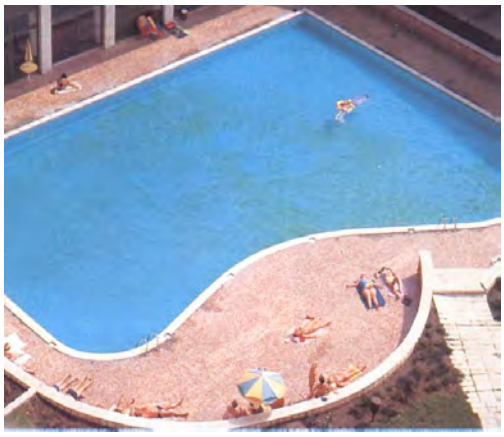

Fig.13. Swimming pool in a spa center in Bulgaria

Experience with geothermal district heating systems is spread in much higher number of countries. Most developped is in Turkey, where about 40.000 residents are connected to several district heating systems. In Russia, there are about 15.000. Much smaller number of residences, heated by geothermal energy, exist also in Romania, Bulgaria, Ukraine, Macedonia, etc. Unfortunatelly, except in Turkey, where new development is in progress, the other ones are of elder data and need modernization and recompletion.

Central heating of small houses exists in many countries. Different technological solutions can be found, from the very primitive to very modern ones.

Geothermal heating of greenhouses was a very prospective direction of development up to 20 years ago. There are large complexes in Russia (22 ha), Romania (35 ha), Georgia (70 ha), Bulgaria (22 ha), Macedonia (27 ha), etc. New development is present only in Turkey (63 ha), and recently in Romania, where three new complexes have been developped recently. Existing experience is positive and important worldwide because proved that positive economy can be reached only with large complexes and not with small independent units. However, applied technology is old fashionned and moderniztion and recompletion is needed in most of the units.

Other interesting experience exists with aquaculture (fish farming) in Russia, Romania, Turkey, Bulgaria, Ukraine, etc., and microalgae production (Bulgaria). Even the experience is technologically and economically positivelly confirmed, it is not wide accepted in practice. Similar is the situation with wood drying (Russia, Romania), agricultural products drying (Macedonia, Romania), heating of animal husbandry projects (Russia, Romania, Serbia), milk pasterization (Romania) and mineral production (Romania). There is no development in flow of these types of uses.

At last but not least, the experience with balneological uses is quite long and large. Medical spas are known in many countries of the region (Bulgaria, Macedonia, Romania, Ukraine, Russia, Serbia, Georgia, etc.). Modern spa recreational centres have been developped or are in development in Bulgaria, Romania, Serbia, Russia, etc.

As conclusion, rather rich and complex experience exists in the region. However, even some modern technologies have been developped for some applications (electicity production in Russia or district heating schemes in Turkey), most of the experience is outdated, i.e. at the level of 20-25 years ago.

3. MARKET OR POSSIBILITIES FOR DEVELOPMENT

In general, there is a wide market on disposal for geothermal energy application development in the region. For instance, it suits very well for the far East Russian regions for electricity production and heating purposes. Similar is the situation in West Siberia where, in addition, geothermal energy can improve significantly development of the weak agricultural production and food processing industry. Plus, wood drying suits very well for improvment and modernization of developped wood production industry. Kaukasian region is excellent for wide development of out-of-season agricultural production, drying of agricultural products, but also for central heating. In Turkey, there is no field of application which cannot find justification, from the electricity production and district heatings to agricultural production, food processing and balneology. Even poorer with geothermal resources, Ukraine offers the same possibilities, particularly because having problems with energy production and supply. All Balkan countries offer good possibilities for district heatings development, wide use in agriculture and food processing and particularly in developmet of modern balneology. There is no such a clear

orientation for the Central Asian countries but it is for sure that some market can be identified also there without particular problem.

However, in reality, situation is much more complicated. Initial explorations, investigations, completion of the energy source, composition, development and completion of a profitable large geothermal project is of very complex and complicated nature. It is a long years and expensive effort, needing large initial investments without guarantee that shall be repayed under normal bankable conditions. When district heating projects are in question, an additional period of time is necessary to reach the level of consumption, which enables profitable exploitation. Obviously, private initiative itself cannot cover all the links of the final profitable exploitation chain. State intervention is needed to cover some initial risks and costs. Composition of long term strategies of development is necessary, consisting incorporation of geothermal in full economic development of particular regions and countries, i.e. consisting creation of market(s) able to guarantee profitability of neccessary investments.

Unfortunately, such a complete approach is missing in all the region. From one side, state has no real orientation about the importance of energy source and its possibility to improve national energy balance and, from the other side, private capital has no stimulation to take necessary risks for long term investments. No one of the countries has a defined strategy for geothermal energy development, neither on the state or regional or local level. Final result is the present situation with very poor investments in exploration and investigations and absence of knowledge how really big is this energy resource in any one of ECA countries. In connection to that, there is no real orientation for the possible market(s) and real possibilities for its(their) development. Proven advantages of geothermal energy application practically cannot find the way to be widelly applied in practice.

Under that light, initiative of the WB with its GeoFund is playing a pioneer role in the region. Main advantage of it is not of financial nature but in offered possibility to learn what's the composition of development of a geothermal project, based on the marketing approach. By covering the responsibility for a part ot total technology chain, which should be covered by the state and state financial institutions, it creates interest of private capital to invest in concrete development programs or projects, with increased security of final profitability, as result of completed system of analysis under its supervision.

4. CONSTRAINTS

Practical constrains are different in different countries. Generally, they can be grouped in:

a) *Strategic treatment of RES in general, and geothermal energy in particular*; That is the basic background, causing all the other constraints. Without real increasing of its priority in the total state or regional development strategy, overcoming of them cannot be reached.

In now one of the ECA countries geothermal energy has a really priority treatment!

b) *Weak legislation*; As already told, geothermal energy development is of very complex nature, significantly influenced by legal regulations concerning mineral resources, underground and surface water management, human environment management, local or regional economy and social life, etc., etc. That makes the administrative procedure for geothermal project initialization and development extremely complicated and long lasting.

Some improvements are already made in some countries (Romania, Bulgaria, Turkey) but they are far of being satisfactory, i.e. offering a simplified, direct and quick administrative procedure.

c) *Absence or lack of incentives and convenient finance sources*; Covering the whole financial construction for a geothermal project development and its completion is very difficult and sometimes impossible in the way enabling its final profitability. In some countries (Croatia, Macedonia, etc.), first steps are already made by introduction of feeding tariffs for geothermal electricity production. However, still nothing is done for development of district heating projects and other heat consumption projects. Taking into account that larger projects cannot satisfy present banking conditions due to the long time needed to reach necessary full heat loading for economic operation, some more convenient finance mechanisms should be defined and introduced. That's again putting ahead the question of priority for development, accepted by the state and taken part of the responsibilities for fulfilling determined chains of the total technology chain completion.

d) *Weak (or absence of) knowledge and information*; Strange enough, if taking into account the situation with other RES like solar, wind or biomass, situation with "know-how" and information for geothermal energy resource and its use is quite bad in all the region. If some improvements can be located in some European countries, Russia and Turkey, nothing or nearly nothing has been done in the others. In any case, in no one of ECA Region countries geothermal energy is included in the regular education system, at least at the lower levels.

That's very much limiting the possibilities for accepting this green energy source as an important one, deserving to get needed priority treatment.

e) *Weak or no investments in exploration and investigations*; last wider explorations and investigations in all the region have been made about 20 years before. Political and economy transition period is slowly ending but new explorations and investigations are still not introduced. That's again the question of reached priority in state development strategies.

f) *Weak or absence of local industrial interest and support*; Absence of a real development process in the region results with absence of industrial and business sector for its realization. Taking into account the importance of these sectors for creating convenient political and economic environment for their work, that's decreasing the chances to get priority treatment for geothermal energy development. On the other hand, and due to the lack of local political support and convenient stimulating legislative, foreign investors cannot find interest to finance such a development.

g) *Absence of international collaboration*; At last but not least, international collaboration is still rather weak as consequence of previous situations, which prevent transfer of positive changes in the world during the recent years, particular in U.S.A. and EU.

The list of constraints is long and complex and can be resolved only with an organized action of very complex character, consisting necessary legislative changes and improvements, economy measures, environmental measures, etc. It's obvious that listed constraints and needed measures to overcome them are of very general nature and not giving concrete answers to concrete problems. The reason is that there is no "overall" valid receipt for that. However, proven fact is that a wide organized activity with listed elements accommodated to local influencing conditions, i.e. largeness and characteristics of energy resource, possible market, strength of the economy, competitiveness of other available energy resources, characteristics of the overall development strategy of the country should be organized over a longer period. Reached level of priority shall directly influence its characteristics and success!

5. CONCLUSIONS

Situation with geothermal explorations, investigations, applications and development rate is very much different from country to country in the ECA region. However, some common characteristics can be identified, i.e.:

a) Region is reach with geothermal energy resources with different energy value and distribution over the region;
b) Level of realized and explorations&investigations in flow is very low. They are more intensive only in one country in the region (Turkey);
c) Development of geothermal energy application still doesn't have a real priority treatment;
d) Level of local "know-how" is generally low;
e) Necessary legislative is poor and in some countries very poor;
f) There is no organized necessary educational, organizational, administrative and financial background directionned towards acceleration of the development process;
g) International collaboration in the region is very poor, as it is also at the international level with some exceptions (Turkey);
h) Common change of the approach is necessary in order to improve the present situation!

On the other hand:

a) Tradition and successful experience is present in some countries of the region;
b) There are a list of projects proving economic liability of geothermal projects (Turkey, Russia, Bulgaria, Macedonia, etc.);
c) Interest for introduction exists in many countries, however cannot be fulfilled due to the existing constraints;
d) All realized investigations prove that a very large market for development is in question;

Altogether, it's possible to state that pre-conditions for intensification of development exist. Change of present treatment and policy is necessary in order to enable necessary concentration of efforts and organizational frame for geothermal energy wider introduction in the ECA Region countries.

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