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UNIVERSITY**

GEOHERMAL TRAINING PROGRAMME  
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## **CONTRIBUTION OF UNU-GTP TRAINING TO GEOTHERMAL DEVELOPEMENT IN CENTRAL AND EASTERN EUROPE**

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### **ABSTRACT**

For the last 30 years, over 400 geothermal professionals from 43 countries on 4 continents have been trained with great success in the Geothermal Training Programme of the United Nations University (UNU-GTP). The first UNU Fellow from Central and Eastern Europe (CEE) attended the training in 1985. Since then, in this big, international group of scientist and engineers there have been 60 trainees (15%) from 15 countries of CEE. They have been in Iceland for the 6 months highly specialized courses on various aspects of geothermal energy resources exploration and utilization. After graduation from the UNU-GTP the Fellows in most cases have continued work in science or industry in their home countries as well as in international cooperation. They have been utilizing knowledge and experience gained in Iceland as a contribution to geothermal development. Most of the CEE countries has benefited from the training by increasing of professional level of people involved in geothermal. The significant support and assistance of UNU-GTP provided this way to CEE is a tremendous contribution to the development of geothermal energy utilization.

### **1. INTRODUCTION**

The Geothermal Training Programme of United Nations University in Reykjavik, Iceland celebrates 30<sup>th</sup> Anniversary in 2008. This is a special occasion for more than 400 scientist and engineers from 43 countries on 4 continents who have been trained in the programme since 1979 on various aspects of geothermal energy resources exploration and utilization. They were fortunate to be selected for the six-month highly specialized course organized in Iceland – a country leading in geothermal utilization. In this group of professionals trained with great success in UNU-GTP there have been 60 trainees (15%) from 15 countries of Central and Eastern Europe. The significant contribution of the training to geothermal development in CEE countries is described in this paper. A part of the paper is based on work of Kepinska (2003) presented at 25<sup>th</sup> Anniversary of UNU-GTP Workshop.

### **2. UNU GEOTHERMAL TRAINING PROGRAMME**

The United Nations University Geothermal Training Programme was established in 1979 and since 2003 it has been the only international graduate school offering specialized training in all the main fields of geothermal science and engineering (Fridleifsson, 2005). It is located in Reykjavik, Iceland at Orkustofnun - the National Energy Authority – a government agency under the Ministry of Industry and Commerce. The Programme aims to assist developing countries and those in economical transition, where significant potential of geothermal resource can be utilized. The goal of the

geothermal training is to build up or strengthen groups of specialists from all fields of geothermal, working together in development of this renewable energy source. Candidates for the six-month courses are selected from respective institutions involved in geothermal research or industry. The UNU-GTP is supported by the Icelandic Government and the United Nations University.

The highly specialised courses cover all different aspect of geothermal exploration and utilization along with environmental impact of geothermal industry. The trainees are privileged to work with and to be supervised by professionals from Icelandic GeoSurvey – ISOR, Orkustofnun, University of Iceland and other institutions working in geothermal development.

### 3. UNU-GTP FELLOWS FROM CNETRAN END EASTER EUROPE

In the first quarter of century of operation of UNU GTP there were 52 UNU Fellows from Central and Eastern Europe trained (Kepinska 2003). Since the 25<sup>th</sup> anniversary of UNU-GTP in 2003, there have been 8 UNU Fellows from CEE countries (UNU-GTP, 2008), who attended the training (Figure 1). They came from Albania (1), Azerbaijan (1), Turkey (1) and Russia (5). It gives a total number of 60 UNU Fellows from CEE (15%) (Figure 2) to compare with Africa 108 (27%), Asia 175 (43%) and Central America and Mexico 59 (15%).

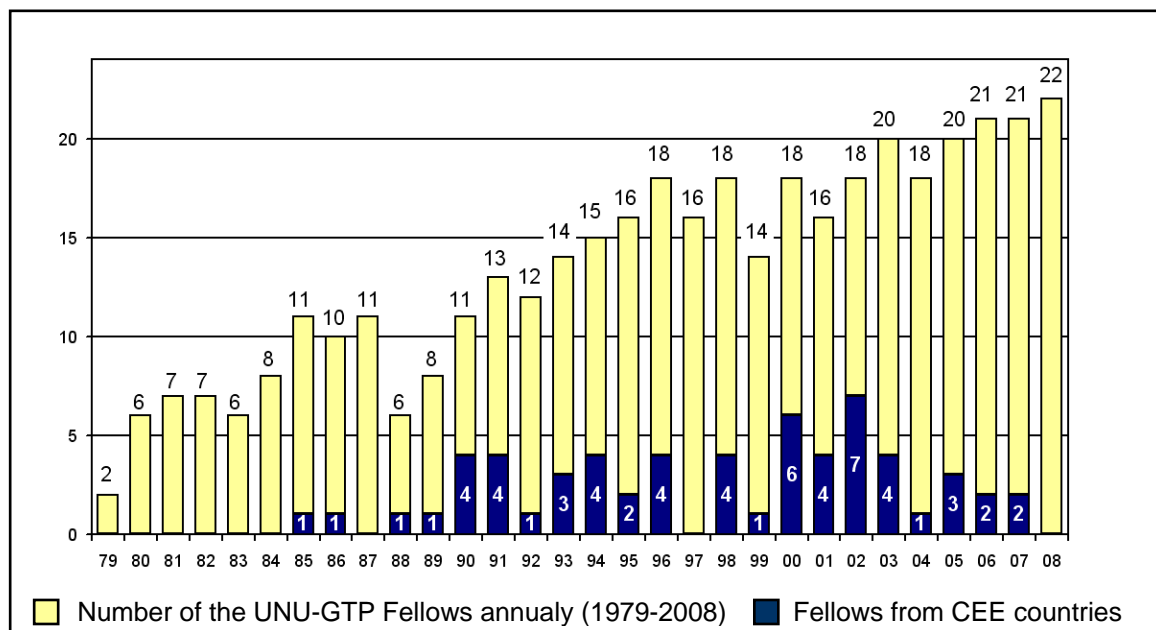


FIGURE 1: Annual numbers of the UNU Fellows (1979-2008) with the contribution of Central and Eastern Europe highlighted

The training provided to Fellows from CEE at UNU-GTP (Table 1) has met the needs of the respective countries. Specialized courses attended by UNU Fellows can generally be divided into two groups:

1. Exploration in initial stages of development – Geological exploration attended by 1 Fellow (1.7%), Borehole Geology 2 (3.3%), Geophysical Exploration 1 (1.7%), Borehole Geophysics 4 (6.7%), and Chemistry of Thermal Fluids 15 (25.0%) (a total of 38.3%).
2. Assessment and utilization of geothermal resources: Reservoir Engineering attended by 15 Fellows (25%), Geothermal Utilization 19 (33.3%) and Environmental Studies 3 (5%) (a total of 61.7%).

Even though Chemistry of Thermal Fluids plays an important role also in the assessment and utilization of geothermal resources (second group) comparison of both above groups shows that CEE countries have presented needs for assisting in the training of specialists in utilization of the resources. Nevertheless training included in the first group is also very important for the countries in Central and Eastern Europe.

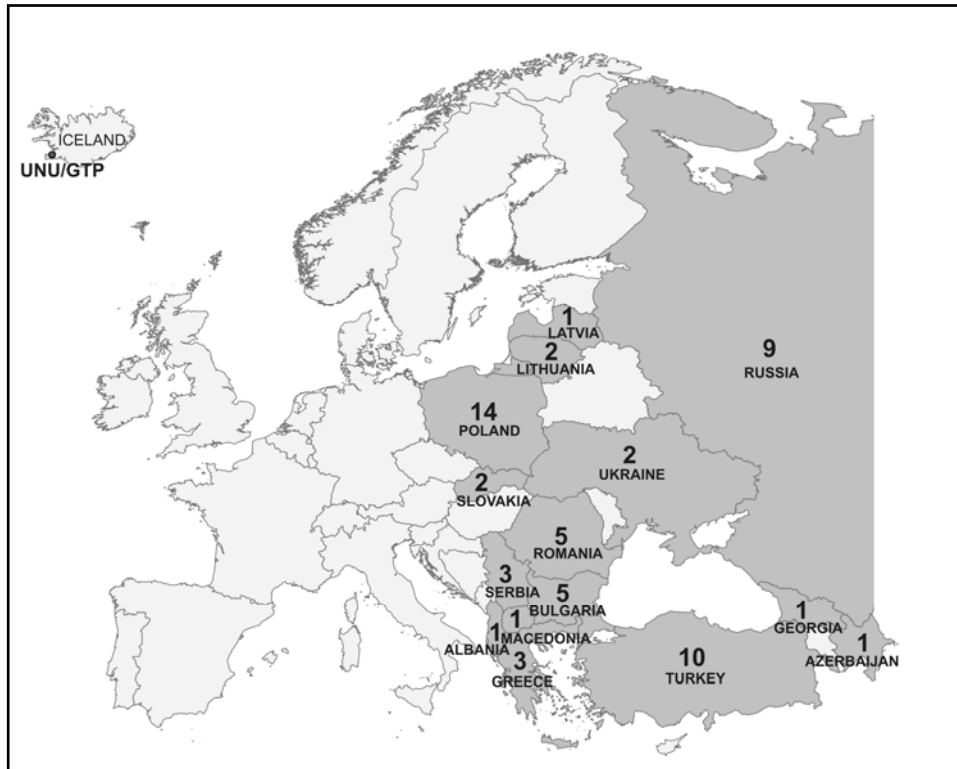


FIGURE 2: Map of Europe with location of Central and European countries participating in the UNU Geothermal Training Programme; number of UNU Fellows shown for each country

#### 4. GEOTHERMAL RESOURCES OF CENTRAL AND EASTERN EUROPE

Significant geothermal resources are well explored in Central and Eastern Europe with majority in sedimentary basins characterized by mean average terrestrial heat flow of 40-80 mW/m<sup>2</sup> with some higher values of 80-100 mW/m<sup>2</sup> in tectonically active southern parts of Europe (Balkan and West Anatolian). Active volcanic areas with high terrestrial heat flow over 150 mW/m<sup>2</sup> are located in the far east of Russia in Kamtchatka. Geothermal utilization in Central and Eastern Europe is mostly based on direct use of hot water in heating, agriculture and balneology with total capacity of 2863 MWt and 13674 GWh/a of produced thermal energy (table 2), which is 31% of total European geothermal energy production in direct applications (Antics, Sanner 2007). Considerable part of this number belongs to shallow resources harnessed by ground source heat pumps. Only in two countries of CEE electric power geothermal generation is implemented. In Russia (Kamtchatka) and Turkey there is 109 MWe installed producing 193 GWh/a of energy (3% of total European production). Comparing to previous reports on status of geothermal utilization in Central and Eastern Europe there is a constant growth of installed capacity and energy produced in most of the countries, as well as new countries emerge in those reports every time.

TABLE 1: Participation of UNU Fellows from Central and Eastern Europe in the different courses of the UNU Geothermal Training Programme.

Country	Geological Exploration	Borehole Geology	Geophysical Exploration	Borehole Geophysics	Reservoir Engineering	Chemistry Of Thermal Fluids	Environmental Studies	Geothermal Utilization	Drilling Technology	Total
Albania	-	-	-	-	-	-	-	1	-	1
Azerbaijan	-	-	-	-	-	-	1	-	-	1
Bulgaria	-	-	-	1	2	2	-	-	-	5
Georgia	-	-	-	-	-	-	-	1	-	1
Greece	-	-	1	-	-	-	-	2	-	3
Latvia	-	-	-	-	-	-	-	1	-	1
Lithuania	-	-	-	-	1	-	-	1	-	2
Macedonia	-	-	-	-	-	1	-	-	-	1
Poland	-	1	-	1	5	1	-	6	-	14
Romania	-	-	-	-	-	1	-	4	-	5
Russia	1	-	-	-	2	5	1	-	-	9
Serbia	-	-	-	1	1	1	-	-	-	3
Slovakia	-	-	-	1	1	-	-	-	-	2
Turkey	-	1	-	-	1	4	1	3	-	10
Ukraine	-	-	-	-	2	-	-	-	-	2
<b>Subtotal, CEE</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>15</b>	<b>15</b>	<b>3</b>	<b>19</b>	<b>0</b>	<b>60</b>
Other	22	33	35	17	71	59	29	61	15	342
<b>GRAND TOTAL</b>	<b>23</b>	<b>35</b>	<b>36</b>	<b>21</b>	<b>86</b>	<b>74</b>	<b>32</b>	<b>80</b>	<b>15</b>	<b>402</b>

TABLE 2: Geothermal energy use in Central and Eastern European countries participating in UNU Geothermal Training Programme (Lund et al., 2005; Bertani, 2005; Antics and Sanner, 2007)

Country	Direct use			Electricity generation	
	Installed capacity (MW <sub>t</sub> )	Total production		Installed capacity (MW <sub>e</sub> )	Total production (GWh/a)
		[TJ/a]	[GWh/a]		
Albania	9.6	8.5	2.4	-	-
Azerbaijan	-	-	-	-	-
Bulgaria	109.6	1671.5	464.3	-	-
Georgia	250.0	6307.0	1752.0	-	-
Greece	74.8	567.2	157.6	-	-
Latvia	-	-	-	-	-
Lithuania	21.3	458.0	127.2	-	-
Macedonia	62.3	598.6	166.3	-	-
Poland	210.0	1108.0	307.8	-	-
Russia	308.2	6143.5	1706.7	79.0	85.0
Romania	145.1	2841.0	787.2	-	-
Serbia	88.8	2375.0	659.8	-	-
Slovakia	187.7	3034.0	842.8	-	-
Turkey	1385.0	24000.0	6667.0	30.0	108.0
Ukraine	10.9	118.8	33.0	-	-
<b>Total</b>	<b>2863.3</b>	<b>49231.1</b>	<b>13674.1</b>	<b>109.0</b>	<b>193.0</b>

## **5. ACTIVITY OF UNU FELLOWS**

### **5.1 Research and Development**

Most of the former UNU-GTP Fellows are still active in various aspects of geothermal. Majority is considerably involved in research and development as they work at universities and research institutions. They lead or participate in numerous projects in science and engineering aiming at assessing resources of geothermal energy and their potential of utilisation. The projects are on domestic or international level.

In 2004 and 2007 6 of the 15 CEE countries that have participated in UNU-GTP joined the European Union: Latvia, Lithuania, Poland, Slovakia (2004) and Bulgaria, Romania (2007). Many of the UNU Fellows have joined European Research & Development projects in the field of geothermal, however in several cases it had been possible even before the accession to EU. The European projects in which UNU Fellows are involved include among others 6 and 7 Framework Programmes and Intelligent Energy Europe initiatives.

### **5.2 Education**

Many of the UNU Fellows continue to work in academic institutions. Their work day activity is shared between research and teaching. After graduation from UNU – GTP several fellows have completed PhD in the fields of science and engineering related to topics studied in Iceland. Some fellows have received higher academic degrees and positions at their universities. The most significant share of UNU Fellows in an academic system of one institution has been observed recently at the University of Oradea in Romania where three of five Romanian alumni of UNU-GTP hold major administrative positions: Rector (Cornel Antal – UNU Fellow 1995), Dean and Vice-Dean (Marcel Rosca – UNU Fellow 1993 and Doina Zmaranda - UNU Fellow 1995). Educational efforts of many UNU Fellows have resulted in numerous MSc and some PhD dissertations on geothermal, completed under their supervision. Some UNU Fellows have been actively teaching at the International Summer School on Geothermal Applications organized by the European Branch of International Geothermal Association.

There are educational initiatives in several countries resulting with establishing new courses and schools like the International Geothermal Training Centre at the University of Oradea. While some UNU Fellows have recently published journals on geothermal and renewable energy (e.g. GLOBEnergia in Poland by Jaroslaw Kotyza; UNU Fellow 2001).

### **5.3. International activity**

The contacts made in Iceland during the six months of the geothermal training are continued by most of the fellows. They participate in international organizations, projects, meetings and other initiatives. Recently in the Board of Directors of the International Geothermal Association two members were former UNU Fellows from Europe (Beata Kepinska – UNU Fellow 1994 and Marcel Rosca – UNU Fellow 1993). They have also been active in the IGA European Regional Branch Forum and Organizing Committee of World Geothermal Congress (WGC 2005: Mahmut Parlaktuna – UNU Fellow 1985 and Marcel Rosca; WGC 2010: Beata Kepinska and Mahmut Parlaktuna).

UNU-GTP Fellows actively participate in the major geothermal event – World Geothermal Congress organized every 5 years. In Florence in Italy in 1995 there were several European UNU Fellows. In Beppu and Morioka in Japan in 2000 there were 15 European UNU Fellows (Kepinska, 2003). In Antalya in Turkey in 2005 there were 40 papers presented by 27 European UNU Fellows. Participation of most of the UNU Fellows was supported by conference grants provided by WGC2005 and UNU. There have also been many minor but important international and domestic conferences and workshops organized by former UNU Fellows in the CEE countries.

## 6. CONCLUSIONS

There is no particular way in such a short paper to list all achievements by the big family of UNU Fellows as well as the professional activities in which they have been involved in Central and Eastern European countries. All these achievements and activities performed for geothermal development in the respective countries and internationally, present enormous contribution of the United Nations University Geothermal Training Programme provided since 1985 to the support and assistance of CEE countries.

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