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The Current Status of Geothermal Energy Use and Development in Slovenia

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ABSTRACT

Geothermal research and development in Slovenia in a period 2000-2004 has been somehow at a lower level than before. Direct use of geothermal energy is mainly attributed to space heating, bathing and swimming (incl. balneology), less for greenhouses, district heating, air conditioning, industrial use and geothermal heat pumps. The total direct use amounted, in 2004, to about 673 TJ at 27 locations with installed capacity of about 47 MWt. At five thermal spas geothermal heat pumps are included. It is believed that at least 102 heat pump units extract an additional heat of about 36.8 TJ from shallow groundwater and 101 closed loop heat pump units extract about 16 TJ/yr, while 1.4 TJ/yr of heat is rejected in the cooling mode. During the last 5 years exploration and development have resulted in only 8 new wells with a total depth of about 6.75 km. One of them encountered formations with possible temperatures of over 100°C in the metamorphic basement. Several thermal spas in north-eastern Slovenia are in a process of merging, and because all users there pump thermal water from the same geothermal reservoir, this will facilitate utilization management and monitoring.

1. INTRODUCTION

The production of electricity and heating energy in Slovenia, with a population of 2 million, amounting to 14,603 GWh/yr, is based, as of December 2002, on partly imported fossil fuels (39.4 %), domestic hydropower (20.9 %), nuclear power (37.9 %) and other renewables (1.8 %, at present only small hydro power plants). At present it is not realistic to expect any production of electricity from geothermal by 2010. It is foreseen that in 2010 also biomass, wind and maybe solar will contribute at least 10 to 20 % within other renewables (Table 1). Following the Kyoto protocol the energetics policy of Slovenia shifted towards the greater use of renewable energy sources with the aim to decrease the dependancy on other imported energy sources and to increase the share of renewable energy resources to about 15 – 20 % in primary energy by 2010. The government supports the direct use of geothermal energy through different projects where few lead agencies are involved in geothermal development, such as: »Agency for Efficient energy use and Renewable energy resources« (AURE in slovene), »Ecological Development Fund of Slovenia« (EKO) which invites public tenders for regional ecological development (i.e. some 20 million US$ in 2004) and supports initiatives for private investments, and »Public Fund for Regional Development«. Also the item »Use of renewable energy resources« (EKO) is included here.

2. GEOLOGY BACKGROUND, GEOTHERMAL RESOURCES AND POTENTIAL

Slovenia lies in the convergent area of the African and Eurasian tectonic plates or, more precisely, on the Adriatic microplate and on the SW part of the Pannonian basin. Slovenia extends over several tectonic units (Fig. 1): the most NE part belongs to the Pannonian basin, while the Eastern Alps (incl. magmatic rock complex), the Southern Alps, the External and Internal Dinarides and Adriatic foreland represent parts of the Adriatic microplate. The Alps and the Dinarides were formed during the collision of these two great tectonic plates that has continued from the Jurassic to the present. Folding and thrusting occurred in several phases, and numerous deep fracture zones were formed in localized areas, enabling thermal water to circulate from depths of several kilometres to the surface, providing the zones are permeable enough. More information on geological aspects can be found in Ravnik et al. (1995) and Placer (1998) and references therein. The 21 thermal springs have constant temperature close to or above 20 °C, however, there are several drilled localities where no surface thermal manifestations existed. Details about the geothermal field of Slovenia and geotectonic background can be found also in papers of Ravnik (1991), Ravnik et al. (1992; 1995) and Rajver and Ravnik (2002). Geothermal resources in the Pannonian basin and the Krsko basin (sometimes called depression) have been studied and monitored in more detail (Fig. 1; Ravnik et al., 1992; Rajver et al., 2002).

The Pannonian basin is filled with Tertiary marine and fresh water sediments. Clays and marls predominate in shallow layers with intercalations of sands, while the deeper layers consist of claystones and marls with intercalations of porous sandstones, where thermomineral and thermal waters reside. The Pliocene and/or Late Miocene sand aquifer has an effective maximum thickness of 60 m, dipping down to depths of 1500 m in the east. The maximum measured permeabilities are about 2.7 darcy and the thermal waters have temperatures of up to 80 °C. Their mineralization was studied among others by Zlebnik (1979) and Kralj and Kralj (2000). In the area of about 1850 km^2 the geothermal resources amount to $0.84 \cdot 10^{15}$ J with a maximum resource per unit area of 2.25 GJ/m^2 in the eastern part of the aquifer.

The main reservoir in the Krsko basin is a Triassic dolomite covered in some places by Cretaceous marly limestone, marl and flysch. On top of this section Miocene and Pliocene-Quaternary sediments were deposited. Borehole data and geophysical surveys confirm a total thickness of the Tertiary deposits of a few 100 m to 1700 m (see e.g. Rajver and Ravnik, 2003). Permeabilities of the Triassic dolomite reach a few darcies, and temperatures are close to 70 °C. The geothermal resources for Triassic (occasionally also Jurassic) carbonates, evaluated for a smaller region (118 km^2) in the eastern Krsko basin, amount to $0.5 \cdot 10^{18}$ J with a maximum of 11.2 GJ/m^2, based on a conservative assessment of net aquifer thickness (400 m).

Other potential areas within the Pannonian basin include deeper sandstone layers of Tertiary (Lendava) formations and the pre-Tertiary basement that is predominantly composed of Paleozoic metamorphic rocks and only locally of Mesozoic dolomites, limestones, breccias and shales, as evidenced by numerous oil wells and underground gas storage research boreholes. The Mesozoic carbonates, overlying the metamorphic rocks, are several 10 m to a few 100 m thick in some places, but their extension and permeabilities are still disputable. Seismic surveys show depths of the basement of less than 400 m to more than 5000 m. The resources in the Mesozoic aquifers, covering an area of about 1880 km^2, amount roughly to $6.3 \cdot 10^{18}$ J and a maximum of 15.4 GJ/m^2, but they are mostly of speculative nature.

Other areas of geothermal interest are described as follows. The Rogatec area comprises Tertiary andesites and Triassic dolomites (at depths of >1400 m and up to 70 °C). The eastern part of the Sava folds, belongs to the Southern Alps, where Tertiary depressions and synclines form deep (1500 m) narrow wedges in the Paleozoic and Mesozoic layers along the faults. The basement consists of Paleozoic and Mesozoic carbonate and clastic sediments, where thermal waters with temperature of 20 to 48 °C are hosted, while thermal springs yield up to 50 kg/s. The Eastern Alps consist mostly of Paleozoic metamorphic rocks. Only more intensely tectonized zones are of geothermal interest (e.g. Maribor area) where deep reaching fracture networks were formed. Eastern Karavanke area is filled with Tertiary clays, sands and at deeper levels marls and sandstones, as well as Mesozoic carbonates in few places (Velenje depression) as geothermal reservoir in depths of >1000 m. In the Coastal area and around Nova Gorica thermal water with temperature of <40 °C reside in Cretaceous limestones underlying flysch sediments.

3. GEOTHERMAL UTILIZATION

At 27 localities direct use of geothermal energy is implemented (Tables 3 and 5). There are no new locations so far, and new investigations with production drilling (i.e. at Benedikt, NE Slovenia) haven't given any reliable results. The main type of use is for bathing and swimming (incl. balneology) and for space heating. A certain percentage of the energy used annually goes through geothermal heat pumps (GHPs) for space heating, sanitary hot water and heating of swimming pools.

3.1 Bathing and swimming

This is the most important type of direct use of geothermal energy in Slovenia. There are 24 thermal spas and recreation centres where swimming pools with a surface area of about 36,000 m^2 and volume of about 50,750 m^3 are heated by geothermal water directly or indirectly through heat exchangers and GHPs. Thermal spas and recreation centres are predominant geothermal localities for direct heat use (Fig. 1) Water temperatures in thermal spas range from 22 to 68 °C. The total geothermal energy used for bathing and swimming is estimated at 245 TJ/yr in comparison with 246 TJ in 1999. New developments of facilities have been completed at Mala Nedelja and Snovik during the last 4 years. At some localities flow rates decreased and at some others only temperature slightly decreased as a consequence of overexploitation with no reinjection (Lendava, Moravci, Murska Sobota, all NE Slovenia), and at others both temperature and flow rate decreased just due to lower utilization or maybe also damaged boreholes (Olimia, Rogaska Slatina, Dobrna, Topolsica). At some other localities improvements were managed chiefly by boreholes' repair or new pumps, such as at Ptuj and at Banovci, while in Maribor and at Lasko with lower outlet temperature, and at Rimske Toplice (S of Celje, see Fig. 1 and Table 3) with improved flow rate.

3.2 Space heating and district heating, air conditioning

This second most important type of direct use is mostly implemented at thermal spas, and at most of them directly. The heating of sanitary hot water there is also included. The users have GHP units installed only in the case when the thermal water temperature is too low. At Murska Sobota 300 dwellings are heated geothermally through heat exchangers, especially from October to April. Lower flow rates are the case at Olimia, while at Moravci higher flow rate but lower inlet temperature. Consequently the total geothermal energy used for space heating is about 224 TJ/yr as compared with 263 TJ in 1999. At Moravci a small amount of 17 TJ/yr is now dedicated to district heating and 23 TJ/yr to air conditioning.

3.3 Greenhouses

The heating of greenhouses with geothermal water began in 1962 at Catez (E Slovenia). It is performed there by the Flowers Catez Co. (total area under glass 4.5 ha) for production of flowers mainly for the domestic market, while at Moravci (1 ha under glass) for tomato production. The total geothermal energy used in the greenhouses is about 100 TJ/yr and is lower compared with the use in 1999 (137 TJ). The active period of Terme Catez is during warmer months, while that of Flowers Catez during colder part of the year, therefore, they do not interfere much with each other despite their closely spaced localities at Catez. They both exploit the same geothermal fractured dolomitic aquifer, where the average annual flow rate is only 20 kg/s.

3.4 Industrial process heat

Industrial use of geothermal energy is active only at Vrhnika, where it amounts to 14.2 TJ/yr. There thermal water of 24 °C is heated to about 55 or 60 °C for the leather industry, while at Trbovlje thermal water is used for cooling at the cement works, and therefore, is not considered as energy use. Only small amount is utilized for the swimming pool in winter months.

3.5 Geothermal heat pumps

The GHPs are used in an open loop system at five thermal spas and /or recreation centres, predominantly for raising the thermal water temperature for further use in swimming pools and for space heating. The geothermal energy used for GHPs amounts to about 36.3 TJ/yr in comparison with 27 TJ in 1999 and 64 TJ in 1994. Small increase in recent years is due to slight improvements in temperature difference at Maribor, at Rimske and Smarjeske Toplice.

There are at least 102 GHP units on water source that extract at least about 36.8 TJ from shallow groundwater and 101 closed loop ground coupled GHP units (87 horizontal and 14 vertical) that extract additional 16 TJ/yr, while at least 1.37 TJ/yr of heat is rejected to the ground in the cooling mode (Table 4). Altogether at least 203 units extract 52.83 TJ/yr. Very probably the real number of GHP units is not much higher. There was low interest in GHPs in 1990's due to high initial costs and high price of electricity and low prices of gas and oil in comparison with the situation before 1990 when GHPs were more popular. The number of closed loop (ground coupled) geothermal or ground-source heat pumps in Slovenia has increased in recent years as a consequence of governmental funding and good promotion of some private companies involved in their installation about their advantages. This increase will hopefully continue.

4. DISCUSSION

All known geothermal resources are of the low enthalpy type with the exception of the high temperature geothermal system (preTertiary basement aquifers) in NE Slovenia. At present there are no new discovered resources of low enthalpy type in the past 5 years. High enthalpy resources are still not in use. Doublet schemes were in use only at Moravci for a period of 3 years in the mid 1990's, otherwise they are not yet in use but should be introduced as soon as possible, due to overexploitation. The most vulnerable locations are in NE Slovenia where thermal water is extracted from the Upper Miocene and/or Lower Pliocene sandy aquifer. In a period 1994 - 1999, the average flow rate decreased in some production wells of this area, tipically at Murska Sobota, Moravci and Ptuj, but during last 5 years only at Lendava, while at other localities it improved, perhaps just temporarily.

The annual energy use from geothermal for space heating has increased in a period 1994-1999 and decreased slightly during last 5 years (a certain amount is now dedicated to district heating and air conditioning). The energy use for bathing and swimming has decreased drastically in a period 1994-1999, and since then has decreased again by 14.5 TJ/yr. The greenhouses' energy use has increased in a 1994-1999 period and decreased substantially in 2000-2004, while that of industrial process heat has faced only small increase. It is worth mentioning that the number of GHPs units (open and closed loop) has increased as well as their energy use during the last 5 years. They contribute 52.8 TJ/yr and, together with those GHPs that are installed at thermal spas, about 89 TJ/yr. It is believed that good promotion of the advantages of shallow geothermics will help increase its use in future also due to unstable oil prices.

The total number of professional personnel in geothermal activities was in the period 2000-2004, allocated as follows (in person-years): 1 – Government, 11 – Public Utilities, 5 – Universities and 27 – Private Industry (Table 7). The investment in table 8 presents the increase of private sector, from 73 % in 1990-1994 to 99 % in 1995-1999, and is still high, about 95 %, in 2000-2004.

The cost of geothermal direct utilization differs from locality to locality, but generally it is lower than the fossil fuel energy prices. For example, the cost of heating oil in Slovenia is 0.062 US$/kWh (gas and coal are even a little bit cheaper), while at present the user of the GHP (horizontal) unit tipically pays about 0.03 to 0.04 US$/kWh (considering the COP about 3). Despite the initial high cost of GHP investments people with ecological and funding feeling push forward this type of use of shallow geothermal energy.

For the past 5 years drilling activity has been lower compared with earlier periods. Only 8 wells have been drilled with a total depth of 6.75 km (Table 6). Three wells have been dedicated to direct use exploration only, while the purpose of 3 production wells with a total depth of 3.19 km has been mainly for new projects at Izola (Coastal area), Benedikt (NE Slovenia) and for flow improvement at Radenci. Some wells were drilled without any previous surface investigations or pre-feasibility studies, and their result was consequently worse than expected. Two shallow wells have been finished for thermal gradient determination.

The users need to pay more attention to the more rational use of the presently available geothermal resources that is especially the case in the NE Slovenia where meteoric precipitation is smaller than elsewhere. Therefore, due to overexploitation there, the doublet systems with reinjection should be introduced at some locations. In some areas, notably in western, southern and central Slovenia, where an interest for development of new recreational centres exists, hydrogeothermal and geophysical investigations need to be used more to better define the geothermal potential before the exploration and exploitation drilling. The cascade system of utilization of thermal water, nowadays performed partly at Moravci, will have to be more considered in future.

5. FUTURE DEVELOPMENT AND INSTALLATIONS

The government funding for efficient energy use has improved in recent years. For example, the Public Fund for Regional Development will support three projects in 2004/05 for exploration and exploitation of thermal and thermomineral waters, dedicated for further development of balneology at tourist centres. This is connected with activity of the Ministry of Economy which invites tenders for the funds of the »European Fund for Regional Development« that will stimulate the further development of touristic activities, especially balneology. Therefore, few new localities for geothermal energy development are proposed in northeastern and southern Slovenia, at Janezovci near Ptuj and at Metlika, respectively.

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TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY (Installed capacity)

	Geothermal		Fossil Fuels		Hydro		Nuclear		Other Renewables (specify)		Total	
	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr
In operation in December 2004			1489	5758.6	879.7	3057.8	707	5528	62.6	258.8	3138.3	14603.2
Under construction in December 2004					32.5	115						
Funds committed, but not yet under construction in December 2004					176	697						
Total projected* use by 2010			1989	5528	1088.2	4331	707	5451	218	491	4002.2	15801

Sources:
Statistical Report for Energetic Economy, 2002.
* values for Gross Production are from the Proposal for National Energetics Program for Slovenia.
Legend:
Fossil Fuels: lignite, extra light oil, natural gas, etc.
Other Renewables (in 2004): Small Hydro Power Plants (<5 MW)
One half of the Nuclear Gross Production goes to Croatia.

TABLE 3. UTILIZATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT AS OF 31 DECEMBER 2004 (other than heat pumps)

1) I = Industrial process heat
C = Air conditioning (cooling)
A = Agricultural drying (grain, fruit, vegetables)
F = Fish farming
K = Animal farming
S = Snow melting
H = Individual space heating (other than heat pumps)
D = District heating (other than heat pumps)
B = Bathing and swimming (including balneology)
G = Greenhouse and soil heating
O = Other (please specify by footnote)

2) Enthalpy information is given only if there is steam or two-phase flow

3) Capacity (MWt) = Max. flow rate (kg/s)[inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.004184 (MW = 10^6 W)
or = Max. flow rate (kg/s)[inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] x 0.001

4) Energy use (TJ/yr) = Ave. flow rate (kg/s) x [inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.1319 (TJ = 10^{12} J)
or = Ave. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] x 0.03154

5) Capacity factor = [Annual Energy Use (TJ/yr)/Capacity (MWt)] x 0.03171
Note: the capacity factor must be less than or equal to 1.00 and is usually less, since projects do not operate at 100% of capacity all year.

Note: please report all numbers to three significant figures.

Locality	Type[1)]	Maximum Utilization					Capacity[3)]	Annual Utilization		
		Flow Rate (kg/s)	Temperature (^{o}C) Inlet	Temperature (^{o}C) Outlet	Enthalpy[2)] (kJ/kg) Inlet	Enthalpy[2)] (kJ/kg) Outlet	(MWt)	Ave. Flow (kg/s)	Energy[4)] (TJ/yr)	Capacity Factor[5)]
1. Moravci	C,H,D,B,G	78	61	32			9.41	34.7	139.7	0.47
2. Murska Sobota	H,B	18	48.5	33			1.17	10	20.44	0.55
3. Terme Lendava	H,B	14	56	29			1.60	4	14.28	0.28
4. Lendava Elizabeta	H	14	64	44			1.17	3	7.91	0.21
5. Ptuj	B	16	34	26			0.54	13.2	13.7	0.81
6. Mala Nedelja	B	7	43	28			0.44	0.7	1.39	0.1
7. Banovci	H,B	20	68.4	33			3	5.1	23.8	0.25
8. Zrece	H,B	27	30.7	25.7			0.57	15	9.89	0.55
9. Olimia Atomske T.	H,B	20	38	28			0.84	15	19.8	0.75
10. Rogaska Slatina	B	8	48	28			0.67	1.5	3.96	0.19
11. Snovik	B	15	30.4	28			0.15	5	1.58	0.33
12. Dobrna	B	8	35	31			0.13	1.6	0.84	0.2
13. Topolsica	B	25	28	15			1.36	5	8.57	0.2
14. Medija	H,B	35	23	20			0.42	14	5.8	0.44
15. Smarjeske Toplice	H,B	40	32	17			2.51	30	59.4	0.75
16. Lasko	B	18	34	25			0.68	18	21.4	1
17. Rimske Toplice	H,B	20	40	32			0.67	6	6.34	0.3
18. Dolenjske Toplice	B	19.6	34.2	32			0.18	9	2.41	0.43
19. Terme Catez	H,B	80	62	30			10.71	41	173.05	0.51
20. Flowers Catez	G	60	54	28			6.53	20	68.59	0.33
21. Bled	B	12	21.7	20			0.09	10	2.24	0.83
22. Vrhnika	I	20	24	15			0.75	12	14.2	0.6
23. Trbovlje	B	11	27	23			0.18	0.2	0.1	0.02
24. Cerkno	H,B	29	27.6	24.5			0.38	8	3.27	0.28
25. Dobova	H,B	15	63	38			1.57	7	23.1	0.47
26. Portoroz	B	0.8	23	16			0.02	0.5	0.46	0.6
27. Maribor	H,B	2.5	39	13			0.27	1.75	6	0.7
TOTAL		650.9					47.18	301.3	672.7	0.45

TABLE 4. GEOTHERMAL (GROUND-SOURCE) HEAT PUMPS
AS OF 31 DECEMBER 2004

This table should report thermal energy used (i.e. energy removed from the ground or water) and report separately heat rejected to the ground or water in the cooling mode. Cooling energy numbers will be used to calculate carbon offsets.

1) Report the average ground temperature for ground-coupled units or average well water or lake water temperature for water-source heat pumps

2) Report type of installation as follows: V = vertical ground coupled (TJ = 10^{12} J)
H = horizontal ground coupled
W = water source (well or lake water)
O = others (please describe)

3) Report the COP = (output thermal energy/input energy of compressor) for your climate

4) Report the equivalent full load operating hours per year, or = capacity factor x 8760

5) Thermal energy (TJ/yr) = flow rate in loop (kg/s) x [(inlet temp. (^oC) - outlet temp. (^oC)] x 0.1319
or = rated output energy (kJ/hr) x [(COP - 1)/COP] x equivalent full load hours/yr

Locality	Ground or water temp. (^oC)[1)]	Typical Heat Pump Rating or Capacity (kW)	Number of Units	Type[2)]	COP[3)]	Heating Equivalent Full Load Hr/Year[4)]	Thermal Energy Used (TJ/yr)	Cooling Energy (TJ/yr)
open loop:								
water - water	13	10.6/unit=212	20	W	2.4 - 3.4	900-2520	8.86	
water - water	11	18/unit=540	30	W	3	1400-2300	8.24	
water - water	11	25/unit=50	2	W	3	2200	1.44	
water - water	1 to 16	623	50	W	2.4 - 4.5	220-2520	18.27	
Total open loop		1425	102	W	2.4 - 4.5	220-2520	36.81	
closed loop:								
ground coupled	0 to 39	706.8	87	H	2.9 - 4.5	1200-2520	9.88	
ground coupled	2.5 to 14	198.3	14	V	3.0 - 4.8	1800	6.14	1.37
Total closed loop		905.1	101		2.9 - 4.8	1200-2520	16.02	
TOTAL		2330.1	203		2.4 - 4.8	220-2520	52.83	1.37

TABLE 5. SUMMARY TABLE OF GEOTHERMAL DIRECT HEAT USES AS OF 31 DECEMBER 2004

[1] Installed Capacity (thermal power) (MWt) = Max. flow rate (kg/s) x [inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.004184
or = Max. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] x 0.001

[2] Annual Energy Use (TJ/yr) = Ave. flow rate (kg/s) x [inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.1319 (TJ = 10^{12} J)
or = Ave. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg) x 0.03154

[3] Capacity Factor = [Annual Energy Use (TJ/yr)/Capacity (MWt)] x 0.03171 (MW = 10^6 W)
Note: the capacity factor must be less than or equal to 1.00 and is usually less, since projects do not operate at 100% capacity all year

Use	Installed Capacity[1] (MWt)	Annual Energy Use[2] (TJ/yr = 10^{12} J/yr)	Capacity Factor[3]
Individual Space Heating[4]	16.07	224.12	0.44
District Heating [4]	0.94	17	0.57
Air Conditioning (Cooling)	1.43	23	0.51
Greenhouse Heating	7.92	99.79	0.4
Industrial Process Heat[6]	0.75	14.2	0.6
Bathing and Swimming[7]	17.57	245.28	0.44
Subtotal	44.68	623.39	0.44
Geothermal Heat Pumps	3.94	89.11	0.72
TOTAL	48.62	712.5	0.46

[4] Other than heat pumps
[5] Includes drying or dehydration of grains, fruits and vegetables
[6] Excludes agricultural drying and dehydration
[7] Includes balneology

TABLE 6. WELLS DRILLED FOR ELECTRICAL, DIRECT AND COMBINED USE OF GEOTHERMAL RESOURCES FROM JANUARY 1, 2000 TO DECEMBER 31, 2004 (excluding heat pump wells)

[1] Include thermal gradient wells, but not ones less than 100 m deep

Purpose	Wellhead Temperature	Number of Wells Drilled				Total Depth (km)
		Electric Power	Direct Use	Combined	Other (gradient)	
Exploration[1]	(all)		3		2	3.556
Production	>150^o C					
	150-100^o C					
	<100^o C		3			3.189
Injection	(all)					
Total			6		2	6.745

TABLE 7. ALLOCATION OF PROFESSIONAL PERSONNEL TO GEOTHERMAL ACTIVITIES (Restricted to personnel with University degrees)

(1) Government
(2) Public Utilities
(3) Universities
(4) Paid Foreign Consultants
(5) Contributed Through Foreign Aid Prograr
(6) Private Industry

Year	Professional Person-Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
2000		3	1			5
2001		2	1			5
2002		2	1			5
2003	1	2	1			6
2004		2	1			6
Total	1	11	5			27

TABLE 8. TOTAL INVESTMENTS IN GEOTHERMAL IN (2004) US$

Period	Research & Development Incl. Surface Explor. & Exploration Drilling	Field Development Including Production Drilling & Surface Equipment	Utilization		Funding Type	
			Direct	Electrical	Private	Public
	Million US$	Million US$	Million US$	Million US$	%	%
1990-1994	1.6	2.92	15.46		73	27
1995-1999	1.94	4.08	13.33		99	1
2000-2004	1.36	4.09	45.45		95	5

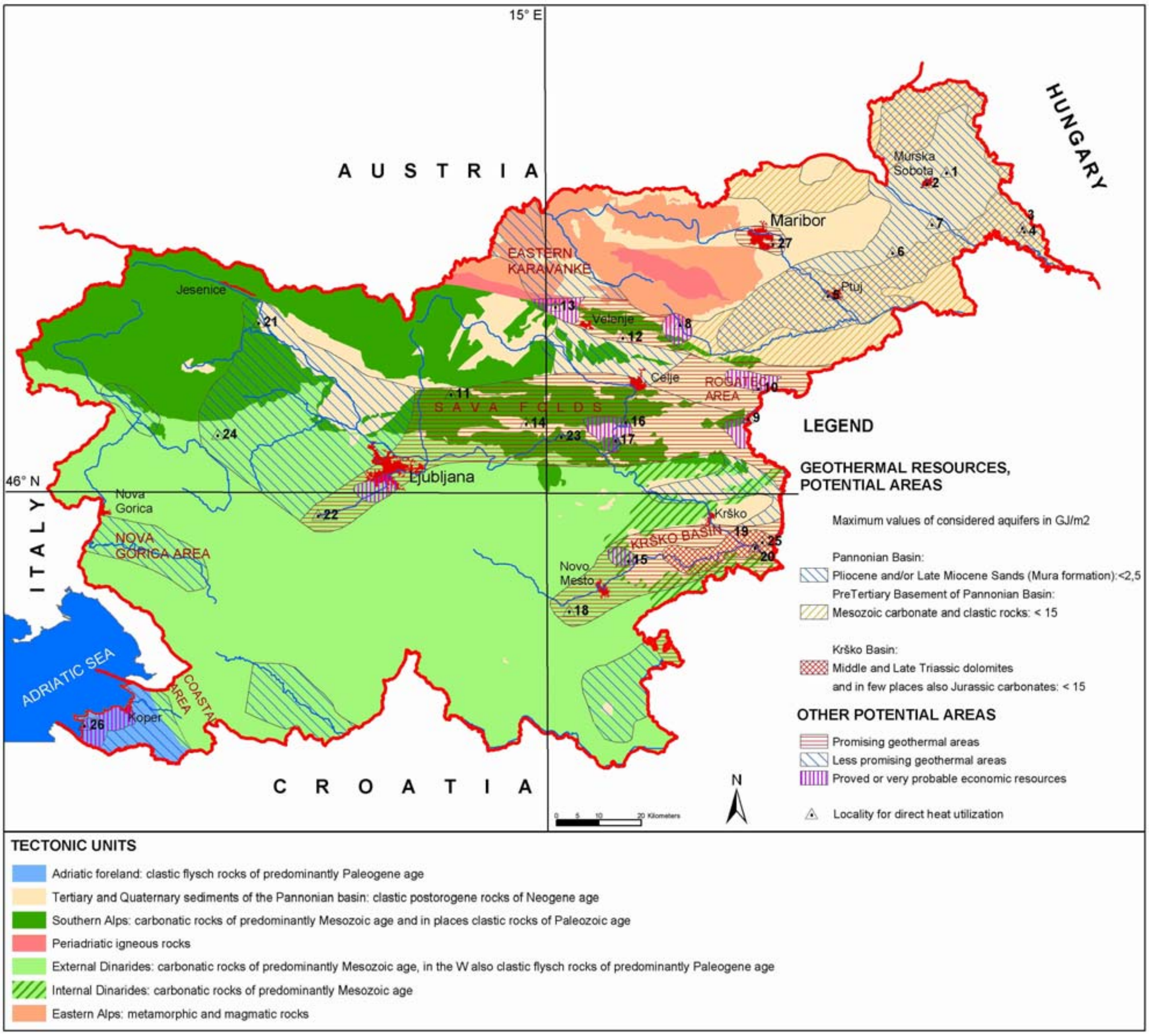

Figure 1: The main tectonic units of Slovenia with their lithological composition and geothermal resources with potential areas.