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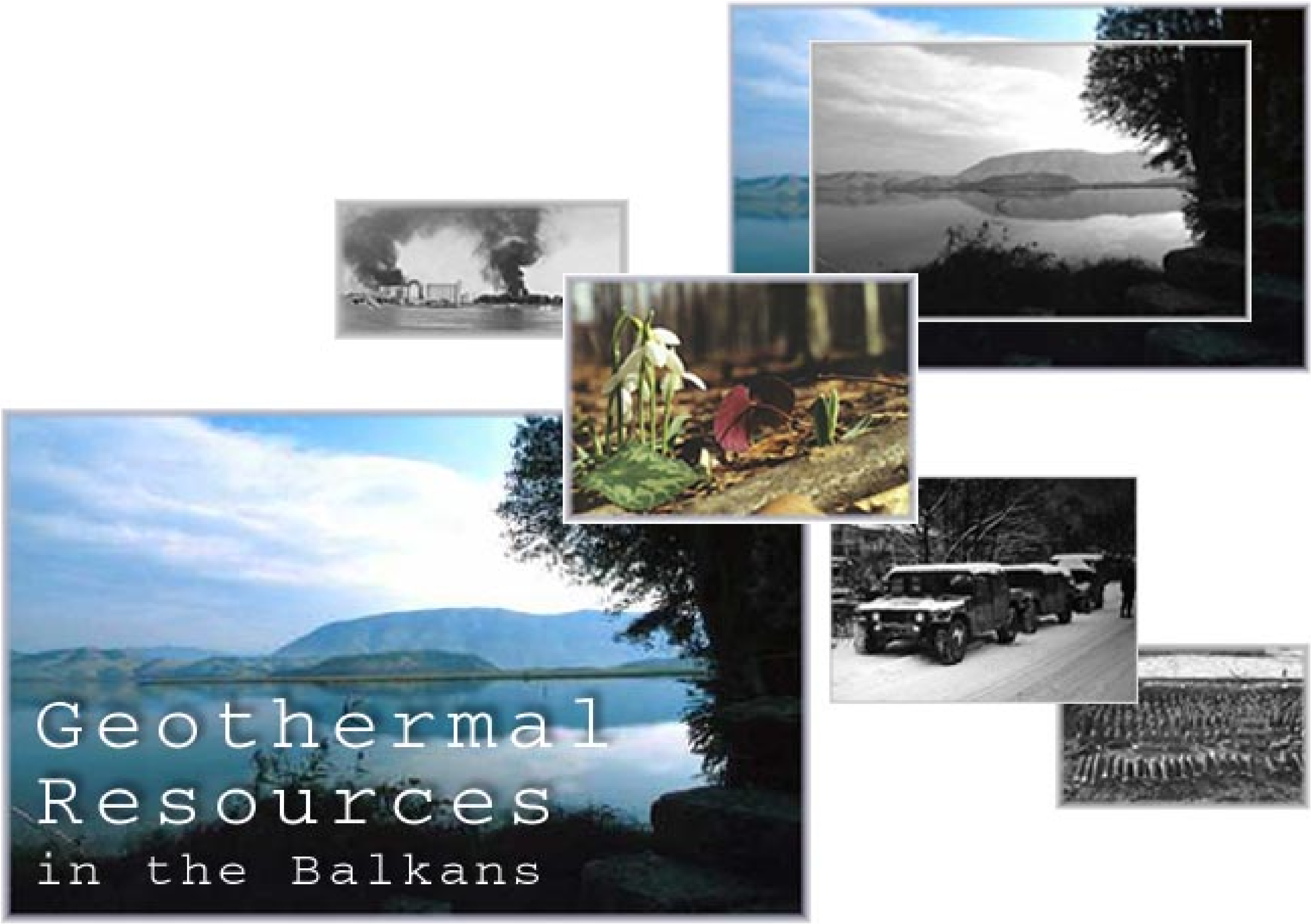
Geothermal Resources in the Balkans



by Liz Battocletti, Bob Lawrence & Associates, Inc. April 2001

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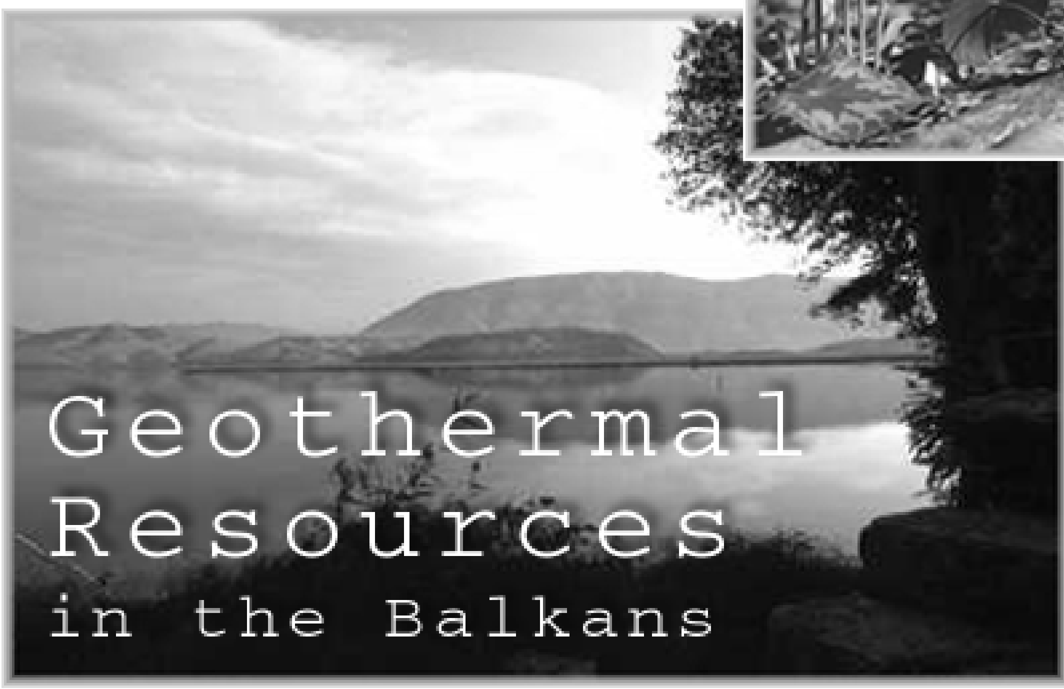

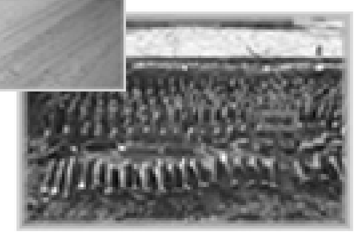

Geothermal Resources in the Balkans

by Liz Battocletti, Bob Lawrence & Associates, Inc.

April 2001

Disclaimer

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Introduction

The **Database of Geothermal Resources in the Balkans** contains information on 237 specific geothermal sites or projects in the six countries which constitute the Balkans – Albania, Bosnia and Herzegovina, Croatia, the Former Yugoslav Republic of Macedonia (FYR Macedonia), Slovenia, and Yugoslavia (Serbia and Montenegro).

A summary of geothermal resources found in the six countries is shown in Table 1. The 237 sites have a projected electricity generation potential of 439 MWe and a direct use potential of 3,390 MWt. Thirty-three or 14% of the sites have a temperature of 100ºC or more, and may be suitable for power generation development.

The Database and market research report were designed, built, and written by a team led by Liz Battocletti of Bob Lawrence & Associates, Inc. (BL&A) for UT-Battelle LLC under Purchase Order Number F99-181039, "Collection and Assembly of Published Data on Geothermal Potential." It was compiled using information collected in an extensive data and Internet search which accessed technical literature dating back 25 years, as well as numerous U.S. and Balkan sources.

Special appreciation is due Joel Renner of Idaho National Engineering and Environmental Laboratory (INEEL) and Allan Jelacic of the U.S. Department of Energy's Office of Wind and Geothermal Technologies for their support.

Particular thanks goes to Edin Fetahovic, U.S. Embassy in Sarajevo; Damjan Bencic, U.S. Embassy in Croatia; Arben Gega, U.S. Embassy in Macedonia; Estref Imeri and Todor Novkovski, Energy and Mining Department, Ministry of Economy, Republic of Macedonia; Marko Mlakar, U.S. Embassy in Slovenia; Marnell Dickson; Ladislaus Rybach; Jenny Gothard and Silvia Savich of the Central and Eastern Europe Business Center (CEEBIC) of the U.S. Department of Commerce; and the other individuals, companies, and organizations who provided assistance and information.

For immediate dissemination to the industry, the report has been converted to a PDF file.[1]

[1] PDF files can be read and printed using the free Adobe® Acrobat® Reader which can be downloaded at http://www.adobe.com/products/acrobat/readstep.html.

The **Database of Geothermal Resources in the Balkans** includes:

- Power Profile - basic information on population, GDP, installed capacity, electricity prices, etc.;
- Power Summary - description of the power sector and privatization efforts;
- Government / Legislation - relevant government agencies and laws; and
- Geothermal Sites / Projects - a Site Summary for each:

    1. Name
    2. Location
    3. Status
    4. Temperature
    5. Installed Capacity (MWe/MWt)
    6. Potential (MWe/MWt)
    7. Chronology
    8. Notes

Dynamic Database

The Database is designed to be dynamic. Created using Microsoft® Access 2000, it can be easily updated or modified to include specific data which the industry would find most useful. In addition, the Database can be made more comprehensive by adding pertinent data, e.g., local population and market data, location of transmission lines and roads, etc., using the Geographic Information System (GIS), to the present structure.

To date, BL&A has conducted similar extensive surveys of geothermal resources in Latin America and the Caribbean, Turkey, Poland, China, Hungary, and Russia, building databases for each. The databases could be adapted for posting on the World Wide Web and searched using a variety of variables, e.g., country, temperature of resource, estimated power potential, and other parameters.

Photo credits (from top to bottom): Albanian landscape, Giovanni Lattanzi, http://www.archart.it/; Novi Sad refinery burning, May 1999, Free Republic, http://www.FreeRepublic.com/forum/a3a56536e6176.htm; Flower (Medvednica by Zagreb), Croatian Mountaineering Association, http://public.srce.hr/hps/slike/slikeeng.htm; Jeep convoy, Camp Diane, Bosnia, Steven Dutch, http://www.uwgb.edu/dutchs/BosPhoto/bospix08.htm; and Land mines, Mine Action Centre, Sarajevo, NATO, http://www.nato.int/.

Country	Number of Geothermal Sites / Projects	Maximum Temp. (ºC)	Average Temp. (ºC)	Number of Sites >100ºC	Power Generation Potential (MWe)	Direct Use Potential (MWt)
Albania	22	105.8	40.6	1	N/A	N/A
Bosnia and Herzegovina	3	85	65.6	0	N/A	33
Croatia	28	170	75.9	4	28	815
FYR Macedonia	32	150	56.7	12	200	2,200
Slovenia	52	175	33.6	2	11	106
Yugoslavia (Serbia and Montenegro)	100	150	47.9	14	200	236
TOTALS	**237**			**33**	**439**	**3,390**

Table 1 – Geothermal Resources in the Balkans

The Balkans

AUSTRIA
HUNGARY
MOLDOVA
UKRAINE
SLOVENIA
CROATIA
ROMANIA
BOSNIA AND HERZEGOVINA
YUGOSLAVIA
BULGARIA
TURKEY
The Former Yugoslav
Republic of Macedonia
ALBANIA
ITALY
GREECE
Ionian Sea

Albania

Power Profile

Population (millions) -July 2000 estimated	3.49
GDP (billion US$) - 1999 estimated	$5.6
Real GDP Growth Rate - 1999 estimated	8.0%
Inflation Rate (CPI) - 1999 estimated	0.5%
Total Installed Capacity (MWe) - January 2000	1,892
Electricity Consumption per Capita (kWh) - 1998	689
Energy Demand Growth Rate	6%
Prices (US¢/kWh) - 2001 Households Companies (price depends on size and profitability of the company) Source: National Agency on Energy	 3.13 5.22-10.1
Geothermal Power Potential (MWe)	N/A
Geothermal Direct Use Potential (MWt)	N/A

Slightly smaller than Maryland, Albania shares land borders with Greece, the Former Yugoslav Republic of Macedonia, the Federal Republic of Yugoslavia's southern province of Kosovo, and the Republic of Montenegro – and an off-shore border with Italy.

The poorest country of Europe has faced many challenges following the collapse of communism and the centrally planned economy. In 1991 and 1992, economic depression and lack of opportunity led to the mass exodus of thousands of young Albanians to Italy and Greece.

The economy recovered in 1993-95 but in election year 1996, the government's weakening resolve to maintain stabilization policies increased inflation and the budget deficit.

The collapse of financial pyramid schemes in early 1997 – which had attracted deposits from a substantial portion of Albania's population – triggered an economic meltdown and widespread civil insurrection including more than 1,500 deaths, widespread destruction of property, and an 8% drop in GDP. Following fundamental reforms in 1998, the economy recovered.

In early 1999, the Government of Albania (GOA), with international assistance, handled the influx of nearly 500,000 Kosovar refugees (which increased the country's population by 14%) with minimal disruption to the country.

Currently, Albania is reviving its infrastructure and privatizing potentially lucrative telecommunications, energy, banking, and mining companies. The country has a well-educated and inexpensive work force, an entrepreneurial populace, and is near lucrative Western European markets. U.S. products and companies are highly regarded by Albanian consumers; the GOA is eager to attract U.S. investment.

Albania's economy is currently growing by 7-8% a year.

Power Summary

Albania has a total installed capacity of 1,892 MWe – 1,668 MWe from hydropower plants (HPPs) and 224 MWe from thermal power plants (TPPs). In 1998, Albania consumed 5.29 billion kWh, produced 5.15 billion kWh, and imported 500 million kWh of electricity. With over 90% of production supplied by HPPs, the country is vulnerable to frequent droughts. Much of the equipment is old and in need of renovation. Technical and non-technical losses are high.

Only 35% of the country's hydropower potential has been developed. The Albanian, state-owned electricity monopoly, Albanian Power Corporation (Korporate Elektoenergjetike Shqiptare [KESH]), plans to build two new HPPs by 2006, and three steam-power plants.[2] A grid overhaul and the rehabilitation of four old HPPs are underway.

In addition to hydropower, Albania has significant hydrocarbon resources (oil and gas) as well as vast reserves of coal. Renewable energy, e.g., solar, wind, and low-enthalpy geothermal for heating, are also potential sources of energy.

Demand for electricity has been increasing 6% annually since 1992. Albania became a net energy importer in 1998, primarily due to an increase in consumer demand for electricity as households imported appliances and electric heaters. Nationally, 80% of home heating demand is covered by electricity. The country imports 37% of its electricity. Forecasters estimate that electricity demand could reach 9.01 TWh in 2010 (up from 4.57 TWh in 1995).

With its significant petroleum and natural-gas reserves, coal deposits, and hydropower resources, Albania could produce enough energy for domestic consumption and export fuels and electricity.

[2] China International Water and Electric Corporation (CWE) will build a 168 MWe (2x84) hydropower plant in Bushat. Both turbines should be operational in 2004.

Government / Legislation

The Government of Albania is very interested in increasing the share of foreign investors' participation in the energy sector of Albania.

Albania has no umbrella energy policy law or basic principles for the whole energy sector in the long-term perspective. The country also lacks legislation in the field of renewable energy sources, as well as energy conservation. The GOA, however, is in the process of preparing an Energy Law and an Energy Efficiency Law.

The principal laws relating to investment in the energy sector are the following:

- Law on Competition, No. 8044 of December 1995
- Law on Environmental Protection, No.. 7664 of January 1993
- Mining Law No.7796 of February 1994
- Law on Foreign Investment, No. 7764 of November 1993
- Law on Concessions and the Participation of the Private Sector in Public Services and Infrastructure, No. 7973 of July 1995
- Law on Electricity, No. 7962 of July 1995
- Law on the Purchase and Sale of Urban Land, No. 7980 of July 1995
- Law on the Privatization of the Power Sector, No. 7963 of July 1995
- Law on Electricity Regulation, No. 7970 of July 1995

The Albanian energy sector is not a legal monopoly; foreign investment is allowed and is not subject to government authorization. The only limitation to foreign investment is the issue of land ownership rights. Foreign investors may own real estate in Albania with the exception of agricultural land, forests, pastures, and meadows. The latter may be leased, however, for up to 99 years under the provisions of the Albanian Civil Code. Foreigners may buy urban land if they invest three times the purchase price.

A bilateral investment treaty between the United States and Albania was signed in 1995 and entered into force on 3 January 1998. This treaty ensures U.S. investors receive national or most-favored-nation treatment and provides for dispute settlement.

Albania's energy sector remains under state ownership. The International Monetary Fund (IMF) has urged Albania to complete reforms in the energy sector in order to continue the country's economic progress, specifically advising the GOA to improve payment collection, promote alternative sources of energy, and change the tariff structure.

Albania's power system development strategy has been elaborated on the basis of studies carried out by international consultants and financed by the World Bank and the European Bank for Reconstruction and Development (EBRD). The strategy foresees:

- Meeting the domestic electricity demand at the lowest cost and good quality by minimizing the interruption of supply to the customers;
- Exporting excess electricity production;
- Rehabilitating existing HPPs and TPPs;
- Developing new capacities for HPPs as well as for TPPs burning imported natural gas;
- Decreasing technical and non-technical losses within the system;
- Restructuring the power system; and
- Attracting private foreign and local capital.

Ministry of Public Economy and Privatization

Since 1997, the Ministry of Public Economy and Privatization represents the Government as the owner of the energy sector assets. (Formerly called the Ministry of Mineral Resources and Energy.)

National Energy Agency

The National Energy Agency is responsible for energy, and acts as an adviser to the Minister of Public Economy and Privatization.

Entity for Electricity Regulation (EER)

Following the adoption of Law No. 7970 on Electricity regulation in July 1995, an independent Entity on Electricity Regulation (EER) was established in September 1995. The EER is responsible for tariff regulation and licensing in the power sector, and is accountable to the Council of Ministers.

Energy prices, with the exception of electricity prices, have been liberalized. In April 1994, electricity prices were increased sharply, to bring them closer to production costs. It is estimated that the long run cost of supply is 4.2-4.6¢/kWh.[3]

Albanian Power Corporation (Korporate Elektoenergjetike Shqiptare [KESH])

KESH is a state-owned joint stock company, established in 1992 in accordance with the Law of State Entities, and operated under the jurisdiction of the Ministry of Public Economy and Privatization.

KESH is responsible for power generation and transmission. It also distributes power through 38 subsidiaries, including Shkoder, Elbasan, and Vlora, which were subject to an unsuccessful pilot privatization process.

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[3] 1 LEK = 0.007067 USD (12 February 2001)

In July 1995 the Albanian parliament passed a package of laws to enable major changes in the management of the power sub-sector. The laws provide for the establishment of a regulatory system, the staged privatization of KESH's distribution functions, and the development of independent private power production.

KESH will be privatized by 2003-2005 most likely by international tenders.

<u>No Specific Law for Geothermal</u>

Albania has no specific geothermal legislation. No guidelines exist for geothermal exploration permits or licensing geothermal exploitation. Geothermal licensing is issued by the state.

The GOA supports investment in geothermal projects through price indexing (price in relation to other energy sources) and the free utilization of existing wells.

Geothermal Sites / Projects

Albania is a predominantly mountainous country. Approximately 75% of its territory is highlands with elevations of 300 m. One mountain range, which generally runs from north to south, is the southern end of the Dinaric Alps. The North Albanian Alps, a glaciated limestone range in extreme northern Albania, are extremely rugged.

The greatest heat flow densities in Albania are located in the center of the Preadriatic Depression, where the value is 42 $mW \cdot m^{-2}$, and in the east of the ophiolitic belt, where heat flow density reaches values of up to 60 $mW \cdot m^{-2}$.

Temperatures vary from a minimum of 12ºC at a depth of 100 m to a maximum of 105.8ºC at a depth of 6000 m. In the central part of the Preadriatic Depression, there are many deep oil wells where the temperature reaches up to 68ºC at a depth of 3000 m. The isotherm runs in a direction that fits that of the strike of the Albanides. The configuration of the isotherm is the same down to a depth of 6000 m. With increasing depth, the zones of highest temperature align in a direction southeast to northwest, towards the center of the Preadriatic Depression and even further towards the northwestern coast (Frasheri, 2000).

Albania has many low enthalpy thermal water springs and wells with temperatures up to 65.5ºC. The country has three main geothermal areas: Kruje, Ardenica, and Peshkopi. The geothermal potential of these three areas is 39-63 GJ/m^2 (Frasheri, 1999).

The Kruje geothermal area is the largest geothermal area in Albania. It begins on the Adriatic coast, north of Rodoni Cape in the Ishmi region, continues southeast to Tirana down to the Albanian-Greek border, and extends into the Konica district in Greece. Aquifer temperatures have been calculated to be 145-250ºC. Surface water temperatures vary from 30ºC to 65.5ºC with flow rates of 3.5-15 l/s (Frasheri, 1999).

Located on the coastal areas, the Ardenica geothermal area is comprised of the molassic-neogenic braehyanticline Ardenica structure, the Semani anticline, the northern pericline of the Patos-Verbas carbonatic structure, and the neogenic molasses [sic] which cover it in the Verbas sector. The Ardenica geothermal area extends on that part of the peri-Adriatic Depression where the Vlora-Elbasan-Diber transverse passes. Water temperatures from deep wells in this area are 32-38ºC; flow rates are 15-18 l/s (KAPA Systems and EGEC, 1999).

The Peshkopi geothermal area is situated in northeast Albania in the Korabi hydrogeologic zone. Two kilometers east of the town of Peshkopi, thermal springs flow out on the Banja river slope, which is composed of flysch deposits. These springs are linked with the disjunctive tectonic zone, in the Ohri-Diber deep fault, peripherically of the Permian-Triassic gypsum diapir, that has penetrated the Eocene flysch which surrounds it in a ring-like pattern. Water temperature is 43.5ºC; flow rates are 14-17 l/s (Frasheri, 1999).

In addition to Kruje, Ardenica, and Peshkopi, numerous thermal springs are found across Albania. Situated primarily in tectonic fractures, thermal springs have temperatures of 21ºC to 58ºC.

Geothermal studies have been conducted throughout Albania. Temperature maps have been compiled for different levels of up to 500 m depth. Geothermal gradient maps and heat flow density maps have also been drawn. Greater activity is needed in an assessment of Albania's geothermal resources, definition of development goals, and selection of priority areas.

Hot springs have been used mostly for bathing and vacation spas; little actual development has occurred.

Albania has no electricity generated from geothermal resources. The country's potential markets for geothermal are district heating, greenhouses and agriculture, and cascaded uses, and to a lesser extent – health spas, swimming pools, and industrial processes. Financing is available for geothermal projects as loans with commercial interest rates.

The **Database of Geothermal Resources in the Balkans** contains information on 22 specific geothermal sites or projects in Albania. See Table 2 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

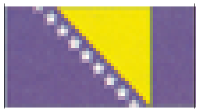
Albania's highest enthalpy geothermal resource identified to date is Peshkopi where the temperature is 105.8ºC at 6000 m. The average temperature of all sites in Albania is 40.6ºC. One site has a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Ardenica	Well(s) or hole(s) drilled	32-38	Unknown
Ballsh	Well(s) or hole(s) drilled	36-38	Unknown
Bubullima	Well(s) or hole(s) drilled	48-50	Unknown
Divjaka	Well(s) or hole(s) drilled	—	Unknown
Frakulla	Well(s) or hole(s) drilled	33-36	Unknown
Gagliati	Direct use -- developed	45-50	Unknown
Gorisht	Well(s) or hole(s) drilled	32-38	Unknown
Ishmi	Direct use -- developed	64	Unknown
Kolonja	Well(s) or hole(s) drilled	—	Unknown
Kozan-Elbasan	Preliminary identification/report	57	Unknown
Kozani	Direct use -- developed	66	Unknown
Krane-Sarande	Preliminary identification/report	34	Unknown
Langareci-Permet	Direct use -- developed	6-31	Unknown
Llixha-Elbasan	Direct use -- developed	58-60	Unknown
Mamurras-Tirane	Preliminary identification/report	21	Unknown
Marinze	Well(s) or hole(s) drilled	40	Unknown
Peshkopi	Direct use -- developed	5-106	Unknown
Sarandaporo-Leskovik	Direct use -- developed	27	Unknown
Semani	Well(s) or hole(s) drilled	35	Unknown
Shupal-Tirane	Preliminary identification/report	30	Unknown
Tervoll-Gramsh	Preliminary identification/report	24	Unknown
Verbasi	Well(s) or hole(s) drilled	29	Unknown
TOTAL			**Unknown**

Table 2 – Geothermal Resources in Albania

Map No. 3769 Rev. 3 UNITED NATIONS
April 1997

Department of Public Information
Cartographic Section



Bosnia and Herzegovina

Power Profile

Population (millions) -July 2000 estimated	3.84
GDP (billion US$) - 1999 estimated	$6.2
Real GDP Growth Rate - 1999 estimated	5.0%
Inflation Rate (CPI) - 1999 estimated	5.0%
Total Installed Capacity (MWe) - January 2000	3,999
Electricity Consumption per Capita (kWh) - 1998	584
Energy Demand Growth Rate	11.0%
Prices (US¢/kWh) – 1 April 2001	
110kV	1.87
35kV	2.24
10(20)kV	2.79
0.4kV	
- Residential	5.17
- Other (commercial)	6.19
- Street lighting	6.91
(For EPBiH and EPM. No prices available for EPRS.)	
Geothermal Power Potential (MWe)	N/A
Geothermal Direct Use Potential (MWt)	33

Slightly smaller than West Virginia, Bosnia and Herzegovina (BiH) is divided into two highly autonomous entities: the Federation of Bosnia and Herzegovina (Federation), composed primarily of Bosnian Muslims (Bosniaks) and Croats, and the Republika Srpska (RS), composed primarily of Bosnian Serbs. BiH is bordered by Croatia, Serbia, and Montenegro.

Both parts of the country have considerable autonomy. The same governing and civil institutions are generally duplicated in each. The central governing entity in Sarajevo is weak and can act only with consensus of the Federation and RS.

Once the scenic backdrop to the 1984 Winter Olympics[4], Sarajevo and Bosnia and Herzegovina were devastated by the 1992-1995 Bosnian War.[5] An estimated 250,000 people were killed, more than 200,000 wounded, and 13,000 permanently disabled. Some 1.2 million people were refugees and an additional 850,000 were internally

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4 Sarajevo is considering a bid to secure the Winter Olympics in 2010.

5 Bosnia and Herzegovina's declaration of sovereignty in October 1991 was followed by a referendum for independence from the former Yugoslavia in February of 1992. The Bosnian Serbs – supported by neighboring Serbia – responded with armed resistance aimed at partitioning the republic along ethnic lines and joining Serb-held areas to form a "greater Serbia."

displaced. Over 400,000 land mines located along the front lines continue to pose a hazard.

Signed in November 1995, the Dayton Agreement brought an end to the conflict, and divided the country into two parts. In 1995-96, a NATO-led international peacekeeping force (IFOR) of 60,000 troops served in Bosnia to implement and monitor the military aspects of the agreement. IFOR was succeeded by a smaller, NATO-led Stabilization Force (SFOR) whose mission is to deter renewed hostilities. SFOR was restructured in early 2000 and currently numbers about 20,000 troops.

Immediately following the war, output plunged to 25% of the pre-war 1990 level. Unemployment was 80-90% with most households surviving off humanitarian assistance. The international community endorsed a US$5.1 Billion Priority Reconstruction Program. BiH's political and economic situation is improving slowly. Elected in November 2000, Bosnia's new reform-oriented government, the first elected since the war, has pledged to focus on economic reform, building a functioning state, returning refugees, and tackling corruption.

According to the IMF, Bosnia's economy growth rate in 2000 was a healthy 10% and inflation under control at 2-3%.

Power Summary

The Bosnian War had a major impact on BiH's energy sector. Overall, damages were estimated at US$1.34 billion. Seventy percent of BiH's generating capacity and 60% of its transmission network and control systems were damaged and made inoperable. District heating facilities in many towns were also severely damaged. Following a massive influx of foreign assistance, by 1998, generation had recovered to 78% of its pre-war levels.

In addition, prior to the war, BiH had a countrywide, vertically-integrated state-owned power company. After the war, three Entity-owned utility companies were created: two in the Federation – Elektroprivreda BiH (EPBiH) and Elektroprivreda Mostar (EPM), and one in the RS – Elektroprivreda Repbublika Srpska (EPRS). Despite being interconnected, the three companies are virtual monopolies within their territories.

As a whole, BiH has a total installed capacity of 3,999 MWe – 51% in hydroelectric plants and 49% in thermal power plants powered by coal or lignite. Sixty-five percent of the capacity is located in the Federation. The power plants' average age is 22 years. The country has no identified oil or natural gas reserves. Coal reserves are estimated at 3.8 billion tons; more than 60% is lignite. The country's rivers – the Bosna, Drina, Una, Vrbas, Nerevta, and Sava – are an abundant source of hydropower.

BiH has several proposed greenfield power projects. EPBiH plans to award a BOT (Build-Operate-Transfer) contract for the 118 MWe Konkjic HPP. EPRS plans to build the 450 MWe Buk Bijela HPP. And EPM has plans for a 550 MWe Kongora TPP and two HPPs totaling 100 MWe at Mostarko Blato and Tihaljina. Enron is negotiating with EPM.

In addition to large HPPs, BiH has little renewable resources developed. BiH issued an invitation for bids to build 20 small hydropower plants on a BOT basis. There is also an interest in developing windmills.

Energy consumption has not grown as quickly as expected. Following growth of 10% in 1998, gross consumption increased only 2.5% in 1999. Distribution gross consumption grew 2.8%; direct consumption decreased 3.4%. The modest increase in 1999 resulted from a warmer winter and reductions in distribution losses.

The World Bank Second Electric Power Reconstruction Project was designed to restore normal and reliable power supply in Bosnia and Herzegovina by increasing coal production, upgrading generation capacities, and rebuilding transmission and distribution networks. The US$200-million Third Power Reconstruction Project ("Power 3"), currently under preparation, will continue post-war reconstruction with support for restructuring and reforming the power sector. A major objective is to reconnect BiH to the Union for the Coordination of Transmission in Europe (UCTE), especially important as BiH is a net energy exporter. BiH exports electricity to Croatia, Montenegro, Italy, and Slovenia.

Government / Legislation

The BiH state-level government is headed by a three-member Joint Presidency. The Presidency appoints the state-level Council of Ministers. Simultaneously, each Entity has a presidency and council of ministers. Except for the Joint Power Coordination Center (JPCC), there are no state-level energy institutions.

<u>Elektroprivreda BiH (EPBiH)</u>

EPBiH, headquartered in Sarajevo, was created in 1993. It is the largest electricity provider in BiH serving 597,000 customers. Supervision of the Federation's electric sector rests with the Ministry of Energy, Mining, and Industry. Tariffs are proposed by the company's management board and approved by the Federation's Council of Ministers. There is no independent, apolitical regulation at this time, and there is no regulatory coordination with the other two utilities, EPM and EPRS.

<u>Elektroprivreda Mostar (EPM)</u>

EPM is headquartered in the city of Mostar and serves the western part of the Federation. EPM is not monitored by a regulatory agency. During the war, the regional government set retail prices; currently, the utility suggests prices to the local administrations. It is then up to the cantons and municipalities to decide how to collect that revenue from their electric customers. If the municipalities feel that the rate is too high to be passed through, they have to make up the difference.

Elektroprivreda Republika Srpska (EPRS)

The Assembly of Republika Srpska established EPRS in June 1992 as a public enterprise according to the Law on the Electrical Power Industry. EPRS's operations are overseen by its government-appointed management board of directors. There is no independent regulatory agency. Electric prices are recommended by the utility to the government. These recommendations are based on the utility's cost of production, transmission, and distribution. The government then decides on the consumer prices. The Ministry of Mining and Energy controls EPRS and sets prices.

Joint Power Coordination Center (JPCC)

In 1999, EPBiH, EPM, and EPRS established the JPCC to coordinate the work of the three power transmission systems in a secure and effective manner and to ensure the transmission of electric energy from generating facilities to domestic and foreign consumers. The ultimate goal is to establish full operation of the 400 kV grid and its synchronization with the Western European Pool and EU systems.

At the State and Entity levels, BiH has virtually no legal and regulatory framework for the power sector. The World Bank has taken the lead in the reconstruction, restructuring, and privatization of the power sector. Norwegian experts, with assistance from the Entity Ministries, are preparing State and Entity electricity acts. The goal is to establish a system which meets EU standards. Unbundling is envisioned as the preferred way of restructuring and privatization of generation capacities is to follow. This scheme would allow independent power producers (IPPs) to enter the market on a larger scale. The Law on the Policy of Foreign Direct Investments is very liberal but not sufficient to attract large IPPs.

No Specific Law for Geothermal

Bosnia and Herzegovina has no specific geothermal legislation at the State or Entity levels. In the Federation, geothermal resources are covered by the Water Act and the Decree on Concession for Water Resources. The Federation Ministry of Agriculture, Water Resources, and Forestry is responsible for geothermal resources. The situation is similar in the RS. No guidelines exist for geothermal exploration permits or licensing geothermal exploitation.

Geothermal Sites / Projects

Most of Bosnia and Herzegovina is covered by the Dinaric Alps. Little exploration for geothermal resources has been done. The country's geothermal potential for space heating and balneological purposes, based on existing wells, is about 33 MWt (KAPA Systems and EGEC, 1999).

A 1-MWe geothermal power pilot plant was to be built in Sarajevo prior to the civil war. Due to lack of financing, however, the project has been put on hold. The resource has a temperature of 58°C and a flow rate of 240 l/s.

The **Database of Geothermal Resources in the Balkans** contains information on 3 specific geothermal sites or projects in Bosnia and Herzegovina. See Table 3 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

BiH's highest enthalpy geothermal resource identified to date is Bosanki Samac with a temperature of 85ºC. The average temperature of all sites is 65.6ºC. No sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Bosanski Samac	Direct use -- developed	85	Unknown
Kakanj	Prefeasibility study	54	Unknown
Sarajevo	Feasibility study	58	1
TOTAL			**1**

Table 3 – Geothermal Resources in Bosnia and Herzegovina

Map No. 3729 Rev. 2 UNITED NATIONS
January 2000

Department of Public Information
Cartographic Section

Croatia

Power Profile

Population (millions) -July 2000 estimated	4.28
GDP (billion US$) - 1999 estimated	$23.9
Real GDP Growth Rate - 1999 estimated	0%
Inflation Rate (CPI) - 1999 estimated	4.4%
Total Installed Capacity (MWe) - January 2000	3,912
Electricity Consumption per Capita (kWh) - 1998	3,014
Energy Demand Growth Rate	5.0%
Prices (US¢/kWh) Average, net of VAT of 22% (1998) Enron PPA (2000)	 7.02 3.79
Geothermal Power Potential (MWe)	28
Geothermal Direct Use Potential (MWt)	815

Slightly smaller than West Virginia, Croatia is the richest of the Balkan countries with a 1999 per capita income of US$5,584. Following its independence from Yugoslavia in 1991, Croatia was immediately plunged into the conflict over Bosnia-Herzegovina, until the March 1994 cease fire.

Following the death of nationalistic President Tudjman in 1999, and the defeat of his party in the 2000 elections, a new government has taken the reins. The new Croatian Government's economic priorities are maintaining stability and moderate growth, completing the transition to a market economy, and gaining admission to the World Trade Organization (WTO), the Central European Free Trade Agreement (CEFTA), and the European Union. Croatia shares borders with Bosnia and Herzegovina, Hungary, Serbia, Montenegro, and Slovenia.

Croatia's 2000 GDP growth rate was 3.7%, up from 0% in 1999. Following a recession which began in 1998, economic growth is forecasted to increase by at least 5%.

Power Summary

Croatia's total installed capacity in January 2000 was 3911.6 MWe – 57% hydropower, 42% fossil fuel, and less than 1% nuclear.[6] The country is a net energy importer, About 10-20% of Croatian demand for electricity has been covered by imports.

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6 The 632-MWe Krsko Nuclear Power Plant (NPP), located on the border with Slovenia, is jointly owned by the two countries. Croatia and Slovenia have failed to resolve financial and other issues concerned with the plant. Currently, Croatia is not using electricity from Krsko and may sell its share of the plant.

Croatia's electricity consumption, which increased from 10.9 billion kWh in 1992 to 13.6 billion kWh in 1999, continues to exceed domestic generation. Domestic demand increased 5% annually from 1993 to 1999.

In order to help satisfy increased demand, Croatia plans to build new generating capacity, which it hadn't done since 1992. In 2000, the new government renegotiated the terms of Enron Europe's PPA with the previous administration to build a 240-MWe natural gas combined cycle plant, agreeing to complete the utility company's restructuring and privatization and fully liberalize the electricity market within the next two years. In return, Enron will build an independent power plant at Jertovec within five years. The two sides agreed to continue the earlier power supply agreement, but with Enron selling electricity to Croatia at 3.79¢/kWh instead of the original 5.6¢/kWh.

In addition, the renovation and rehabilitation of several older plants are planned, as well as the construction of new hydropower and coal-fired plants. All together, including the Enron plant, an additional 1,156.5 MWe of installed capacity is planned. Foreign loans and direct investment are the primary sources of financing. Investment in the reconstruction, modernization, and upgrade of Croatia's generation capacities and distribution network could total US$1 billion.

By 2005, Croatia expects to have 4,650 MWe installed capacity composed of 4.4 MWe geothermal, 2,467.6 MWe fossil fuels, 2,152.0 MWe hydro, and 26.0 MWe other renewables (Jelić et al., 2000).

Government / Legislation

Croatia's power sector is state-owned. The Ministry of Economy is the lead government institution which develops and implements energy policy.

Croatia's energy sector is currently dominated by three state-owned companies:

1. Croatian Electricity Company (Hrvatska Elektroprivreda [HEP]),
2. Croatian Oil and Gas Company (Industrija Nafte [INA]), and
3. Adriatic Pipeline (Jadranski Naftovod [JANAF]).

Croatian Electricity Company (HEP)

HEP is responsible for the generation, transmission, and distribution of electricity. The utility presently generates about 95% of Croatia's electricity, the remainder coming from privately-owned industrial co-generation power plants and small HPPs. Its infrastructure is old and insufficient.

HEP posted a 690 million Croatian kuna (US$80.1 million) net loss in 2000, due primarily to drought and the increase in heating fuel and natural gas prices, which rose 86% and 66% respectively. The utility is owed its book value – 1.8 billion kuna (US$211 million) – by industry, households, and local administrations. HEP's CFO forecasted in March that HEP's net profit would be 27 million kuna (US$ 3.2 million) in 2001.

The U.S. Agency for International Development (USAID)-HEP Joint Electricity Reconstruction Project, formally launched in April 2001, will restore electric service in war-affected areas with the aim of promoting the return of refugees to their homes. Under the initiative, USAID will finance US$5 million worth of equipment and construction services. HEP will provide design, construction supervision, and electro-mechanical services totaling US$2.1 million.

The Government of Croatia (GOC) selected a consortium headed by the British law firm Norton Rose, and including French bank, BNP Paribas, and Ernst & Young, to prepare HEP for a sell-off later in 2001. INA is slated for a sell-off in 2002. Transmission will most likely remain under state control.

Company Act

Foreign investments in Croatia are regulated by the Company Act.[7] Foreign legal entities in Croatia are allowed to acquire the right to exploit natural resources or other assets of interest to Croatia; and take part in BOT and BOOT (Build-Own-Operate-Transfer) deals. IPPs are allowed under Croatian law.

The right to exploit natural resources and other resources, and the right to conduct certain other business activities, are granted by concession. A concession may be granted to a domestic or foreign legal or natural person for a period of up to 99 years.

Foreign persons who conduct business activities in the Republic of Croatia may, on the basis of reciprocity and without any restrictions, acquire ownership rights to real estate. A foreign person may also lease real estate.

Investment Incentives Law

Enacted in July 2000, the Investment Incentives Law establishes employment and tax incentives for new investment. Most notable, the Law offers the following tax reductions for investments satisfying criteria set down in the law:

- 7% corporate tax for 10 years for companies that invest 10 million kuna (US$1.2 million) and create 30 new jobs;

[7] Croatia has adopted a more sophisticated approach to the legal and regulatory framework for foreign investment with the presumption being that, since foreign investors receive national treatment, no special legislation is required. Rather, the rights and protections for foreign investors are implicit and incorporated into domestic laws.

- 3% corporate tax for 10 years for companies that invest 20 million kuna (US$2.3 million) and create 50 new jobs; and
- 0% corporate tax for 10 years for companies that invest 60 million kuna (US$7 million) and create 75 new jobs.

The Law also provides a one-time lump sum subsidy of 15,000 kuna (US$1,800) to the new investment for each new employee. Investors may also receive assistance from the GOC in offsetting costs of employee re-training. The GOC may also be able to contribute real estate (or permits or infrastructure) to an investment either cost-free or on a preferential basis. Finally, the GOC will allow the importation of capital equipment for the investment on a duty-free basis.

No Specific Law for Geothermal

Croatia has no specific geothermal legislation. No guidelines exist for geothermal exploration permits or licensing geothermal exploitation. Geothermal licensing is issued by the state.

The GOC supports investment in geothermal projects through price indexing (price in relation to other energy sources) and the free utilization of existing wells. Financing is available for geothermal projects as loans with commercial interest rates and grants.

Program of Geothermal Energy Utilization, (GEOEN)

In 1997, the GOC created the Program of Geothermal Energy Utilization, (GEOEN), as part of the National Program of the Croatian Energy Sector Development and Organization. GEOEN's objective is to promote knowledge and experience in the geothermal energy sector. Institutional coordination is carried out by the Energy Institute "Hrvoje Pozar." Other participants involved in program are: the Ministry of Economy, the Ministry of Development and Reconstruction, the Ministry of Science and Technology, the State Administration for Environmental Protection, HEP, INA, and the Faculty of Mining Geology and Petroleum Engineering. GEOEN's second phase, currently in progress, includes pilot projects and implementing a geothermal energy utilization program.

The future development of geothermal energy in Croatia has been defined within the GEOEN Program, according to three possible scenarios:

1. Slow introduction of new technologies and insufficient government activities in the energy sector reform and restructuring;

2. Implementation of new technologies, made possible by technology transfer resulting from Croatia joining the European Union and supported by state incentive mechanisms; and

3. Compilation of highly technological and ecological features, characterized by a strong influence of the environmental protection concept to global economic and energy development.

Geothermal Sites / Projects

Croatia can be divided into two geological regions. In the southeastern part, which belongs to the Dinaride area, Mesozoic carbonate rocks prevail. Towards the northeast, in the area belonging to the Pannonian Basin, Quaternary and Tertiary sedimentary rocks predominate, overlying crystalline bedrock and occasional Mesozoic sedimentary rocks.

Croatia is endowed with significant geothermal potential in the Pannonian area. The temperature gradient in this region ranges from 0.03 to 0.07°C/m. The terrestrial heat-flow density is also high, ranging from 60 to 100 mW/m^2, and occasionally up to 120 mW/m^2 (Kovačić,, 2000). INA, in the process of exploring for oil and gas, has discovered, explored, and tested geothermal fields since 1976.

More than 50 deep boreholes have been drilled through geothermal aquifers in the Pannonian region. Temperatures are 40-170°C. Some geothermal fields have been defined, but the majority require further investigation. A small fraction of known geothermal energy potential in Croatia is currently under exploitation.

As of 2000, Croatia had 113.9 MWt of installed capacity. The bulk – 77.24 MWt – is used for bathing and swimming, followed by 36.66 MWt for space heating (Jelić et al., 2000). The country's direct use potential from tested reservoirs is estimated at 815 MWt.

Croatia's potential markets for geothermal are district heating, greenhouses and agriculture, fish farming, health spas, swimming pools, and cascaded uses, and to a lesser extent – industrial processes (e.g., drying, pasteurization, and fruit and vegetable processing), and combined space heating and cooling.

Croatia currently has no electricity generated from geothermal resources. Estimated power generation from tested reservoirs with temperatures higher then 120ºC is approximately 28 MWe (GEOEN). Total power generation potential using the data included in the database is 47.87 MWe. It is estimated that geothermal energy could produce 3.9% of Croatia's total electricity.

Unfortunately, the most promising geothermal fields for power generation, located in northern Croatia, are relatively far (10-15 km) from potential consumers. Northern Croatia is also well supplied by a natural gas pipeline, leaving little incentive to develop geothermal resources for power generation at this time.

Plans are underway to build Croatia's first geothermal power plant – a 4.4 MWe combined heat and power plant in Velika Ciglena – by 2005. The plant would be increased to 13.1 MWe by 2015.

The **Database of Geothermal Resources in the Balkans** contains information on 28 specific geothermal sites or projects in Croatia. See Table 4 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

Croatia's highest enthalpy geothermal resource identified to date is Velika Ciglena with a temperature of 170ºC. The average temperature of all sites is 75.9ºC. Four sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Babina Greda	Preliminary identification/report	125	1.88
Bizovac	Direct use -- developed	91-96	Unknown
Daruvar	Direct use -- developed	47	Unknown
Ernestinovo	Preliminary identification/report	80	Unknown
Ferdinandovac	Well(s) or hole(s) drilled	125	1.88
Hrvatsko Zagorje	Direct use -- developed	—	Unknown
Istra	Direct use -- developed	—	Unknown
Ivanic Grad	Direct use -- developed	62	Unknown
Krapinske	Direct use -- developed	41	Unknown
Lesce	Direct use -- developed	—	Unknown
Lipik	Direct use -- developed	60	Unknown
Livade	Direct use -- developed	28	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Lunjkovec-Kutnjak	Prefeasibility study	120-140	29.37
Madarince	Preliminary identification/report	96	Unknown
Recica	Preliminary identification/report	120	1.67
Samobor	Direct use -- developed	28	Unknown
Stubicke	Direct use -- developed	53	Unknown
Sveta Jana	Direct use -- developed	26	Unknown
Sveta Nedjelja	Well(s) or hole(s) drilled	68	Unknown
Topusko	Direct use -- developed	62	Unknown
Tuhelj	Direct use -- developed	32	Unknown
Varazdinske Toplice	Direct use -- developed	58	Unknown
Velika	Direct use -- developed	25	Unknown
Velika Ciglena	Prefeasibility study	165-170	13.07
Vuckovec	Direct use -- developed	—	Unknown
Zagreb	Direct use -- developed	55-82	Unknown
Zelina	Direct use -- developed	40	Unknown
Zlatar	Direct use -- developed	32	Unknown
TOTAL			**47.87**

Table 4 – Geothermal Resources in Croatia

Map No. 3740 Rev. 2 UNITED NATIONS
August 1998

Department of Public Information
Cartographic Section

Republic of Macedonia

Power Profile

Population (millions) -July 2000 estimated	2.04
GDP (billion US$) - 1999 estimated	$7.6
Real GDP Growth Rate - 1999 estimated	2.5%
Inflation Rate (CPI) - 1999 estimated	1.0%
Total Installed Capacity (MWe) - January 2000	1,494
Electricity Consumption per Capita (kWh) - 1998	3,075
Energy Demand Growth Rate	3.0%
Prices (US¢/kWh) – April 2001 Residential Commercial (for export) Industrial (Ministry of Economy, Energy and Mining Department)	 3.5 3.0 2.0
Geothermal Power Potential (MWe)	200
Geothermal Direct Use Potential (MWt)	2,200

The Former Yugoslav Republic of Macedonia (FYR Macedonia) is a landlocked country slightly larger than Vermont. It is located on a major transportation corridor from Western and Central Europe to the Aegean Sea, and from Southern Europe to Western Europe. FYR Macedonia shares borders with Albania, Bulgaria, Greece, Serbia (Kosovo), and Montenegro.

International recognition of FYR Macedonia's independence from Yugoslavia in 1991 was delayed by Greece's objection to the new state's use of what it considered a Hellenic name and symbols. Greece finally lifted its trade blockade in 1995, and the two countries normalized relations.

United Nations sanctions against Yugoslavia took away 60% of the country's export market, resulting in US$3.5 billion in losses. Economically, despite a very rough start from blockades and loss of export markets, FYR Macedonia has made significant progress toward westernizing its economy and furthering its goal of integration with Euro-Atlantic structures.

By mid-1998, 95% of industrial, commercial and mining enterprises had been privatized. In the same year, FYR Macedonia's exports increased faster than imports for the first time since independence, and foreign investment exceeded all previous years' Foreign Direct Investment (FDI) combined.

For 2001, the Government of FYR Macedonia predicts that inflation will be maintained at 2.2% and that GDP will grow by 6%.

A multi-ethnic society in a volatile region, FYR Macedonia faces internal challenges. During NATO's bombing campaign, almost 260,000 Kosovar refugees arrived in the country. Most returned to Kosovo after June 2000.

More recently, fighting broke out between the Albanian National Liberation Army (NLA) and Macedonian security forces in Tetovo, the country's second largest city, located in northwestern Macedonia. Among the NLA's demands are to change the Macedonian constitution to give Albanians equal status with Macedonians as a "state-forming" people and to place the Albanian language on par with Macedonian as an official language. The NLA denies wanting to create a "Greater Albania" or a "Greater Kosovo." International organizations are working with the Macedonian Government to address the Albanian minority's concerns in the political arena.

Power Summary

FYR Macedonia has an installed capacity of 1,494 MWe – 423 MWe hydroelectric and 1,071 MWe thermal. The country lacks oil, gas, or high quality coal resources. Wood is used extensively for home heating. The country imports around 40% of its energy consumption – mostly petroleum, and is beginning to import natural gas from Russia.

After declining following FYR Macedonia's independence and the economic contraction resulting from the UN and Greek embargoes, energy demand is expected to increase commensurate with GDP, at approximately 3% annually. The state utility, Elecktrostopanstvo na Makedonija (ESM) forecasts that electric demand will reach 7,229 GWh in 2005, up from 6,329 GWh in 1996. Using these projections, no additional generating capacity is needed until about 2003. Priority will be given to developing domestic resources, e.g., hydropower. Concessions or BOT will be used.

FYR Macedonia is strategically located in the heart of the Balkans, which places it in the middle of critical energy transmission links. The US$85-100 million Trans-Balkan Electric Transmission System Interconnection Project, which will connect the electric grids of Macedonia, Bulgaria, and Albania, has high priority within the Stability Pact.

Under the World Bank US$39.6 million Power System Improvement Project scheduled for completion in 2005, ESM will rehabilitate the country's six largest hydropower plants; improve the utility's Energy Management System including controls, dispatch center, and communications; and begin rehabilitating the electricity distribution system. The project will also facilitate the development of independent power producers, and the eventual reintegration of ESM into UCTE.

The development of alternative domestic energy sources received considerable attention in recent years, including numerous efforts to assess and develop geothermal energy for greenhouses and space heating. Such activity was not extensive, however, due to economic constraints.

Government / Legislation

FYR Macedonia's power sector is controlled by the state with ESM as the principal entity. State control is principally in the areas of investment planning, management selection, and pricing. Several ministries and the Council of Ministers have various responsibilities.

<u>Elektrostopanstvo na Makedonija (ESM)</u>

ESM manages the production, transmission, and distribution of energy in FYR Macedonia.

<u>Council of Ministers</u>

The Council of Ministers sets electricity prices based on a request from ESM through the Ministry of Economy. The Council also makes top management appointments for ESM and ratifies major investments by ESM.

Energy prices generally cover costs. Under an EBRD loan to FYR Macedonia, a target pattern of real electricity price increases in German Marks (DM) has been established. District heating prices are comparable on a heat equivalent basis to West European prices for light fuel oil or natural gas supplied to households, averaging around $35/Gcal.

Regarding prices for geothermal energy, one of the most difficult problems is to overcome the conception by consumers that geothermal energy is free of charge and that therefore they do not have to pay for its use, apart from distribution and maintenance costs (Popovska et al., 1995).

According to a new state regulation introduced in 1999, the price of geothermal energy is set relative to the prices of other sources (e.g., fossil fuels and electricity), and determined by m^3 rather than by kWh used heat. According to the regulation, energy of geothermal origin has a certain value and price which should be covered by users. The value is composed of the costs for exploration and investigation, project development, and system exploitation and maintenance. The price should be not lower than 40% or higher than 60% of the heat unit of a heavy oil origin. In order to ensure proper use of the temperature difference on disposal, used energy should not be calculated in energy units but in cubic meters of the used thermal water. The regulation has not been properly applied (Popovski and Lund, eds., Popovski and Popovska-Vasilevska, 1999).

<u>Ministry of Economy</u>

The Ministry of Economy has principal oversight responsibility for the energy sector, and reviews and approves ESM's investment plans. It recommends to the Council of Ministers the tariffs for electricity, based upon the proposals of the interested companies. In the special case of district heating prices, the Ministry can approve these prices without the intervention of the Council of Ministers. It is involved in the selection of top management for ESM.

Under proposed restructuring, the Ministry of Economy would be responsible for policy and oversight. A new, independent regulatory system would be created which would be responsible for setting prices for transmission, distribution, and power generation, by both IPPs and ESM.

Ministry of Development

The Ministry of Development reviews and comments on major investment plans, especially those of ESM, and may also review and comment on pricing proposals.

Ministry of Finance

The Ministry of Finance may review and comment on pricing proposals as well.

The legal framework for the energy sector in FYR Macedonia is being developed. Two key pieces of legislation affecting the energy sector are the proposed Energy Law and the proposed Law on Public Enterprises.

Energy Law (draft)

The draft Energy Law establishes a basis for the operation of energy companies. It establishes that, at least initially, energy utilities are required to be public enterprises with majority Government ownership. Private companies would be allowed to operate in the sector, including the electricity subsector, with the agreement of ESM on obtaining access to the transmission system.

If agreement cannot be obtained, the Ministry of Economy would be allowed to prescribe the terms and conditions of an agreement designed to facilitate participation by IPPs in power generation. There is significant potential for IPPs both as small scale hydropower plants and as co-generators. The Energy Law also requires the Government to develop a comprehensive Energy Plan.

Law on Waters

The Law on Waters applies to "spring, stream, standstill and underground waters, then to the atmosphere water, the drinking water and the waste water, to both the beds and the banks of the water streams, the torrents, the lakes and the accumulations, as well as to the thermal and mineral waters, unless otherwise determined by another Law."

Pursuant to Article 132, legal persons who produce electric power pay compensation for the used water for every produced kW per hour. Pursuant to Article 153, water is given for use by concession for the production of electric power.

The Ministry of Agriculture, Forestry, and Water-economy supervises this Law and its regulations.

No Specific Law for Geothermal

FYR Macedonia has no specific geothermal legislation. The ownership of geothermal resources has not been defined.

General legislation on geothermal resources is covered by the Law for Mineral Resources (24 March 1999) which is governed by the Ministry of Economy.

Pursuant to Articles 85 and 86 of the Law, a concession for geothermal resources may be granted to any foreign or local legal or physical entity which possesses financial resources and equipment to invest in, develop, and exploit such resources. Pursuant to Article 85 of the Law, a concession is granted by the Government of the Republic of Macedonia by submitting a written application or a letter of intent. The following information is required:

- Name and address of the legal or physical entity, and description of the company;
- Company bank statement;
- Location and size of geothermal area;
- A topography map (scale of 1:25,000) in which the boundaries of the area are outlined;
- General geology of the area;
- General hydrogeology and geothermal characteristics of the area; and
- Brief description of planned utilization of resource.

The Government will submit the concession application to the Ministry of Economy for further consideration. The Ministry will prepare a decision on which basis the Government shall issue the concession.

A concession for geothermal exploration may be granted for four years with a possible four-year extension. A concession for geothermal exploitation may be granted for 30 years with a 30-year extension. A concession is limited to an area of 200 km^2. The area size is reduced after the first year to 50% of the area granted, and by 15% of the remaining area in each successive year of exploration. There is no limit to the number of concessions a company may have.

Fees are as follows:

- Area fee – US$50/$km^2$ per year for exploration; US$1,000/$km^2$ per year for exploitation;

- Royalty – 0.2-2% of the value of the commercial product

The Government of FYR Macedonia also supports investment in geothermal projects through price indexing (price in relation to other energy sources), free utilization of existing wells, tariffs, and a special selling price.

Financing is available for geothermal projects as loans with commercial interest rates.

Geothermal Sites / Projects

FYR Macedonia is located in the central part of the Balkan Peninsula, in the geothermal zone which runs from Hungary in the north and Italy in the west, and crosses Greece, Turkey, and beyond to the east. Specifically, the country is situated in the southernmost part of the Bosnian-Serbian-Macedonian geothermal area which includes the mountains of the internal Dinarides and parts of the Serbian-Macedonian massif.

The country contains six geotectonic zones: the Cukali-Krasta zone, the West Macedonian zone, the Pelagonian horst anticlinorium, the Vardarian zone, the Serbo-Macedonian massif, and the Kraisthide zone. Geothermal manifestations are mainly connected to the Vardarian zone where the earth's crust is about 32 km.

FYR Macedonia has 18 geothermal fields. More than 50 thermal springs, boreholes, and wells discharge almost 1,400 l/s water with temperatures of 20-79ºC. Thermal waters are primarily bicarbonate with equal amounts of Na, Ca and Mg. Dissolved minerals range from 0.5 to 3.7 g/l. All are of meteoric origin (Dragasevic, 1974).

FYR Macedonia's hot springs have been used since Roman times for bathing. More recently, in 1963, the first geothermal greenhouse in the world was built near Bansko. The 1979-1984 energy crisis stimulated more geothermal exploration. Six large greenhouse heating projects, a rice drying project, a complete hotel heating project, and several smaller heating installations were developed during this period. Some have been abandoned or operate below their design capacity. Development ceased after independence and during the U.N. and Greek embargoes. The bulk of Macedonia's low-enthalpy geothermal resources are used for greenhouses.

As of 2000, Macedonia had an installed capacity of 81.2 MWt producing 510 TJ/yr or 142 GWh/yr. The capacity factor is 20%. One well has been drilled; 55 person-years and US$15 million have been invested in geothermal development (Lund and Freeston, 2000).

FYR Macedonia's geothermal development objectives to 2010 are:

- The reconstruction, modernization, and optimization of existing projects;
- The addition of new industrial and residential projects in the Kochani geothermal system;
- Connecting additional hotels to the Bansko heating system; and
- Completing the water center at Negorci and the medical center in the Katlanovo Spa (Popovski and Popovska-Vasilevska, 1999).

In addition, the country will draft a national geothermal master plan with Italian assistance.

Macedonia has approximately 2,200 MWt in unexploited low-enthalpy geothermal resources (GEOTHERNET). The country's potential markets for geothermal are district heating, greenhouses and agriculture, and cascaded uses, and to a lesser extent – fish farming, health spas, swimming pools, and industrial processes.

FYR Macedonia has no electricity generated from geothermal resources. The country's estimated power generation potential is 200 MWe.[8] Total power generation potential from the specific sites included in the database is unknown.

The **Database of Geothermal Resources in the Balkans** contains information on 32 specific geothermal sites or projects in FYR Macedonia. See Table 5 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

FYR Macedonia's highest enthalpy geothermal resource identified to date is Gornitchet with a temperature of 150ºC. The average temperature of all sites is 56.7ºC. Twelves sites have a temperature of 100ºC or more.

[8] Geothermal Energy Association, *Preliminary Report: Geothermal Energy, the Potential for Clean Power from the Earth* (Washington, D.C., April 1999).

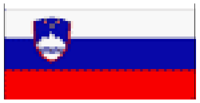
Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Banja Spa	Direct use -- developed	40-100	Unknown
Banjishte Spa	Direct use -- developed	39-52	Unknown
Bansko	Direct use -- developed	35-120	Unknown
Debarska Banja	Direct use -- developed	39-70	Unknown
Deribash	Preliminary identification/report	20	Unknown
Gevgelia	Direct use -- developed	54-100	Unknown
Gornitchet	Preliminary identification/report	24-150	Unknown
Istibanja (Vinica)	Direct use -- developed	30-100	Unknown
Katlanovo Spa	Direct use -- developed	28-115	Unknown
Kezovica Spa	Direct use -- developed	30-115	Unknown
Kochani	Direct use -- developed	65-90	Unknown
Kosovrasti Spa	Direct use -- developed	48	Unknown
Kratovo-Zletovo	Well(s) or hole(s) drilled	28-49	Unknown
Kumanovo Spa	Direct use -- developed	38	Unknown
Lci	Preliminary identification/report	100-115	Unknown
Mrezichko	Preliminary identification/report	21-28	Unknown
Negorska Banja (Negorci)	Direct use -- developed	32-100	Unknown
Paltchiste	Preliminary identification/report	23	Unknown
Podlog	Direct use -- developed	22-100	Unknown
Povisica	Preliminary identification/report	80	Unknown
Proevci	Preliminary identification/report	28-31	Unknown
Raklesh	Direct use -- developed	26-30	Unknown
Sabota voda	Well(s) or hole(s) drilled	21-100	Unknown
Stip	Direct use -- developed	32-59	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Skopje	Preliminary identification/report	54-115	Unknown
Smokvica	Direct use -- developed	34-70	Unknown
Strnovec	Well(s) or hole(s) drilled	40-50	Unknown
Toplec	Direct use -- undeveloped	25-26	Unknown
Topli dol	Preliminary identification/report	28	Unknown
Toplik	Preliminary identification/report	22	Unknown
Trkanie	Well(s) or hole(s) drilled	71	Unknown
Volkovo	Well(s) or hole(s) drilled	22-90	Unknown
TOTAL			**Unknown**

Table 5 – Geothermal Resources in the Former Yugoslav Republic of Macedonia

Map No. 3789 Rev. 1 UNITED NATIONS
October 1995

Department of Public Information
Cartographic Section



Slovenia

Power Profile

Population (millions) -July 2000 estimated	1.93
GDP (billion US$) - 1999 estimated	$21.4
Real GDP Growth Rate - 1999	4.9%
Inflation Rate (CPI) - 1999 estimated	6.3%
Total Installed Capacity (MWe) - January 2000	2,517
Electricity Consumption per Capita (kWh) - 1998	5,581
Energy Demand Growth Rate	0.5%
Prices (US¢/kWh) – 15 December 1998 (pre-tax)	
Industry	
Middle season	1.99-3.38
Low season	1.65-2.82
Households	4.04-6.88
Commercial	4.68-7.95
Geothermal Power Potential (MWe)	11
Geothermal Direct Use Potential (MWt)	106

The furthest west of the former Yugoslav republics, Slovenia declared its independence in 1991. The country has done well, averaging 4% annual growth since 1993, and is one of the most advanced countries in the Balkans with a GDP per capita comparable to several EU member countries. In information technology, Slovenia is at the forefront of the Internet revolution, with the highest concentration in Europe of Internet connections per inhabitant or per server. Slightly smaller than New Jersey, Slovenia borders Austria, Croatia, Italy, Hungary, and the Adriatic Sea.

Slovenia is currently aligning its political and economic systems with EU requirements. Subject to continued sound macroeconomic management, the prospects for Slovenia appear good. The country's ability to sustain high growth rates with price stability, however, will increasingly depend on its capacity to reinvigorate the structural reform agenda. The accession process to the EU is helping in this respect, encouraging the authorities to advance key structural reforms. Slovenia is well positioned to be among the first Central and Eastern European countries to become a full member of an enlarged EU (World Bank, Country Brief).

Power Summary

Slovenia has an installed capacity of 2,517 MWe – 1,117 MWe fossil fuels, 768 MWe hydropower, and 632 MWe nuclear.[9]

[9] Due to an unresolved dispute with Croatia over restructuring and operational costs, since July 1998, the 632-MWe Krsko NPP has delivered all its electricity to Slovenia, resulting in a power surplus.

The country has minimal indigenous reserves of oil and gas, and is dependent upon imports from Croatia, Algeria, and Russia for over half of its total primary energy supply. The country has proven lignite coal reserves, and also imports coal from Indonesia, Germany, and the Czech Republic. In the future, natural gas will be substituted for coal and hydropower will be prioritized.

With an estimated 8,800 GWh/yr of technically feasibly hydropower potential, only a third of which has been developed to date, and a desire to minimize import costs, increased hydroelectric power generation is a strategic objective of the Government of Slovenia's (GOS) energy policy. An additional 1.5 TWH of electricity by 2010 is planned, requiring that 70% of the potential sites are exploited. In addition to large HPPs, small, mini, and micro hydro plants are being constructed.

The Government of Slovenia's vision for the energy sector is outlined in its "Strategy of Efficient Use and Supply of Slovenia" which was approved in 1995. The main objectives of the Strategy are to maintain a sustainable level of electric power production in the present thermal power plants and newly constructed capacities, to disengage and decommission nuclear power production, to increase natural gas use by commercial and residential users, to maintain the rate of domestic coal use, and to increase the share of renewable energy sources.

Based on high and low demand forecasts, four supply scenarios to 2010 have been prepared using three sets of basic assumptions: high and low rates of economic growth; larger and smaller investments in energy conservation and efficiency; and different supply options. According to the low economic growth scenario model designed by the Ministry of Economic Affairs (MEA), electric consumption could grow 0.5% per year from 1995 to 2010. The high economic growth scenario forecasts a growth rate of 2.3% per year in the same period.

The GOS's 10-year expansion program for 1997-2006 calls for a total of US$1.5 billion in investment financing (Energy Sector Management Assistance Programme, 1999).

For the transmission and distribution system, investment plans up to 2010 include the modernization of the national dispatching and local distribution control centers, renovation of the transmission grid, better control of reactive power in the system and the completion and renovation of the east-west 400 kV transmission lines with a connection to Hungary and a 400 kV substation.

By 2005, Slovenia's projected installed capacity will be 2,870 MWe – 1,345 MWe fossil fuels, 883 MWe hydropower, and 10 MWe geothermal.

A Westinghouse PWR which operates to U.S. Nuclear Regulatory Commission safety standards and regulations, the Krsko NPP is scheduled for decommission in 2023.

Increasing renewable energy is a long-term strategic goal, i.e., increasing the use of hydropower, biomass, geothermal, solar, and waste-to-energy sources for electricity generation. The GOS promotes renewable energy via tax incentives.

Government / Legislation

Slovenia has a well-developed, structured legal system. The GOS's operational goal is to have the entire energy sector in full conformity with EU standards by the end of 2002.

Slovenia's energy industry is divided according to generation, transmission, and distribution and is primarily publicly-owned.

Ministry of Economic Affairs (MEA)

The MEA is responsible for planning long-term energy investments and operational management. It heads the Agency of the Republic of Slovenia for Efficient Use of Energy and the Inspectorate of the Republic of Slovenia for Energy, Mining, and Construction.

Elektro-Slovenija (ELES)

State-owned ELES is in charge of energy transmission and dispatching as well as electricity trade and technical relations with the West European interconnected grid UCTE. The Slovenian power system is part of the UCTE network, with interconnecting links to Italy, Austria, and Croatia. ELES is also formally responsible for establishing purchase and sales contracts between power sector enterprises.

Public companies buy power from ELES, which was, prior to the new Energy Law, the only company authorized to purchase and transfer electricity from generators. ELES in turn supplies the country's five largest industrial consumers through direct sales. Electricity is otherwise marketed through five regional distributors (Elektro Ljubljana, Elektro Maribor, Elektro Celje, Elektro Gorenjska, and Elektro Primorska). . There are eight generating companies.

Trade and Investment Promotion Office (TIPO)

Companies making foreign direct investments in Slovenia may be eligible for financial assistance in the form of grants from TIPO. Incentives are provided to projects that create at least 100 new jobs; or 20 new jobs in less developed areas or where investment is made in R&D. Foreign investors are treated legally the same way as domestic companies and enjoy the same rights and obligations as domestic Slovenian companies. Foreign-owned companies may own property in Slovenia.

Phare Programme

Supported by the EU, the Phare Programme granted Slovenia €228 million (US$203 million) between 1992-

1998, and plans to give a further €560 million (US$499.6 million) by 2002.

With a zero-interest loan from the Phare Programme, the MEA energy efficiency agency created an energy efficiency investment fund in January 1998 to develop the potential of decentralized energy supply based on cogeneration and utilization of renewable energy sources. Managed by the Austria National Bank, the fund provides industry and institutions with a limit of €500,000 (US$446,000) per project under attractive interest rates.

The Phare Programme is the main channel for the EU's financial and technical cooperation with the countries of central and eastern Europe. The fundamental objective for Phare in Slovenia is to help the country join the EU as soon as possible.[10]

Energy Law

Enacted in September 1999, the Slovenian Energy Law ensures full harmonization with the energy-related laws and practices of the EU's electricity market directive especially with respect to environmental protection and the establishment of a market.

Under the Law, Slovenia's electricity market will be opened for domestically produced electricity. Specifically, by January 2001, all electricity users with at least 41kV connected power, all of industry, and most services (about 62% of the market) will be able to freely choose domestic suppliers, and in January 2003, to import electricity given national reciprocity.

Slovenia's internal electricity market will be opened to foreign players on 1 January 2003, but only on a reciprocity principle, i.e., if Slovenia has not entered the EU by then, the date for integration into the EU electricity market will be extended accordingly. The future electricity market will be comparable to the United Kingdom model.

Article 119a of the Law allows public electricity producing or distributing enterprises to privatize. Utilities engaged in electricity transmission, operating the electricity transmission network, or operating the organized electricity market, as well as the Krsko NPP, are specifically exempted from privatization under this Law.

The Law also foresees the establishment of the Energy Agency, an independent regulatory body, which will be responsible for setting prices for electricity, fuel, and services.

10 The Phare partner countries fall into two basic groups: those that have applied to become members of the European Union (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia), and those that have not (Albania, Bosnia and Herzegovina, and FY Macedonia). (Croatia was suspended from the Phare Programme in 1995.)

The GOS introduced a new tariff system on 15 December 1998 and value-added tax (VAT) on 1 July 1999. It has raised electricity prices several times since. In November 2000, prices for households increased 4% (roughly in line with inflation); for other users, 2%. Prices for industrial consumers rose more modestly as Slovenian industry already pays more than its EU counterparts on average. Electricity prices in Slovenia are generally higher than in the EU.

Public Trading Services (PTS) Act

The PTS Act allows for concession arrangements but refers to sectoral legislation to define for which particular services concessions may be granted. Foreign investors may obtain concessions for the exploitation of renewable and non-renewable natural and public goods.

No Specific Law for Geothermal

Slovenia has no specific geothermal legislation. Geothermal licensing is issued by the state. Some financing is available for geothermal projects as loans with commercial rates, grants, and project financing.

Geothermal Sites / Projects

With the Julian and Karawanken Alps in the north, and the Dinaric Alps in the south, Slovenia is extremely mountainous. The country's complicated tectonic and stratigraphical setting is reflected in the Earth's thermal field. In the upper few kilometers of the crust, temperatures increase from southwest to northeast.

The geothermal conditions in western Slovenia are influenced by the large crustal thickness in the Outer Dinarides and Southern Alps. Thermal springs in this area located southwest of the Pannonian Basin, have temperatures of less than 45ºC. Northeastern Slovenia is affected by the high enthalpy geothermal system, Termal II, in the Pannonian Basin. At depths of more than 2500 m, thermal fluids reach temperatures of 100-200ºC. About 6% of the country's total area, or 3200 km^2, is promising for geothermal development.

Geothermal resources in northeast Slovenia total about 7 x 10^6 TJ. East Slovenia's geothermal resources total 7.66 x 10^6 TJ (Rajver et al., 1995).

Geothermal exploration for high enthalpy resources on Slovenia began after the first energy crisis in 1973. Systematic geothermal investigation aimed at acquiring rock temperatures and their gradients, measuring thermal conductivity, and identifying the concentration of radiogenic elements in the rocks began in 1982. From 1995 to 2000, 18 wells with a total depth of almost 12 km were drilled (Kralj and Rajver, 2000). Forty-three person-years and US$16.08 million have been invested in geothermal development (Lund and Freeston, 2000).

Presently, hydrogeothermal and geophysical investigations are needed in general, especially in western and central

Slovenia where there is an interest in developing new recreational facilities. A cost-benefit analysis to determine the most rational use for proven resources is also needed.

As of 2000, Slovenia had an installed capacity of 42 MWt producing 196 GWh/yr. Geothermal resources are primarily used for thermal spas and recreation, space heating and cooling, greenhouses, industrial processing, and heat pumps. Reinjection is not currently used. Slovenia has an additional 64 MWt in unexploited, proven resources.

Slovenia's potential markets for geothermal are district heating, health spas, swimming pools, and cascaded uses, and to a lesser extent – greenhouses and agriculture, fish farming, and industrial processes.

Slovenia has no electricity generated from geothermal resources. A 1-MWe plant (probably binary) is planned at Lendava and should be operational by the end of 2002.

The **Database of Geothermal Resources in the Balkans** contains information on 52 specific geothermal sites or projects in Slovenia. See Table 6 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

Slovenia's highest enthalpy geothermal resource identified to date is Ljutomer with a temperature of 175ºC. The average temperature of all sites in Slovenia is 33.6ºC. Two sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Banovci	Direct use -- developed	25-68	Unknown
Bled	Direct use -- developed	15-22	Unknown
Catez (Brezice)	Direct use -- developed	28-64	Unknown
Celje's Hollow	Direct use -- developed	20	Unknown
Cerkno	Direct use -- developed	28-30	Unknown
Dabinka	Direct use -- developed	—	Unknown
Dahlenske Toplice	Direct use -- developed	—	Unknown
Dobova	Direct use -- developed	38-63	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Dobrna	Direct use -- developed	25-36	Unknown
Dolenjske Toplice	Direct use -- developed	32-37	Unknown
Dragonja Vas	Well(s) or hole(s) drilled	19	Unknown
Gozd Martuljek	Well(s) or hole(s) drilled	9	Unknown
Koprivica	Direct use -- developed	131	Unknown
Kostanjevica	Well(s) or hole(s) drilled	—	Unknown
Krsko	Direct use -- developed	23-64	Unknown
Lasko	Direct use -- developed	30-41	Unknown
Lendava	Construction underway	14-65	10
Ljubljana	Well(s) or hole(s) drilled	21	Unknown
Ljutomer	Feasibility study	175	1
Lucija	Well(s) or hole(s) drilled	28	Unknown
Marezige	Well(s) or hole(s) drilled	30	Unknown
Maribor	Direct use -- developed	21-69	Unknown
Medija	Direct use -- developed	21-24	Unknown
Moravci	Direct use -- developed	36-66	Unknown
Moravci-Buckovci	Direct use -- developed	25-43	Unknown
Murska Sobota	Direct use -- developed	25-51	Unknown
Nova Gorica	Direct use -- developed	16-28	Unknown
Okonina	Well(s) or hole(s) drilled	18	Unknown
Osp	Well(s) or hole(s) drilled	20	Unknown
Otocec	Well(s) or hole(s) drilled	15	Unknown
Podcektrek	Direct use -- developed	15-35	Unknown
Portoroz	Direct use -- developed	16-23	Unknown
Posavje's Faults (Ljubljana's Hollow)	Direct use -- developed	18-23	Unknown
Ptuj	Direct use -- developed	29-39	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Radenci	Direct use -- developed	25-40	Unknown
Rimske Toplice	Direct use -- developed	32-38	Unknown
Rogaska Slatina	Direct use -- developed	30-55	Unknown
Secovlje	Well(s) or hole(s) drilled	22	Unknown
Sempeter	Well(s) or hole(s) drilled	32	Unknown
Slovenj Gradec	Well(s) or hole(s) drilled	38	Unknown
Smarjeske Toplice	Direct use -- developed	17-34	Unknown
Snovik	Direct use -- developed	18-30	Unknown
Topolsica	Direct use -- developed	20-32	Unknown
Trbovlje	Direct use -- developed	20-25	Unknown
Trebavle	Direct use -- developed	—	Unknown
Tuhnije Valley	Direct use -- developed	22-28	Unknown
Vaseno	Well(s) or hole(s) drilled	22	Unknown
Vihnitka	Direct use -- developed	—	Unknown
Vrhnika	Direct use -- developed	15-22	Unknown
Zagorje Valley	Direct use -- developed	25	Unknown
Zalec	Well(s) or hole(s) drilled	40	Unknown
Zrece	Direct use -- developed	22	Unknown
TOTAL			**11**

Table 6 – Geothermal Resources in Slovenia

Map No. 4134 Rev. 1 UNITED NATIONS
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Department of Public Information
Cartographic Section

Yugoslavia

Power Profile

Population (millions) -July 2000 estimated	10.66
GDP (billion US$) - 1999 estimated	$20.6
Real GDP Growth Rate - 1999 estimated	-20%
Inflation Rate (CPI) - 1999 estimated	42%
Total Installed Capacity (MWe) - January 2000	10,410
Electricity Consumption per Capita (kWh) - 1998	3,451
Energy Demand Growth Rate	5.0%
Prices (US¢/kWh) – 1 October 2000 (in Serbia)	
Household (two-tariff meter)	
High	1.2
Low	0.07
At 0.4 kV II degree (two-tariff meter)	
High	1.4
Low	0.08
(Source: Elektroprivreda of Serbia)	
Geothermal Power Potential (MWe)	200
Geothermal Direct Use Potential (MWt)	236

Note: All data dealing with population is subject to considerable error because of the dislocations caused by military action and ethnic cleansing.

Created by the dissolution of the Socialist Federal Republic of Yugoslavia (SFRY) in 1992, the Federal Republic of Yugoslavia is composed of two republics – Serbia and Montenegro, and two autonomous provinces – Vojvodina and Kosovo (which includes Metohija). Kosovo effectively became a U.N. protectorate in June 1999.

Combined, Serbia and Montenegro are slightly smaller than Kentucky. Serbia is slightly larger than Maine; Montenegro is slightly smaller than Connecticut. The country shares borders with Albania, Bosnia and Herzegovina, Bulgaria, Croatia, and Hungary.

How long Yugoslavia retains its current structure is uncertain. President Djukanovic wants Montenegro to break away from the existing federation, then negotiate a much looser confederal arrangement, sharing only foreign affairs, defense, and a common currency with Serbia. Montenegro's parliamentary election of 22 April, however, was very close and did not indicate a clear popular mandate for independence. Yugoslav President Kostunica is against any break-up and favors a much closer relationship, one that would include economic affairs.

The break-up of SFRY in 1992 was economically disruptive as trade ties between the six former republics were severed. In addition, Milosevic's repeated attempts to build a "Greater Serbia," conduct ethnic cleansing campaigns, and wage wars have prevented Serbia and Montenegro's economies from recovering. The country has 800,000 refugees, an unemployment rate of 40%, a shrinking GDP, US$30 billion worth of damage caused by the NATO bombing, and is US$12 billion in debt.

Following the democratic election of President Kostunica in October 2000, the EU and U.S. lifted their sanctions and oil embargoes against Serbia. The U.S. established diplomatic relations with the Federal Republic of Yugoslavia on 17 November 2000. Many international financial institutions, e.g., the World Bank, IMF, EU, EBRD, and USAID are developing assistance programs for Yugoslavia.

The Government of Yugoslavia hopes the arrest of Milosevic on 1 April persuades the U.S. administration to recommend the release of US$50 million in aid and back Yugoslavia's request for loans from the World Bank and the IMF. The Government calculates it needs a further US$600 million in 2001. On top of that, Serbia expects to receive an additional US$1 billion at a donors' conference in May-June.

Power Summary

Yugoslavia has a total installed capacity of 10,410 MWe – 7,430 MWe in Serbia proper, 850 MWe in Montenegro, 1,567 MWe in Kosovo, and 563 MWe in Vojvodina.[11] Coal-fired plants produce 70% of the country's electricity with the balance coming from hydropower. HPPs are located on the Danube, Drina, and Morava rivers in Serbia, and on the Moraca, Piva, and Zeta rivers in Montenegro.

The 78-day NATO bombing campaign during the Kosovo conflict (March-June 1999) targeted the Serbian power sector. Fourteen power stations, two major refineries, and many transmission facilities, including nine key oil storage depots, were damaged or destroyed.[12]

Serbia has nearly 13 billion tons of exploitable lignite reserves, primarily located in the Kosovo coal basin, now under UN control, and nearly 7,000 GWh of hydro

[11] These are 1994 estimates. U.N. estimates are higher. The U.N. reported total capacity for Serbia and Montenegro at a constant 11.8 gigawatts (11,800 MW) for 1994-1997.

[12] A high level executive of the State Power Corporation of China, currently reconstructing power facilities damaged by NATO bombing in 1999, traveled to Belgrade in August 2000 to assess future cooperation.

potential. With such resources, Serbia should be in a position to export electricity again by 2002-2003.

According to power company executives, the Serbian power system has been severely neglected since the early 1990s. Due to mismanagement, corruption, lack of maintenance, and drought, the Serbian power system was near collapse by October 2000. During one of the worst blackouts in December, power for most homes was shut off 8-18 hours a day.

Gross consumption in Serbia in 2000 was 33.3 GWh; production was 32.9 GWh. The existing plants are based on U.S. technology from the 1950s (Country Commercial Guide, 1997).

In the past several years, electricity demand increased at an average rate of more than 5% per year. According to Serbian power company forecasts, gross electricity consumption in Serbia will increase at an average yearly rate of 2.1% by the middle of next decade.

Government / Legislation

The majority of Serbia and Montenegro's electricity generation, transmission, and distribution is carried out by two state-run companies.

Yugoslavia plans to privatize its power sector within the next two years.

Elektroprivreda of Serbia (EPS)

EPS is active in Serbia and Vojvodina Autonomous Province. EPS manages one transmission company (Elektroistok), 11 distribution companies, and seven public power generation companies. The responsible authority is the Ministry of Mining and Energy of the Republic of Serbia.

EPS's Managing Board defines the structure of the tariff system, according to the Law on Electric Power Industry, The Ministry of Trade approves price changes. Kept artificially low by the Government to subsidize all parts of the economy, electricity prices will be increased to cover generating costs and bring a reasonable profit.[13]

Elektroprivreda of Montenegro (EMK)

EMK is a small company, with one coal-fired power plant and two large hydroelectric plants.

Kosovo Electricity Company (KEK)

KEK is the sole electricity service provider in Kosovo. The United Nations Mission in Kosovo (UNMIK) Public Utilities Department (PUD) has regulatory, supervisory,

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13 In Vojvodina, where there is a well developed natural gas distribution network, households often heat with electricity, rather than the more-effiecient natural gas, because it is cheaper.

and management control responsibilities, including oversight of organizational structure, staffing levels, budget, and government subsidies for KEK.

Having dealt with emergency repair and maintenance, UNMIK is developing a comprehensive strategy to address Kosovo's long-term energy needs. World Bank consultants are expected to begin a 12-month energy sector study of Kosovo in April 2001.

Serbian Law on Electric Power Industry ("Official Bulletin of the Republic of Serbia [RS]" No. 45/91, 67/93, 48/94, 69/94, and 44/95)

The Electric Power Industry Law defines in detail electricity supply industry's activities which cover the generation, transmission, and distribution of electricity.

Serbian Law on Resources owned by the Republic ("Official Bulletin of RS" No. 53/95, 3/96, 54/96, and 23/97)

Under the Resource Law, resources of common interest (e.g., natural resources, public goods) may be exploited by concession or by the right of usufruct.[14]

[14] Usufruct is the right to enjoy the use and advantages of another's property short of destruction or waste of its substance.

Serbian Law on Concessions ("Official Bulletin of RS," No. 20/97)

The Concession Law of the Republic of Serbia outlines a general frame or common rules for all kinds of concessions. Detailed conditions for pursuing a concession are dealt with in special laws, e.g., the Law on Mining, the Law on Electric Power Industry, the Law on Railways, and the Law on Roads. The Concession Law regulates the execution of projects on the basis of BOT and may be granted for a period of up to 30 years. A concession is granted through a public bidding process.

A foreign national may build, manage, and use for no longer than 20 years an object, facility, or plant as his own company or infrastructure. For infrastructure projects, the approval can be given for up to 30 years ("Official Bulletin of RS," No. 6/90).

The Ministry of Mining and Energy of the Republic of Serbia, a competent local government agency (town and municipality), or an interested party through the Agency for Investment in Activities of Concern to the Republic would recommend a concession to the Government of the Republic of Serbia.

The Government of Serbia passed a Decree on granting a concession, under public bidding, for exploring, exploiting, and developing the geothermal field in Bogatic municipality.

Serbian Law on Foreign Investments ("Official Bulletin of RS" No. 79/94 and 29/96)

The Law allows investments by concessions, including BOT projects, with the condition for foreign investments being reciprocity. In the energy and electricity sector, the Law does not provide for special limitations or constraints to foreign investments in Yugoslavia. Foreign investments are protected in case of subsequent change of regulations in Yugoslavia.

Firms established by foreign capital are exempt from profit tax for 72 months after entry in Serbia and 60 months in Montenegro. If a firm is located in a free zone, this tax break lasts for 6 years in Serbia and 10 years in Montenegro. New jobs created by investors are graced with a two-year, 40% reduction in wage taxes in Serbia (50% in Montenegro). Foreign citizens employed in Serbia by foreign investors are entitled to a 50% reduction in income tax.

The Montenegrin Law on Special Conditions for Foreign Companies contains some additional incentives for foreign investment under certain circumstances.

No Specific Law for Geothermal

Serbia and Montenegro have no specific geothermal legislation. Some financing is available for geothermal projects as conditional loans, grants, and project financing.

Geothermal Sites / Projects

Serbia is located in the tectonic center of the Balkan peninsula where three main tectonic-structural systems are developed, all of Alpine origin: the Dinarides in the west, the Serbian-Macedonian Massif (or Rhodopes) in the center, and the Carpatho-Balkanides in the east and southeast. The Pannonian Basin in northern Serbia has the most promising high-enthalpy geothermal resources. The location of all Yugoslav oil and gas deposits, the Pannonian region has been well investigated geologically.

Geothermal exploration in Montenegro has been minimal. Most of the country is covered by high and extensive mountain massifs intersected by river gorges and deep valleys. The high Dinaric mountains of Orjen, Lovcen and Rumija rise steeply from the Adriatic Sea. Larger lowland areas are located in the south, along the coast.

S. Radavanovic, the "father of Serbian hydrogeology and geothermology" first described the area's geothermal resources in 1897. Thermal spring exploration began between the two World Wars. The first borehole in the Pannonian Basin was drilled in 1969.

Following the energy crisis of 1974, a preliminary evaluation of geothermal potential was completed in 1975. A more detailed regional exploration was conducted from 1981-1988. From 1991 to 1995, geothermal exploration was ceased due to the breakup of the SFRY and the economic crisis caused by the U.N. embargo. Progress since 1995 has been slow.

Serbia has 60 convective hydrogeothermal systems – 25 in the Dinarides, 20 in the Carpatho-Balkanides, 5 in the Serbian-Macedonian Massif, and 5 in the Pannonian Basin. Conductive hydrogeothermal systems are developed in basins filled with Paleogene and Neogene sedimentary rocks, and are primarily located in the Pannonian Basin in Vojvodina in northern Serbia (Milivojevic and Martinovic, 1999).

Thermometric measurements in northern Serbia, down to 5 km, have produced temperatures as high as 240ºC. At 3 km, temperatures close to 150ºC have been found in the Pannonian Basin, the Vardar Zone, and the Serbo-Macedonian Massif. Serbia's geothermal potential or geothermal resource base to a depth of 10 km is estimated at 250×10^{21} J (Milivojevic, 1990).

As of 2000, Serbia had an installed capacity of 80 MWt producing 2,375 TJ/yr or 660 GWh/yr (Lund and Freeston, 2000). Low enthalpy resources are used for balneology and recreation. Serbia has 59 thermal spas, many which have been used since Roman times, and nine mineral water bottling companies utilizing geothermal water. Using geothermal resources for space heating is in the initial stages. In addition, the country has an additional 156 MWt of unexploited, proven resources.

Yugoslavia's potential markets for geothermal are district heating, greenhouses and agriculture, health spas, swimming pools, combined space heating and cooling, and cascaded uses, and to a lesser extent – fish farming, electricity generation, and industrial processes.

Geothermal energy is not used for power generation. Exploration has shown, however, that geothermal energy use in Serbia for power generation could provide a significant component of the national energy balance. The prospective geothermal reserves in the reservoirs of the geothermal systems amounts to 400×10^6 tonnes of thermal-equivalent oil.

Yugoslavia's estimated power generation potential is 200 MWe.[15] Total power generation potential from the specific sites included in the database is unknown.

The **Database of Geothermal Resources in the Balkans** contains information on 100 specific geothermal sites or projects in Yugoslavia. All are located in Serbia. See Table 7 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

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15 Geothermal Energy Association, *Preliminary Report: Geothermal Energy, the Potential for Clean Power from the Earth* (Washington, D.C., April 1999).

Serbia's highest enthalpy geothermal resource identified to date is Vranjska Banja with a temperature of 150ºC. The average temperature of all sites in Serbia is 47.9ºC. Fourteen sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
"VRMAC"-Prcanj	Direct use -- developed	—	Unknown
Arandjelovac	Direct use -- developed	34-60	Unknown
Avala	Preliminary identification/report	26	Unknown
Backi Manastir	Prefeasibility study	73	Unknown
Banja "Junakovic"-Apatin	Direct use -- developed	56	Unknown
Banja Istok	Direct use -- developed	—	Unknown
Banja Rusanda-Melenci	Direct use -- developed	92	Unknown
Banja Topilo	Direct use -- developed	37	Unknown
Banja Vuca	Direct use -- developed	30	Unknown
Banjska	Direct use -- developed	54-120	Unknown
Becej	Direct use -- developed	24-65	Unknown
Bioska Banja	Direct use -- developed	36	Unknown
Biostanska Banja	Direct use -- developed	37	Unknown
Bogatic	Prefeasibility study	75-90	Unknown
Bogutovac	Direct use -- developed	—	Unknown
Brestovacka Banja	Direct use -- developed	30-100	Unknown
Bujanovacka Banja	Direct use -- developed	24-70	Unknown
Bukovicka Banja	Direct use -- developed	28-34	Unknown
Cedovo	Preliminary identification/report	26	Unknown
Cibutkovica	Preliminary identification/report	21	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Dag	Preliminary identification/report	30	Unknown
Debrc	Direct use -- developed	48-70	Unknown
Despotovac	Preliminary identification/report	26	Unknown
Donjobadanjska	Direct use -- developed	—	Unknown
Dublje	Well(s) or hole(s) drilled	44-85	Unknown
Dvorovi	Direct use -- developed	50-90	Unknown
Gamzigradska Banja	Direct use -- developed	24-80	Unknown
Gornja Trepca	Direct use -- developed	24-50	Unknown
Grocka	Preliminary identification/report	30	Unknown
Indjija	Prefeasibility study	60-70	Unknown
Josanicka Banja	Direct use -- developed	40-130	Unknown
Jugovo	Preliminary identification/report	42	Unknown
Kanjiza	Direct use -- developed	26-65	Unknown
Kikinda	Direct use -- developed	26-51	Unknown
Klokot Banja	Direct use -- developed	25-80	Unknown
Knjazevac	Direct use -- developed	—	Unknown
Koviljaca	Direct use -- developed	24-40	Unknown
Kravlje	Preliminary identification/report	32-40	Unknown
Kula	Direct use -- developed	25-53	Unknown
Kupinovo	Prefeasibility study	54-70	Unknown
Kursumlijska Banja	Direct use -- developed	25-140	Unknown
Ljig	Direct use -- developed	32	Unknown
Lukovska Banja	Direct use -- developed	35-90	Unknown
Macva	Feasibility study	80-110	Unknown
Malo Laole	Well(s) or hole(s) drilled	38-40	Unknown
Mataruge	Direct use -- developed	24-110	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Mataruska Banja	Direct use -- developed	43-52	Unknown
Melenci	Direct use -- developed	33	Unknown
Metkovic	Well(s) or hole(s) drilled	55-90	Unknown
Miljakovac	Preliminary identification/report	33-40	Unknown
Milkovac	Preliminary identification/report	30	Unknown
Mladenovac	Direct use -- developed	25-90	Unknown
Mlakovac	Preliminary identification/report	28-30	Unknown
Mokrin	Direct use -- developed	26-51	Unknown
Nikolicevo	Preliminary identification/report	37	Unknown
Nikolocevska Banjica	Direct use -- developed	34	Unknown
Niska Banja	Direct use -- developed	25-60	Unknown
Novopazarska Banja	Direct use -- developed	52-54	Unknown
Ovcar Banja	Direct use -- developed	27-60	Unknown
Palanacki Kiseljak	Direct use -- developed	55	Unknown
Palic	Direct use -- developed	48	Unknown
Pazar	Direct use -- developed	28-120	Unknown
Pec	Direct use -- developed	26-48	Unknown
Pecka Banja	Direct use -- developed	25-80	Unknown
Petrovac	Direct use -- developed	24-46	Unknown
Pirotska Banjica	Direct use -- developed	31	Unknown
Pozarevac	Preliminary identification/report	36	Unknown
Pribojska Banja	Direct use -- developed	30-60	Unknown
Prigrevica	Direct use -- developed	25-54	Unknown
Prolom Banja	Direct use -- developed	24-60	Unknown
Radalj	Prefeasibility study	28-60	Unknown
Rajcinovica Banja	Direct use -- developed	28-100	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Rakovac	Preliminary identification/report	42	Unknown
Rgoska Banjica	Direct use -- developed	32	Unknown
Rgoste	Feasibility study	30-45	Unknown
Ribarska Banja	Direct use -- developed	25-110	Unknown
Sabac	Well(s) or hole(s) drilled	—	Unknown
Sarbanovac	Preliminary identification/report	29-100	Unknown
Selo	Direct use -- developed	26-43	Unknown
Selters	Direct use -- developed	50	Unknown
Sierinska Banja	Direct use -- developed	68	Unknown
Sijarinska Banja	Direct use -- developed	72-130	Unknown
Sisevac	Preliminary identification/report	26-40	Unknown
Slanaca	Preliminary identification/report	37	Unknown
Smed. Palanka	Direct use -- developed	25-75	Unknown
Soko Banja	Direct use -- developed	33-42	Unknown
Srbobran	Direct use -- developed	24-63	Unknown
Stari Slankamen	Direct use -- developed	—	Unknown
Sumrakovac	Preliminary identification/report	24-100	Unknown
Suva Cesma	Prefeasibility study	22-60	Unknown
Svackovci	Preliminary identification/report	28	Unknown
Temerin	Direct use -- developed	25-41	Unknown
Vica	Preliminary identification/report	21	Unknown
Vranjska Banja	Direct use -- developed	50-150	Unknown
Vrbas	Direct use -- developed	23-51	Unknown
Vrdnik	Direct use -- developed	35-60	Unknown
Vrnjacka Banja	Direct use -- developed	25-120	Unknown
Vrnjci	Preliminary identification/report	35	Unknown

Site/Project Name	Status	Temperature (ºC)	Potential (MWe)
Vrujci	Direct use -- developed	26	Unknown
Zvonacka Banja	Direct use -- developed	28-60	Unknown
TOTAL			**Unknown**

Table 7 – Geothermal Resources in Serbia

Map No. 3815 Rev. 2 UNITED NATIONS
March 1997 (Colour)

Department of Public Information
Cartographic Section

Conclusion

The multi-ethnic Balkans is a highly volatile region with great potential, resources, and opportunity.

Of the six countries of the region, four – Croatia, FYR Macedonia, Slovenia, and Yugoslavia (specifically Serbia) – have high-enthalpy geothermal resources which may be suitable for power generation. Combined, the four countries have 32 sites with a temperature of 100ºC or more. Based on political and economic stability, and a favorable regulatory framework, Croatia and Slovenia are the best candidates for geothermal resource development in the short-term. More work is required in all countries, however, in resource assessment, definition of development goals, selection of priority areas, and cost-benefit analyses.

Three items may support the development of geothermal resources for both power generation and direct use across the Balkans:

1. Increased international financing,
2. Greater regional cooperation, and
3. EU renewable energy directive.

Following the Kosovo campaign of 1999, under the Stability Pact, created by the U.S. and the EU, a significant amount of international financing began flowing into the region. The EU will provide €2.4 billion (US$2.1 billion) for the development of some 200 energy projects in Southeastern Europe. The funds will play a catalyst role in the development of the energy sectors and attract other foreign investments.

In addition, many International Financial Institutions (IFIs), including the World Bank, the EBRD, and the European Investment Bank (EIB), have increased their allocation of funds to the countries of Southeast Europe for development projects.

The EIB is expanding its global loans program to Southeastern Europe to support regional cooperation. EIB funding could cover up to 50% of the cost of specific projects, the loans could be extended for terms of up to 25 years with a grace period of 10 years. The EIB lending program for countries that have applied for accession to the EU[16], plus Albania and FYR Macedonia, is €3.5 billion (US$3.1 billion) annually from 2000 to 2006.

As of late 2000, the EBRD had invested US$2.13 billion in Southeastern Europe. As part of its Southeast European Regional Action Plan (SEEAP), the EBRD is focusing on

16 In the Balkans, Slovenia is the only "pre-accession" country.

supporting private sector investment, including large corporations, small and medium-sized enterprises (SMEs), and micro-enterprises; commercial approaches to infrastructure financing, including telecommunications, airports, and municipal finance; and improving the institutional capacity of the financial sector (Harris, 2000).

The EBRD launched a program in July 2000 to assist small (less than 250 employees) businesses in Southeastern Europe. The program is funded by US$100 million from the EBRD, and up to US$50 million, over a four-year period, from the United States.

An additional source of funding is the Southeast Europe Equity Fund. Managed by Soros Private Funds Management, the US$150-million Fund, capitalized by the Overseas Private Investment Corporation (OPIC), will make equity and equity-related investments in privately-owned or privatizing companies in Southeast Europe. The Fund will seek to generate significant capital gains on its invested capital over a three to five year average holding period. The Fund will be administered through an office in Sofia, Bulgaria, and operates in Albania, Bosnia-Herzegovina, Bulgaria, Croatia, FYR Macedonia, Montenegro, Romania, Slovenia, and Turkey. Secondly, the countries of the Balkans and Southeastern Europe are working to integrate their respective infrastructures, including their power sectors. In September 1999, Albania, Bosnia-Herzegovina, Bulgaria, FYR Macedonia, Greece, and Romania agreed to establish a unified regional electricity market (REM). The first phase of the REM is targeted for completion by 2006.

Finally, to date, one country of the Balkans – Slovenia – is the closest to becoming an EU member. Once it does accede to the EU, according to EU directives , 12% of its total inland energy must be generated by renewable energy sources by 2010. The Government of Slovenia may offer support or subsidies to geothermal development after EU accession.

The EU is also negotiating Stabilization and Association Agreements (SAAs), a first step towards EU membership, with several other countries in the region. The FYR Macedonian Parliament ratified the SAA in April 2001. EU began negotiations with Croatia in 2000, may begin negotiations with Albania in 2001, is conducting a feasibility study for negotiations with Yugoslavia, and is encouraging Bosnia Herzegovina to undertake further reforms before talks begin.[17]

[17] For additional information, see the CEEBIC web site: http://www.mac.doc.gov/eebic/euAccession.htm.

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Appendix

Albania

Site/Project Name	***Ardenica***
Location	In Selenica District, about 40 km north of Vlore in southwestern Albania
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	32
Temperature (ºC) to	38
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Ardenica geothermal area is comprised of the molassic-neogenic braehyanticline Ardenica structure, the Semani anticline, the northern pericline of the Patos-Verbas carbonate structure, and the neogenic molasses which cover it in the Verbas sector. The Ardenica geothermal area extends on that part of the peri-Adriatic Depression where the Vlora-Elbasan-Diber transverse passes. The geothermal area is characterized by identified geothermal resources of 8.19 x 10*9 GJ. The specific reserves amount to 0.39GJ/m² in the anticline structures. Between the anticline structures, sectors have been evaluated to have reserves below 0.25GJ/m² (KAPA Systems and EGEC, 1999). The Ardenica 3 well discharges thermal water at a rate of 15-18 l/s. The Ardenica 12 well also discharges thermal water.

Site/Project Name	***Ballsh***
Location	At 40º 35' Latitude, 19º 44' Longitude

Albania

Status	Well(s) or hole(s) drilled
Temperature (ºC) from	36
Temperature (ºC) to	38
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Ballsh 52 and 57 wells have water temperatures of 38ºC and 36.5ºC respectively.

Site/Project Name	***Bubullima***
Location	At 40º 48' Latitude, 19º 39' Longitude
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	48
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Albania

Notes	The Bubullima 5 well discharges thermal water.

Site/Project Name	***Divjaka***
Location	In southwestern Albania, north of Selenica, near the Adriatic Sea
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The area, located in the peri Adriactic Depression, has a geothermal gradient of 18-20°C/m; there are several abandoned oil and gas wells which could be used for single or doublet ground-source heat pump installations. Greenhouses could be built to use the hot water (KAPA Systems and EGEC, 1999).

Site/Project Name	***Frakulla***
Location	In southwestern Albania
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	33
Temperature (ºC) to	36

Albania

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Frakulla 27 and 33 wells have water temperatures of 36ºC and 33ºC respectively.

Site/Project Name	***Gagliati***
Location	In southern Albania; close to the Greek border; at 40º 56' Latitude, 20º 10' Longitude
Status	Direct use -- developed
Temperature (ºC) from	45
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for medicinal purposes. The Gagliati 2 well discharges thermal water at a rate of 0.9 l/s.

Site/Project Name	***Gorisht***

Albania

Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	32
Temperature (ºC) to	38
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Gorisht 6, 103, and 120 wells have water temperatures of 38ºC, 33ºC, and 32ºC respectively.

Site/Project Name	***Ishmi***
Location	Located in the plain near Tirane; close to the future route of an international highway which will connect Yugoslavia, Albania, and Greece; at 41º 30' Latitude, 19º 41' Longitude
Status	Direct use -- developed
Temperature (ºC) from	64
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Albania

Chronology	N/A
Notes	The geothermal resource has been used for medicinal purpose for several decades. The resource could also be used for greenhouses and industrial and scientific purposes. The Ishmi 1/b well discharges thermal water at a rate of 4.4 l/s.

Site/Project Name	***Kolonja***
Location	In the east-central part of the country
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The area, located in the peri Adriactic Depression, has a geothermal gradient of 18-20°C/m; there are several abandoned oil and gas wells which could be used for single or doublet ground-source heat pump installations. Greenhouses could be built to use the hot water (KAPA Systems and EGEC, 1999).

Site/Project Name	***Kozan-Elbasan***
Location	In Elbasan District; southeast of Tirane; at 41º 08' Latitude, 20º 02' Longitude

Albania

Status	Preliminary identification/repo
Temperature (ºC) from	57
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Kozani***
Location	Located near the West-East Interbalkan highway that will pass the town of Elbasan
Status	Direct use -- developed
Temperature (ºC) from	66
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Albania

Notes	The geothermal resource is used for medicinal purposes. The resource could also be used for greenhouses and industrial and scientific purposes. The Kozani-8 well discharges thermal water at a rate of 10.4 l/s.

Site/Project Name	***Krane-Sarande***
Location	In Sarande District in southern Albania; at 39º 54' Latitude, 20º 05' Longitude
Status	Preliminary identification/repo
Temperature (ºC) from	34
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Langareci-Permet***
Location	In Permet District; in southeast Albania; at 40º 14' Latitude, 20º 26' Longitude
Status	Direct use -- developed
Temperature (ºC) from	6
Temperature (ºC) to	31

Albania

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for medicinal purposes.

Site/Project Name	***Llixha-Elbasan***
Location	In Elbasan District; in the central western part of Albania; at 41º 20' Latitude, 20º 05' Longitude
Status	Direct use -- developed
Temperature (ºC) from	58
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for medicinal purposes. A 200-bed medical center uses the water to treat rheumatism and skin diseases. The most important resources explored until now are located in the northern half of the Kruje geothermal area, from Llixha-Elbasan in the south to Ishmi north of Tirane. The values of specific

reserves vary between 38.5 and 19.6GJ/m2.

The southern part of the Kruje area has resources of 20.63GJ/m2, evaluated by data obtained in the Galigati section. According to the geological conditions in this zone, its hydrogeological and geothermal characteristics, and referring to the geothermal springs found in Greece as a direct continuation of that zone towards south, it is expected that even in this part of the Kruje geothermal area there are important geothermal resources, at least to an extent similar to those of the Tirana-Elbasani zone (KAPA Systems and EGEC, 1999).

Site/Project Name	***Mamurras-Tirane***
Location	In Tirane District; northwest of Tirane
Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Marinze***
Location	At 40º 43' Latitude, 19º 56' Longitude

Albania

Status	Well(s) or hole(s) drilled
Temperature (ºC) from	40
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Marinze 120 well has a water temperature of 40ºC.

Site/Project Name	***Peshkopi***
Location	In Peshktopi District; in northeastern Albania, in the Korabi hydrogeologic zone; at 41º 40' Latitude, 20º 28' Longitude
Status	Direct use -- developed
Temperature (ºC) from	5
Temperature (ºC) to	106
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Albania

Notes	The geothermal resource is used for medicinal purposes. Two kilometers east of Peshkopi, thermal springs are situated very close to each other. The thermal springs flow out on the Banja River slope, which is composed of flysch deposits, and are linked with the disjunctive tectonic zone, in the Ohri-Diber deep fault, peripherically of the Permian-Triassic gypsum diapir, that has penetrated the Eocene flysch which surrounds it in a ring-like pattern. Temperatures vary from a minimum of 12ºC at 100 m to 105.8ºC at 6000 m. In the central part of the Pre-Adriatic depression, where there are many boreholes, the temperature reaches 68ºC at 3000 m. The thermal springs, which are situated mainly in the regional tectonic fractures, have temperatures ranging from 21 to 58ºC (KAPA Systems and EGEC, 1999).

Site/Project Name	***Sarandaporo-Leskovik***
Location	In Leskovik District; in southeastern Albania; at 40º 06' Latitude, 20º 40' Longitude
Status	Direct use -- developed
Temperature (ºC) from	27
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for medicinal purposes.

Albania

Site/Project Name	***Semani***
Location	In west-central Albania
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	35
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Semani 1 well discharges thermal water at a rate of 5 l/s.

Site/Project Name	***Shupal-Tirane***
Location	In Tirane District; northeast of Tirane; at 41º 26' Latitude, 19º 56' Longitude
Status	Preliminary identification/repo
Temperature (ºC) from	30
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Albania

Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Tervoll-Gramsh***
Location	In Gramsh District; in central Albania; southeast of Tirane
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Verbasi***
Location	In the southwestern part of the country
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	29
Temperature (ºC) to	0

Albania

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Verbasi 2 well discharges thermal water at a rate of 1-3 l/s.

Bosnia and Herzegovina

Site/Project Name	***Bosanski Samac***
Location	45º Latitude, 18.5º Longitude
Status	Direct use -- developed
Temperature (ºC) from	85
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Kakanj***
Location	44.5º Latitude, 18º Longitude
Status	Prefeasibility study
Temperature (ºC) from	54
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bosnia and Herzegovina

Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Sarajevo***
Location	44º Latitude, 18.5º Longitude
Status	Feasibility study
Temperature (ºC) from	58
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	1
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Before the recent civil war, the first 1-MWe pilot plant working on geothermal water was to be built in Sarajevo. Due to lack of money the project has not been further developed. The flow rate is 240 l/s at a temperature of 58°C.

Croatia

Site/Project Name	***Babina Greda***
Location	In the southeastern corner of the country
Status	Preliminary identification/repo
Temperature (ºC) from	125
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	1.88
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Bizovac***
Location	In the northeastern corner of the country, south of the Hungarian border
Status	Direct use -- developed
Temperature (ºC) from	91
Temperature (ºC) to	96
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	8.67

Croatia

Potential (MWt) 0

Chronology N/A

Notes The geothermal resource is used for space and district heating, sanitary warm water, swimming pools, and balneology at Termia Recreational Center.

Fluid is extracted from two reservoirs at depths of 1800 m and 1600 m. Wellhead temperatures are 96ºC and 85°C with flow rates of 5 kg/s and 3 kg/s (mineralization 2 g/l and 30 g/l), respectively. Waste geothermal water has been discharged into surface water bodies. Separate treatment of waste water is planned.

Bizovac is part of the East-Slavonija geothermal area.

There is an oil-bearing reservoir in a separate lithologic and hydrodynamic unit. The water from Biz-gneiss reservoir contains 30 g/l dissolved solids and 1.5 m^3/m^3 hydrocarbon gas. The water from Biz-sandstone reservoir contains 2 g/l dissolved solids and 1.3 m^3/m^3 hydrocarbon gas. The initial reservoir pressure in the gneiss was 30 bars above hydrostatic but rapidly dropped about 30 bars in the first year of production. In the sandstone reservoir pressure (initially hydrostatic) declines slowly. Scale appeared in the upper 30 m of the production wells and surface facilities. An inhibitor is now used (Cubric and Jelic, 1995).

Site/Project Name ***Daruvar***

Location In the east central part of the country

Status Direct use -- developed

Temperature (ºC) from 47

Temperature (ºC) to 0

Installed capacity (MWe) 0

Croatia

Potential (MWe)	0
Installed capacity (MWt)	2.73
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space heating, sanitary warm water, swimming pools, and balneology for Daruvar Spa. Aruvar is part of the West-Slavonija geothermal area.

Site/Project Name	***Ernestinovo***
Location	In the eastern part of the country, north of Babina Greda, south of Madarince
Status	Preliminary identification/repo
Temperature (ºC) from	80
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Ferdinandovac***

Croatia

Location	In north central Croatia, north of Velika Ciglena, near the border with Hungary
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	125
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	1.88
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Hrvatsko Zagorje***
Location	In central Croatia
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Croatia

Chronology	N/A
Notes	The Hrvatsko Zagorje geothermal area includes several spas which use the resource for sanitary warm water, swimming pools, balneology, and space heating: Jezercica, Krapinske, Stubicke, Varazdinske, Sutinske, Semnicke, and Tuheljkse.

Site/Project Name	***Istra***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for swimming pools at the Sveti Stjepan Spa.

Site/Project Name	***Ivanic Grad***
Location	In the central part of the country, west of Daruvar
Status	Direct use -- developed
Temperature (ºC) from	62
Temperature (ºC) to	0

Croatia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.58
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at Naftalan Hospital. The water has a flow rate of 2 kg/s and 10 g/l of dissolved solids, and a wellhead temperature of 62°C. The reservoir pressure (initially hydrostatic) declines slowly.

Site/Project Name	***Krapinske***
Location	In the northwest part of the country, west of Zlatar
Status	Direct use -- developed
Temperature (ºC) from	41
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	9.14
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating and balneology at Krapina Spa.

Croatia

Krapinske is part of the Hrvatsko Zagorje geothermal area.

Site/Project Name	***Lesce***
Location	In the west-central part of the country
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for swimming pools at the Lesce Spa.

Site/Project Name	***Lipik***
Location	In the southeast central part of the country, south of Daruvar
Status	Direct use -- developed
Temperature (ºC) from	60
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Croatia

Installed capacity (MWt)	1.71
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, sanitary warm water, and balneology at Lipik Spa. Lipik is part of the West-Slavonija geothermal area.

Site/Project Name	***Livade***
Location	In the far western part of the country
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.14
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at Istria Spa.

Site/Project Name	***Lunjkovec-Kutnjak***
Location	In north-central Croatia

Croatia

Status	Prefeasibility study
Temperature (ºC) from	120
Temperature (ºC) to	140
Installed capacity (MWe)	0
Potential (MWe)	29.37
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1995 - Prefeasibility study conducted by Virkir Orkint Consulting Group Ltd. found project to be questionable in terms of financial viability (Jelic et al., 2000).
Notes	Carbonate breccia, which form the reservoir rock, is characterised by a porosity of ~7.5. The water contains 5 g/l of dissolved solids and 3 m³ of gas (85% CO_2, about 15% hydrocarbon and traces of H_2S). The measured productivity index is 450 m³/bar. In the reservoir evaluation study, an average flowrate of 80 kg/s with WHP 3-5 bars and wellhead temperatures of 125-140°C has been predicted. Reservoir was tested by two exploratory (oil) wells -- Lunj-1 and Kt-1. The distance between the wells is 4.1 km; an interference test proved their hydrodynamic connection. The water contains 5 g/l dissolved solids and 3 m³/m³ gas (85% CO_2, about 15% hydrocarbon and traces of H_2S). Scale appears at pressures below 10 bars. The reservoir rock is carbonate breccia with an average porosity of 7.5%. The average reservior pressure is hydrostatic. The estimated pore volume, by a reservoir limit test, is about 10*9 m³ and the reservoir area about 100 km². In the impermeable rocks, between the geothermal reservoir and the earth's surface, the temperature gradient is higher than 0.06ºC m^{-1} (Cubric and Jelic, 1995).

Site/Project Name	***Madarince***
Location	In the eastern part of the country, south of Bizovac and north of Ernestinovo

Croatia

Status	Preliminary identification/repo
Temperature (ºC) from	96
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Recica***
Location	In the west-central part of the country, south of Sveta Jana
Status	Preliminary identification/repo
Temperature (ºC) from	120
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	1.67
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Croatia

Notes	N/A

Site/Project Name	***Samobor***
Location	In western Croatia, near the Slovenian border, north of Sveta Nedjelja
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.98
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at the Smidhen Sports Recreation Center.

Site/Project Name	***Stubicke***
Location	In north-central Croatia, north of Zagreb
Status	Direct use -- developed
Temperature (ºC) from	53
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Croatia

Installed capacity (MWt)	17.21
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating and balneology at Stubica Spa. Stubicke is part of the Hrvatsko Zagorje geothermal area.

Site/Project Name	***Sveta Jana***
Location	In the west-central part of the country, north of Recica
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.55
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at Sveta Jana Recreation Center.

Site/Project Name	***Sveta Nedjelja***
Location	In the west-central part of the country, near the Slovenian border, south of Samobor
Status	Well(s) or hole(s) drilled

Croatia

Temperature (ºC) from	68
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Topusko***
Location	In the south-central part of the country
Status	Direct use -- developed
Temperature (ºC) from	62
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	22.03
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and districting heating, sanitary warm water, swimming pools, and balneology at Topusko Spa.

Croatia

Site/Project Name	***Tuhelj***
Location	In the west-central part of the country, northwest of Zagreb
Status	Direct use -- developed
Temperature (ºC) from	32
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	6.9
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at Tuhelj Spa. Tuhelj is part of the Hrvatsko Zagorje geothermal area.

Site/Project Name	***Varazdinske Toplice***
Location	In the northernmost part of the country, southwest of Lunkovec-Kutnjak
Status	Direct use -- developed
Temperature (ºC) from	58
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Croatia

Installed capacity (MWt)	5.42
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating and balneology at Varazdin Spa. Varazdinske Toplice is part of the Hrvatsko Zagorje geothermal area.

Site/Project Name	***Velika***
Location	In the east-central part of the country, west of Ernestinovo
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.73
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for swimming pools and balneology at Toplice Recreational Center and the Velika Spa. Velika is part of the West-Slavonija geothermal area.

Site/Project Name	***Velika Ciglena***

Croatia

Location	In north-central Croatia, northeast of Zelina
Status	Prefeasibility study
Temperature (ºC) from	165
Temperature (ºC) to	170
Installed capacity (MWe)	0
Potential (MWe)	13.07
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1990 - Reservoir discovered by the exploratory oil well, VC-1 drilled to 4790 m. Log analyses showed several permeable zones in the interval 2550-2900 m. 1991 - Special geothermal well, VC-1A, confirmed predicted temperature and a productivity index of about 10,000 m^3/d bar. Reservoir limit test and an inteference test indicated relatively small pore volume of 200-250 10 6 m^3; wellhead pressure is 20-25 bars (Cubric and Jelic, 1995). 2005 - 4.4-MWe plant scheduled to become operational using existing well. The prefeasibility study on combined electricity and heat production in Velika Ciglena showed that such an energy generating plant could operate under economically acceptable conditions (Jelic et al., 2000). 2015 - Two additional production wells would allow a total installed capacity of 13.07 MWe.
Notes	The water from the dolomite reservoir (depth 3000 m) contains 24 g/l dissolved solid and 30 m^3/m^3 CO_2 with 59 ppm H_2S. The predicted production well flowrate is 100 kg/s with wellhead pressure of 20-25 bars and wellhead temperature of 165-170°C.

Site/Project Name	***Vuckovec***

Croatia

Location	In the southeastern part of the country
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for swimming pools at Vuckovec Spa. Vuckovec is part of the Medimurje-Podravina geothermal area.

Site/Project Name	***Zagreb***
Location	In north-central Croatia
Status	Direct use -- developed
Temperature (ºC) from	55
Temperature (ºC) to	82
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	22.02

Croatia

Potential (MWt)	0
Chronology	N/A

Notes

The geothermal resource is used for space and district heating, balneology, and sanitary warm water at several facilities.

The Zagreb aquifer was discovered by an oil exploratory well. The geothermal water contains 2g/l of dissolved solids, $0.1m^3/m^3$ of CO_2 and traces of H_2S. The reservoir temperature is 55-82°C at depths between 500 and 1000m. The very permeable section of the aquifer covers an area of $10km^2$ in the south-western part of the town in the sub-localities of Blato and Mladost.

At the Blato site, the planned geothermal capacity is 7MWt. In Mladost, there are several large buildings for sports activities (indoor and outdoor swimming pools and two other halls), which are entirely geothermally heated (6.3MWt), including peak consumption.

"Mladost" Sport Center, located in the south-western part of the capital Zagreb, uses the water from the Zagreb geothermal reservoir. The whole complex, including open-air and indoor swimming pools with all the accompanying facilities, as well as two sport halls, is entirely heated by geothermal energy, including peak consumption. Heat is extracted from the water flowing in a closed system, consisting of a production well, cascaded heat exchangers, injection pumps and an injection well. Pressure resulting from the density difference of water with different temperatures is used to establish thermosiphon injection. Consequently, the injection system can operate without the support of the injection pumps for more than 7500 hours/year; installed capacity is 14.54 MWt (Jelic et al., 2000)

The University Hospital uses the geothermal resource for space heating and sanitary warm water;

installed capacity is 6.90 MWt

INA Consulting uses the geothermal resource for space and district heating; installed capacity is 0.58 MWt.

The Lucko Factory uses the geothermal resource for space heating and sanitary warm water.

The Sveta Helena and Sveta Jana Spas use geothermal water for swimming pools.

A total of 17 exploratory and development wells have been drilled. Biogenic limestone of the Miocene age underlies the entire town and its suburbs (200 km2), but its permeability in the major part is not high enough for reasonable geothermal development. The geothermal water contains 2 g/l disolved solids, 0.1 m3/m3 CO_2, and trace H_2S. The most permeable part of the aquifer covers an area of 10 km2 in Blato and Mladost, the southwest suburbs of Zagreb. Initial reservoir pressure was 106 bars at 1000 m (Cubric and Jelic, 1995).

Site/Project Name	***Zelina***
Location	In central Croatia, northeast of Zagreb
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.49
Potential (MWt)	0

Croatia

Chronology	N/A
Notes	The geothermal resource is used for balneology at Zelina Recreation Center.

Site/Project Name	***Zlatar***
Location	In north-central Croatia, north of Stubiecke
Status	Direct use -- developed
Temperature (ºC) from	32
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	11.6
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at Sutinske Spa. Zlatar is part of the Hrvatsko Zagorje geothermal area.

FYR of Macedonia

Site/Project Name	***Banja Spa***
Location	About 5km north of Podlog in the Kochani valley; in the southernmost part of the Bosnian-Serbian-Macedonian geothermal area; in the Kochani geothermal field; 42º Latitude, 22.5º Longitude
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	20.1
Chronology	1985 - Pumped well drilled to 800 m; encountered a maximum temperature of 42ºC; flowing enthalpy of 176 kJ/kg (Dimitrov et al., 1990).
Notes	The geothermal resource was used for balneology at Banja Spa. As a result of over-development at Kochani, the well in Banja, fed by the same geothermal field, ran dry and the existing balneological use was stopped. One successful well yields about 50 l/s of thermal water at 65°C, but the latest borehole (450 m) was unsuccessful. Banja has temperatures of 40-63.2ºC, flow rates of 1-55.3 l/s, and a heat power of 20.1 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 100ºC (Popovski and Lund, eds., Gorgieva, 1999). Banja and Podlog are in direct hydraulic connection. The Banja-Podlog reservoir is of Paleozoic carbonate slates and marbles (Popovski and Lund, eds., Gorgieva, 1999).

FYR of Macedonia

Site/Project Name	***Banjishte Spa***
Location	Near the town of Debar in west-central Macedonia; in the West Bosnian-Serbian-Macedonian geothermal zone; in the Debar geothermal field
Status	Direct use -- developed
Temperature (ºC) from	39
Temperature (ºC) to	52
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at the Banjishte Spa.

Site/Project Name	***Bansko***
Location	In the Strumica valley in southeastern Macedonia; northeast of Smokvica; in the Strumica geothermal field; 41.5º Latitude, 23º Longitude
Status	Direct use -- developed
Temperature (ºC) from	35
Temperature (ºC) to	120
Installed capacity (MWe)	0

FYR of Macedonia

Potential (MWe)	0
Installed capacity (MWt)	8.05
Potential (MWt)	20.5

Chronology

Roman times - A natural hot spring with 30-35 l/s of 72ºC water was used for bathing.

1963 - Agricultural company "Strumica" built the first commercial glasshouse for vegetable production in Macedonia. The 3.2-ha greenhouse complex was built about 200 m from the Bansko spring, becoming the first geothermally heated greenhouse in the world.

1985 - The Hotel "Car Samuil" was built near the spring. It uses geothermal water for heating, sanitary water, and balneology.

1988 -Thermal well drilled to 600 m; encountered a maximum temperature of 60ºC; flowing enthalpy of 251 kJ/kg (Dimitrov et al., 1990).

1994 - The geothermal system broke down due to political changes and the resulting undefined legal property issue. A "war for water" began as small farmers (owners of the complex of small soft plastics-covered greenhouses) tried to obtain the right to exploit the geothermal water, using the water in an improper way and destroying the previously accommodated water distribution system (Popovska-Vasilevska and Popovski, 2000).

The geothermal heat source and the common elements of the integrated project (e.g., well, central station, distribution pipes, etc.) belong to no one; no one is responsible for their proper maintenance and exploitation. The well is over-pumped continuously during the winter months.

1999 - Feasibility study called for reorganizing the integrated Bansko project.

2000 - Legislation was introduced to define ownership rights.

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Notes

The geothermal resource is used for greenhouse and soil heating, space and district heating, sanitary warm water, and bathing and swimming in the Bansko integrated geothermal project.

The water is low corrosive and is used directly in the steel-pipe heating installation.

Bankso was the first commercial block of greenhouses to be heated by geothermal energy in the world. The greenhouse complex is the only one in Macedonia that has constantly been profitable, even during the most difficult economic times (Popovski and Lund, eds., Popovski, 1999).

Seven users utilize the resource: the ZIK Strumica Greenhouse, the Hotel "Car Samuil," the Spiro Zakov Hotel, the ZIK Strumica Hotel, private farmers' greenhouses, an open air swimming pool, and rest houses for children and retirees. The maximum geothermal heat power is 7.804 kW; the required flow rate is 70.09 l/s.

The greenhouse installations are connected improperly and disturb the proper use of the total system.

Bankso has temperatures of 68-73ºC, flow rates of 6-55 l/s, and a heat power of 20.5 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 115-120ºC (Popovski and Lund, eds., Gorgieva, 1999).

The Bankso project has never been finished. The Hotel "Car Samuil" is working more or less according to the design capacity; the greenhouse installations are obsolete and incorrect and hinder the overall system's proper use. Two additional hotels are not yet connected to the system (Popovski and Popovska-Vasilevska, 1999).

If taking the temperature of effluent water of 25ºC as economically feasible for the existing composition of users, the maximum geothermal heat power on disposal is 10.3 MWt.

According to the results of the feasibility studies made (Popovski et al., 1989), (Popovski, 1992) and (Popovski, Lund, 1999), it is technically possible and economically feasible to connect the heat users by introducing a heat accumulator and activation of the already installed light oil boilers (in the Hotel "Car Samuil") for covering the peak loadings during the cold winter mornings. In that way, the system shall be composed of heat users with a total design heat power of 7.8 MWt. If market conditions for out-of-season vegetables improve, it shall be possible to reach even 9 MWt (by connecting a larger number of small greenhouses, using the lower part of the temperature difference on disposal), which is very near to the maximal heat power on disposal.

The main characteristics of the Bansko system are: the recharge and discharge zone occur in the same lithological formation-granites; there are springs and boreholes with different temperatures within small distances; maximum measured temperature is 73ºC; the predicted maximum temperature is 120ºC (Gorgieva, 1989); the reservoir in the granites lies under thick Tertiary sediments. The Bansko geothermal system has not been examined in detail apart from the drilling of several boreholes with depths of 100-600 m (Gorgieva et al., 2000).

Flow rate is 55 kg/s; inlet temperature is 70ºC; outlet temperature is 35ºC; installed capacity is 8.05 MWt; annual utilization is 83.26 TJ/yr (Dimitrov et al., 2000).

Site/Project Name	***Debarska Banja***
Location	41.5º Latitude, 20.5º Longitude
Status	Direct use -- developed
Temperature (ºC) from	39
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

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Chronology	1987 - Thermal pumped well drilled to 400 m; encountered a maximum temperature of 50ºC; flowing enthalpy of 209 kJ/kg (Dimitrov et al., 1990).
Notes	The geothermal resource is used for bathing and swimming. Estimated reservoir temperature is 70ºC.

Site/Project Name	***Deribash***
Location	Near Dojran
Status	Preliminary identification/repo
Temperature (ºC) from	20
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.3
Chronology	N/A
Notes	Deribash has a temperature of 20.5ºC, a flow rate of 10 l/s, and a heat power of 0.3 MWt (Popovski and Popovska-Vasilevska, 1999).

Site/Project Name	***Gevgelia***
Location	In the southern part of the country; close to the main highway from Skopje to Thessalonica, Greece; 70-80 km from Thessalonica, Greece's main port
Status	Direct use -- developed

FYR of Macedonia

Temperature (ºC) from	54
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Chronology

1983 - Greenhouses (22.5 ha) using geothermal energy began operating.

2001 - The greenhouse company is interested in finding a foreign partner to help develop the geothermal field. They would like to drill deep exploration and production wells (1500-2000 m).

Notes

The geothermal resource is used for the Negorska Banja Spa and the Smokvica agricultural project.

The hydrogeothermal system in the Gevgelia Valley is emptied at the surface through a natural spring near the village of Gornitchet, numerous natural springs and exploratory boreholes in Negorska Banja, and seven exploratory wells in Smokvica.

The Gevgelia Valley is located within the subduction Vardar zone which runs from Turkey through Greece to the Hungarian (Pannonian) basin. There are two geothermal fields in the Gevgelia valley: Negorska Banja and Smokvica. The discharge zone in both geothermal fields is in fault zones bounded by Jurassic diabases and spilites. Although these two fields are separated by several km there is no hydraulic connection between them, despite intensive pumping of thermal waters. The maximum temperature is 54ºC, and the predicted reservoir temperature is 75-100ºC. The geothermal system in the Gevgelia valley has been well studied by 15 boreholes with depths between 100-800m (Gorgieva et al., 2000).

Site/Project Name ***Gornitchet***

FYR of Macedonia

Location	In the Gevgelia valley in the river Vardar zone; in the southern part of the country; in the Gevgelia geothermal field
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	150
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The hydrogeothermal system in the Gevgelia Valley is emptied at the surface through a natural spring near the village of Gornitchet, numerous natural springs and exploratory boreholes in Negorska Banja Spa, and seven exploratory wells in Smokvica. Gornitchet has not yet been sufficiently explored. There are two springs yielding 5l/s thermal water at 24°C. Geothermometers indicate that the water has a temperature of 150°C.

Site/Project Name	***Istibanja (Vinica)***
Location	North of Podlog; in the Kochani valley; in the southernmost part of the Bosnian-Serbian-Macedonian geothermal area; in the Kochani geothermal field; 42º Latitude, 22.5º Longitude
Status	Direct use -- developed

FYR of Macedonia

Temperature (ºC) from	30
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	4.92
Potential (MWt)	5.3
Chronology	N/A

Notes

The geothermal resource is used for greenhouses (6 ha) and soil heating. 14,160 kWh annually is used for heating 6 ha of glasshouses. Installed capacity is 4.92 MWt; annual utilization is 50.99 TJ/yr (Dimitrov et al., 2000).

The Istibanja project was never completed. Due to improper installation, operation is intermittent and the connections are rusted (Popovski and Popovska-Vasilevska, 1999). The geothermal system is now nearly abandoned.

Istibanja has temperatures of 56.6-67ºC, flow rates of 4.2-12 l/s, and a heat power of 5.3 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 100ºC (Popovski and Lund, eds., Gorgieva, 1999).

After electrical resistivity measurements, 12 shallow wells (up to 30 m deep) were drilled to locate the upflow zone. The water temperature in all 12 is 30-40ºC. In addition, a 180 m-deep borehole yielded 2 l/s of 60ºC thermal water, and another at 190 m yielded 6 l/s at 60ºC. The latest production wells have been drilled to 200-350 m and resulted in a total flow of about 60 l/s at 60ºC (Popovska et al., 1995).

The Istibanja reservoir is of gneisses and granites (Popovski and Lund, eds., Gorgieva, 1999).

FYR of Macedonia

Site/Project Name	***Katlanovo Spa***
Location	In the Skopje valley in northern Macedonia; in the Skopje geothermal field
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	115
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2.46
Chronology	N/A
Notes	The geothermal resource is used for balneology at the Katlanovo Spa. Katlanovo has temperatures of 28-54.2ºC, flow rates of 0.2-10 l/s, and a heat power of 2.46 MWt (Popovski and Popovska-Vasilevska, 1999). The Skopje geothermal system has not been examined in detail. There is only one borehole with a depth of 86m in Katlanovo spa. The main characteristics of the Skopje hydrogeothermal system are: maximum measured temperature of 54.4ºC and predicted reservoir temperature, by chemical geothermometers, of 80-115ºC (Gorgieva et al., 2000; Gorgieva, 1989).

Site/Project Name	***Kezovica Spa***

FYR of Macedonia

Location	In east-central Macedonia; southwest of Kochani; in the Shtip geothermal field
Status	Direct use -- developed
Temperature (ºC) from	30
Temperature (ºC) to	115
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	1.3
Chronology	N/A
Notes	The geothermal resource is used for balneology at the Kezovica Spa. The geothermal system is manifested at the surface through the natural spring Lzi in Novo Selo, on the right bank of the Bregalnica River. Its temperature in 1977 was 54ºC, but it now has a temperature of 30ºC and a very small flow. The spa uses water from two shallow wells with a flow of 4.5 l/s and a temperature of 63ºC (Popovski and Lund, eds., Gorgieva, 1999). Kezovica has a temperature of 57ºC, a flow rate of 7 l/s, and a heat power of 1.3 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 100-115ºC (Popovski and Lund, eds., Gorgieva, 1999). The Kezovica geothermal systems lies in granites of Jurassic age (Gorgieva et al., 2000).

Site/Project Name	***Kochani***
Location	In northeastern Macedonia; in the southernmost part of the Bosnian-Serbian-Macedonian geothermal area.

FYR of Macedonia

Status	Direct use -- developed
Temperature (ºC) from	65
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	43.36
Potential (MWt)	80

Chronology

1980 - Borehole EBMP-1 drilled to 328 m; maximum capacity of 150 l/s (100 l/s for continual use) offered possibilities to resolve the bad energy situation of the neighboring 12 ha-greenhouse complex "Kotchansko pole."

1982 - 18 ha of geothermally-heated glasshouses began operating. Non-corrosive water permitted the direct use of brine in the heating system.

Agricultural combine "Mosha Pijade" decided to build a new greenhouse complex of 6 ha (15 MWt design heat power). The initial artesian pressure of 6.5 bars dropped to 0 bars during the first year of joint exploitation. As a result, the well in Banja, fed by the same geothermal field, ran dry and the existing balneological use was stopped.

A contract was later signed which regulated the division of available water flow.

1983 - A rice drying plant of 1.36 MWt was connected to the geothermal system.

New borehole yielded up to 400-600 l/s, far above the real renewal capacity of the reservoir.

1990s - Due to the economic blockade of the early 1990s and the loss of export markets in the former Yugoslavia, the export markets for vegetables, paper, and rice were lost. The vehicle parts production industry stopped operating. Rice, formerly exported to Yugoslavia, lost that market and could not compete with cheaper Asian rice on the world market; the rice drying facility ceased operations.

1994 - The integrated system consisted of different heat users of about 60 MWt design heat power.

A concession to exploit the Kochani geothermal field was given to the publically-owned water management firm, Vodovod, which has no interest in picking up additional "side" work (Popovski and Popovska-Vasilevska, 2000).

Notes

The geothermal resource is used for greenhouses, agricultural drying, industrial processing, and district heating.

The integrated Kochani geothermal system is the largest in Macedonia and among the largest in Europe. It includes a heating system for 180,000 m^2 of greenhouses, a rice drying facility, a paper production facility, a vehicle parts production factory, and six buildings (Popovska et al., 1995). The system's maximum heat power is 70-80 MWt.

The district heating scheme (designed 10-12 years ago) and the greenhouses (designed 15 years ago) are not in optimal working condition due to weak maintenance. The rice drying unit is out of working condition (Popovski and Popovska-Vasilevska, 1999).

The 78ºC water is too hot for the known types of submersible pumps. Spare pumps and reserve wells are necessary for secure exploitation of the resource. In order to neutralize the aggressive effects of used thermal water, a treatment plant has been designed. (Dimitrov et al., 2000).

The Kochani geothermal system is the best-investigated system in Macedonia. There are more than 25 boreholes and wells with depths of 100-1170 m (Gorgieva et al., 2000).

The geothermal system was developed without a defined development strategy. In the future, it is necessary to collect all the effluent water of the system and to reinject it back into the reservoir. More "reserve" wells should be drilled. A complete reconstruction of the heating system and addition of new low-temperature users (e.g., aquaculture, soil heating, etc.) is necessary.

The task for the near future is to improve the present annual heat loading factor of about 0.35 to 0.60 (based on the maximum allowed continuous geothermal water flow of 170 l/s) with a better heat consumption distribution over the year. That should decrease the price of the used heat unit for about 60% and prevent winter over-pumpings and sudden water level decreases.

The Kochani Valley has three primary geothermal localities: Podlog, Banja, and Istibanja (or Vinica). The valley forms the border between the Vardarian zone and the Serbo-Macedonian mass. The Kochani hydrogeothermal system is drained through the exploitation wells and boreholes in three fields: the village Banja, the village Dolni Podlog, and the village Istibanja. Banja and Podlog are in direct hydraulic connection (Popovski and Lund, eds., Gorgieva, 1999). Two major faults, both seismically active, run east-west.

The basic characteristics of the main geothermal spring are:
- constant discharge temperature of 78°C
- high but variable discharge capacity of 100-250 l/s
- high but variable water pressure at the discharge point with a mean value of 0.65 MPa
- non-aggressive water, with low levels of total dissolved solids and a pH = 6.8
- carbonic hardness of 23.9°C (425 mg/l $CaCO_3$ equivalent)
- CO_2 is in balance with free CO_2 and the water is potable.
- The well is sited in an aquifer with thermally advantageous hydro-geological parameters but with limited dimensions.
- The production well reaches only the upper part of the aquifer and its thickness is still not established.
- The aquifer is bounded horizontally by several aquifers of lower transmissivity, and there are hydraulic boundaries

at different distances.

Site/Project Name	***Kosovrasti Spa***
Location	Near the town of Debar in west-central Macedonia; in the West Bosnian-Serbian-Macedonian geothermal zone; in the Debar geothermal field
Status	Direct use -- developed
Temperature (ºC) from	48
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at Kosovrasti Spa.

Site/Project Name	***Kratovo-Zletovo***
Location	In northeast Macedonia; northwest of Kochani
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	28
Temperature (ºC) to	49
Installed capacity (MWe)	0

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Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.7
Chronology	N/A
Notes	The geothermal system in the Kratovo-Zletovo volcanic area is probably the most pervasive one in Macedonia but detailed investigations are lacking. The main characteristics of this system are: primary reservoir in Precambrian and Paleozoic marbles covered by thick volcanogenic sedimentary rocks; presence of magmatic intrusions near the surface; borehole temperature up to 42ºC; travertine deposits over young andesite and breccia (Gorgieva et al., 2000). The Povisica-Kratovo hydrogeothermal system is one of the largest in Macedonia, according to volume. It lies at the border of the Vardarian zone and the Serbo-Macedonian mass. The system is drained through two exploratory boreholes in the Povisica River valley near the village of Zdravevci, and three boreholes in the Dobrevo mine (Popovski and Lund, eds., Gorgieva, 1999). Kratovo has temperatures of 28-31ºC, flow rates of 4-5.5 l/s, and a heat power of 0.7 MWt (Popovski and Popovska-Vasilevska, 1999).

Site/Project Name	***Kumanovo Spa***
Location	In the north-central part of the country; north of Skopje; in the Kumanovo geothermal field
Status	Direct use -- developed
Temperature (ºC) from	38
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

FYR of Macedonia

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at the Kumanovo Spa. The hydrogeothermal system Proevci-Kumanovo is drained through an exploratory borehole near the spa and the Kumanovka Mineral Water Factory (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Lci***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	100
Temperature (ºC) to	115
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Predicted temperature is 100-115ºC (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Mrezichko***
Location	Near Kozuf

FYR of Macedonia

Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	28
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Mrezichko has a temperature of 21ºC and a flow rate of 0.2 l/s (Popovski and Popovska-Vasilevska, 1999).

Site/Project Name	***Negorska Banja (Negorci)***
Location	In the Gevgelia valley in the river Vardar zone; in the southern part of the country; in the Gevgelia geothermal field
Status	Direct use -- developed
Temperature (ºC) from	32
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.67
Potential (MWt)	13.1

FYR of Macedonia

Chronology

1983 - Several shallow boreholes, between 20 and 130 m deep, were drilled.

1984 to 1985 - Two boreholes of 600 m each were drilled, resulting in a total thermal water flow by pumping of 80l/s at 51°C.

1986 - Borehole drilled to 300 m intersected a permeable fault at 250 m with a water temperature of 62ºC; used Head-On Resistivity profiling for the first time in the country.

1988 - Thermal pumped well drilled to 400 m; encountered a maximum temperature of 60ºC; flowing enthalpy of 251 kJ/kg (Dimitrov et al., 1990).

Notes

The geothermal resource is used for space and district heating, bathing, and swimming.

The Negorska Banja has a very primitive, "self-made" central heating system which is presently not operating (Popovski and Popovska-Vasilevska, 1999).

Negorska Banja has temperatures of 32-53.2ºC, flow rates of 3-40 l/s, and a heat power of 13.1 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 75-100ºC (Popovski and Lund, eds., Gorgieva, 1999).

Flow rate is 80 kg/s; inlet temperature is 51ºC; outlet temperature is 46ºC; installed capacity is 1.67 MWt; annual utilization is 8.67 TJ/yr (Dimitrov et al., 2000).

Negorska Banja is characterized by steeply dipping diabases of Tertiary age and by numerous dykes and granite intrusions. The production horizon seems to be associated with spilites at a very shallow depth of 100-150m, and at the intersection of faults.

There are two geothermal fields in the Gevgelia valley: Negorska Banja and Smokvica. The discharge zone in both geothermal fields is in fault zones bounded by Jurassic diabases and spilites. Although these two fields are separated by several kilometers, there is no hydraulic connection between them, despite intensive pumping of thermal waters. The maximum temperature is 54ºC, and the predicted reservoir temperature is 75-100ºC. The geothermal system in the Gevgelia valley has been well studied by 15 boreholes with depths between 100-800 m (Gorgieva et al., 2000).

Site/Project Name	***Paltchiste***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	23
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Podlog***
Location	In the middle of the Kochani valley; in the northeastern part of the country; in the southernmost part of the Bosnian-Serbian-Macedonian geothermal area; 42º Latitude, 22.5º Longitude
Status	Direct use -- developed
Temperature (ºC) from	22
Temperature (ºC) to	100
Installed capacity (MWe)	0

FYR of Macedonia

Potential (MWe)	0	
Installed capacity (MWt)	77.2	
Potential (MWt)	161.6	

Chronology

1967 - First well EBMP-1 was drilled to 70 m, giving 5 l/s free water flow at 60°C.

1980 - A deeper well was drilled near EBMP-1. At 307 m, an aquifer was intersected, yielding over 150l/s free flowing water at 79°C.

1980 to 1986 - Eighteen (18) exploratory and production wells were drilled in the area, resulting in a total possible yield of 600 l/s and water temperatures of 57-79°C.

1988 -Two production artesian wells drilled to 350 m; encountered maximum temperatures of 68ºC and 60ºC; flowing enthalpies of 285 kJ/kg and 251 kJ/kg, respectively (Dimitrov et al., 1990).

Notes

The geothermal resource is used for industrial process heat, greenhouse and soil heating, space and district heating, bathing and swimming, and agricultural drying.

Podlog has temperatures of 22.4-78ºC, flow rates of 0.5-150 l/s, and a heat power of 161.6 MWt. Designed in the early 1980s, the system is not optimized for the intensive growing of vegetables and flowers but, due to good maintenance and proper exploitation, the system works well (Popovski and Popovska-Vasilevska, 1999).

Flow rate is 300-450 kg/s; inlet temperature is 79ºC; outlet temperature is 38ºC; installed capacity is 51-77.20 MWt; annual utilization is 223.00 TJ/yr (Dimitrov et al., 2000). The predicted temperature is 100ºC (Popovski and Lund, eds., Gorgieva, 1999).

Podlog and Banja are in direct hydraulic connection. The Banja-Podlog reservoir is of paleozoic carbonate slates and marbles (Popovski and Lund, eds., Gorgieva, 1999).

FYR of Macedonia

Site/Project Name	***Povisica***
Location	In northeast Macedonia; near the village of Zdraveci
Status	Preliminary identification/repo
Temperature (ºC) from	80
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Povisica-Kratovo hydrogeothermal system is one of the largest in Macedonia, according to volume. It lies at the border of the Vardarian zone and the Serbo-Macedonian mass. The system is drained through two exploratory boreholes in the Povisica River valley near the village of Zdravevci, and three boreholes in the Dobrevo mine (Popovski and Lund, eds., Gorgieva, 1999). The predicted temperature is 80ºC (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Proevci***
Location	At the south margin of the Kumanovo valley in north-central Macedonia; south of Skopje
Status	Preliminary identification/repo
Temperature (ºC) from	28
Temperature (ºC) to	31

FYR of Macedonia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.2
Chronology	N/A
Notes	Proevci has a temperature of 31ºC, a flow rate of 2 l/s, and a heat power of 0.2 MWt (Popovski and Popovska-Vasilevska, 1999). This system is characterized by relatively low temperatures, up to 28ºC, and low predicted reservoir temperatures because of lack of water-rock equilibrium and mixing of hot and cold water. It has not been studied in detail (Gorgieva et al., 2000). The hydrogeothermal system Proevci-Kumanovo is drained through an exploratory borehole near the spa and the Kumanovka Mineral Water Factory (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Raklesh***
Location	Near Radovis
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

FYR of Macedonia

Potential (MWt)	0.1
Chronology	N/A
Notes	The geothermal resource is used for a fountain. Drainage of the system is through an exploratory borehole that has a flow rate of 2 l/s. Raklesh has a temperature of 26ºC, a flow rate of 2 l/s, and a heat power of 0.1 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 30ºC (Popovski and Lund, eds., Gorgieva, 1999). This system is characterized by relatively low temperatures, up to 28ºC, and low predicted reservoir temperatures due to a lack of water-rock equilibrium and mixing of hot and cold water. It has not been studied in detail (Gorgieva et al., 2000).

Site/Project Name	***Sabota voda***
Location	In central Macedonia; near Veles
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	21
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.2
Chronology	N/A

FYR of Macedonia

Notes	Sabota voda has a temperature of 21ºC, a flow rate of 5 l/s, and a heat power of 0.2 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 80-100ºC (Popovski and Lund, eds., Gorgieva, 1999). This system is characterized by relatively low temperatures, up to 28ºC, and low predicted reservoir temperatures due to a lack of water-rock equilibrium and mixing of hot and cold water. It has not been studied in detail (Gorgieva et al., 2000). The hydrogeothermal system Sabota voda has a paleozoic marble reservoir. Drainage of the system is through one exploratory borehole (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Skopje***
Location	In the north-central part of the country
Status	Preliminary identification/repo
Temperature (ºC) from	54
Temperature (ºC) to	115
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The Skopje geothermal system has not been examined in detail. The main characteristics of the Skopje hydrogeothermal system are: a maximum measured temperature of 54.4ºC and predicted reservoir temperature, by chemical geothermometers, of 80-

115ºC (Gorgieva et al., 2000; Gorgieva, 1989).

Site/Project Name	***Smokvica***
Location	In the Gevgelia valley in the river Vardar zone; in the southern part of the country; in the Gevgelia geothermal field; 41º Latitude, 22.5º Longitude
Status	Direct use -- developed
Temperature (ºC) from	34
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	15.56
Potential (MWt)	30.4
Chronology	N/A
Notes	The geothermal resource is used for greenhouses and soil heating, space heating, and balneology. Smokvica has temperatures of 45.1-68.5ºC, flow rates of 5.2-60 l/s, and a heat power of 30.4 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 70ºC (Popovski and Lund, eds., Gorgieva, 1999). The inlet temperature is 65ºC; outlet temperature is 34ºC; installed capacity is 15.56 MWt; annual utilization is 160.94 TJ/yr (Dimitrov et al., 2000). The Smokvica geothermal site was found after the drilling of 22 boreholes to 30-850 m. The largest aquifer was found at 350-500 m. The maximum total yield from 4 production wells is about 180 l/s with an average temperature of 65°C. The flow of 80 l/s has been found as a realistic maximum for

the field, without causing a negative influence on the water temperature. Up to 10ºC cooling has been observed during exploitation, probably due to the infiltration of colder water from surrounding rocks or non-sealed, non-cemented wells.

There are two geothermal fields in the Gevgelia valley: Negorska Banja spa and Smokvica. The discharge zone in both geothermal fields is in fault zones bounded by Jurassic diabases and spilites. Although these two fields are separated by several kilometers, there is no hydraulic connection between them, despite intensive pumping of thermal waters. The maximum temperature is 54ºC, and the predicted reservoir temperature is 75-100ºC. The geothermal system in the Gevgelia valley has been well studied by 15 boreholes with depths between 100-800 m (Gorgieva et al., 2000).

Site/Project Name	***Stip***
Location	In the east-central part of the country
Status	Direct use -- developed
Temperature (ºC) from	32
Temperature (ºC) to	59
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2.7
Chronology	N/A
Notes	Stip has temperatures of 32-59ºC, flow rates of 1-30 l/s, and a heat power of 2.7 MWt (Popovski and Popovska-Vasilevska, 1999).

FYR of Macedonia

Site/Project Name	***Strnovec***
Location	In the Kumanovo geothermal area in north-central Macedonia
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	40
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2
Chronology	1987 - Thermal artesian well drilled to 400 m; encountered a maximum temperature of 50ºC; flowing enthalpy of 209 kJ/kg (Dimitrov et al., 1990).
Notes	Strnovec has a temperature of 40ºC, a flow rate of 17 l/s, and a heat power of 2.0 MWt (Popovski and Popovska-Vasilevska, 1999). Seven exploratory boreholes have been drilled to a maximum of 172 m. The deepest exploitation well, yields 17 l/s artesian water at 40ºC (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Toplec***
Location	Near Lake Dojran; in the southeastern corner of the country
Status	Direct use -- undeveloped
Temperature (ºC) from	25
Temperature (ºC) to	26

FYR of Macedonia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.1
Chronology	N/A
Notes	The geothermal resource is used for irrigation.

Toplec has a temperature of 25ºC, a flow rate of 2 l/s, and a heat power of 0.1 MWt (Popovski and Popovska-Vasilevska, 1999).

This system is characterized by relatively low temperatures, up to 28ºC, and low predicted reservoir temperatures because of lack of water-rock equilibrium and mixing of hot and cold water. It has not been studied in detail (Gorgieva et al., 2000).

Two exploratory boreholes were drilled in the vicinity of the natural spring; the water is used for irrigation. The system is also drained with the exploitation well "Deribas" near the town of Star Dojran, and with the natural spring near Mrdaja (Popovski and Lund, eds., Gorgieva, 1999).

The Toplec hydrogeothermal system is drained naturally by the thermal spring in Toplec which gradually lowers the flow and temperature of the water.

Site/Project Name	***Topli dol***
Location	Near Kozuf Mountain
Status	Preliminary identification/repo

FYR of Macedonia

Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.03
Chronology	N/A
Notes	Topli dol has a temperature of 28ºC, a flow rate of 0.5 l/s, and a heat power of 0.03 MWt (Popovski and Popovska-Vasilevska, 1999). The hydrogeothermal system of Kozuf Mountain is drained through two springs: Topli dol and Trnik. The primary reservoir of this system is composed of triassic dolomites and dolomitized limes in the Toplik area near the Alsar mine, and triassic limes near Topli dol and the Rzanovo mine (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Toplik***
Location	In the central part of the country
Status	Preliminary identification/repo
Temperature (ºC) from	22
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

FYR of Macedonia

Potential (MWt)	0.5
Chronology	N/A
Notes	Toplik has a temperature of 22ºC, a flow rate of 8 l/s, and a heat power of 0.5 MWt (Popovski and Popovska-Vasilevska, 1999). The hydrogeothermal system of Kozuf Mountain is drained through two springs: Topli dol and Trnik. The primary reservoir of this system is composed of triassic dolomites and dolomitized limes in the Toplik area near the Alsar mine, and triassic limes near Topli dol and the Rzanovo mine (Popovski and Lund, eds., Gorgieva, 1999).

Site/Project Name	***Trkanie***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	71
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	14.5
Chronology	N/A
Notes	Trkanie has a temperature of 71.3ºC, flow rates of 50-85 l/s, and a heat power of 14.5 MWt (Popovski and Popovska-Vasilevska, 1999).

FYR of Macedonia

Site/Project Name	***Volkovo***
Location	In the Skopje valley; west of Skopje
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	22
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	
Potential (MWt)	4.3
Chronology	1986 - Thermal, artesian well drilled to 186 m; encountered a maximum temperature of 25ºC; flowing enthalpy of 104 kJ/kg (Dimitrov et al., 1990). 1988 - Thermal artesian well drilled to 351 m; encountered a maximum temperature of 22ºC; flowing enthalpy of 92 kJ/kg (Dimitrov et al., 1990).
Notes	The Skopje geothermal system has not been examined in detail. Volkovo has temperatures of 22-25ºC, flow rates of 22-63 l/s, and a heat power of 4.3 MWt (Popovski and Popovska-Vasilevska, 1999). The predicted temperature is 80-90ºC (Popovski and Lund, eds., Gorgieva, 1999).

Slovenia

Site/Project Name	***Banovci***
Location	In northeastern Slovenia
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	68
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.76
Potential (MWt)	0
Chronology	1991 - Production well drilled to 1481 m; artesian well produced water of 58ºC at 10 kg/s (Rajver et al., 1995).
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 4.2 kg/s, a capacity of 0.76 MWt, produces 15.9 TJ/yr, and has a capacity factor of 66% (Kralj and Rajver, 2000).

Site/Project Name	***Bled***
Location	In northwestern Slovenia, south of the Austrian border
Status	Direct use -- developed
Temperature (ºC) from	15
Temperature (ºC) to	22
Installed capacity (MWe)	0

Slovenia

Potential (MWe)	0
Installed capacity (MWt)	0.07
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 10 kg/s, a capacity of 0.07 MWt, produces 2.2 TJ/yr, and has a capacity factor of 100% (Kralj and Rajver, 2000).

Site/Project Name	***Catez (Brezice)***
Location	In eastern Slovenia; in the Krsko basin; 46º Latitude, 15.5º Longitude
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	64
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	18.74
Potential (MWt)	0
Chronology	1959 - Reflection seismic investigation was carried out by Geofizica Company (Croatia) to look for oil; identified a syncline structure. 1962 - Agraria-Flowers Co., using geothermal water to heat its greenhouses, began operating; 5.5 ha under glass; flowers grown for domestic market.

1985 and 1986 - Exploration continued; 704 m-deep well (L-1/86) drilled on the left bank of the Mostec River, near Catez. Maximum yield is 40 l/s and temperature is 61ºC.

1991 - Exploration well drilled to 500 m; pumped well produced 20ºC water (Rajver et al., 1995).

2000 - Greenhouses now use an estimated 137 TJ/yr compared to 72 TJ/yr in 1994.

Notes

The geothermal resource is used for space and district heating, greenhouse and soil heating, and bathing and swimming.

With a surface area of 7000 m^2, Terme Catez is the largest geothermally heated pool complex in Slovenia. The resource at Terme Catez has a maximum flow rate of 80 kg/s, a capacity of 10.04 MWt, produces 158.3 TJ/yr, and has a capacity factor of 5%.

The Agraria Catez resource has a maximum flow rate of 80 kg/s, a capacity of 8.70 MWt, produces 137.2 TJ/yr, and has a capacity factor of 5% (Kralj and Rajver, 2000).

The maximum flow rate at utilization is 80 kg/s for both the pool and the greenhouse complex. They do not interfere much with each other because Terme Catez is most active during the summer and the Agraria is most active during the winter.

More than 20 wells have been drilled in Catez. The deepest borehole is 570 m, the maximum yield from a single well is 50 l/s, the maximum temperature is 64ºC.

Site/Project Name: ***Celje's Hollow***

Location: In the east-central part of the country

Status: Direct use -- developed

Slovenia

Temperature (ºC) from	20
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for therapeutic uses.

Site/Project Name	***Cerkno***
Location	In western Slovenia
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.34
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, bathing, and swimming.

Slovenia

The geothermal resource has a maximum flow rate of 40 kg/s, a capacity of 0.34 MWt, produces 2.6 TJ/yr, and has a capacity factor of 25% (Kralj and Rajver, 2000).

Cerkno has both the deepest exploration and the lowest temperature production wells, 2450 m and 1948 m, respectively.

Site/Project Name	***Dabinka***
Location	In north-central Slovenia
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Dahlenske Toplice***
Location	In south-central Slovenia
Status	Direct use -- developed

Slovenia

Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Dobova***
Location	In eastern Slovenia; northeast of Catez; in the Krsko basin
Status	Direct use -- developed
Temperature (ºC) from	38
Temperature (ºC) to	63
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.57
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, bathing, and swimming.

Slovenia

The geothermal resource has a maximum flow rate of 15 kg/s, a capacity of 1.57 MWt, produces 23.1 TJ/yr, and has a capacity factor of 47% (Kralj and Rajver, 2000).

Exploitation well AFP-1/95 with a depth of 700 m, yields 15 l/s at 62ºC (Rajver, 2000).

Site/Project Name	***Dobrna***
Location	In the east-central part of the country
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	36
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.14
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 8.1 kg/s, a capacity of 0.14 MWt, produces 3.4 TJ/yr, and has a capacity factor of 8% (Kralj and Rajver, 2000).

Site/Project Name	***Dolenjske Toplice***
Location	In the southeastern part of the country
Status	Direct use -- developed

Slovenia

Temperature (ºC) from	32
Temperature (ºC) to	37
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.18
Potential (MWt)	0
Chronology	1992 - Production well drilled to 45 m; pumped well produced 36.8ºC water at 40 kg/s (Rajver et al., 1995).
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 19.6 kg/s, a capacity of 0.18 MWt, produces 2.4 TJ/yr, and has a capacity factor of 43% (Kralj and Rajver, 2000).

Site/Project Name	***Dragonja Vas***
Location	In the northeastern part of the country
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	19
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Slovenia

Chronology	1990 to 1993 - Three thermal gradient wells drilled to a combined depth of 638 m; pumped wells produced 18.7ºC water (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Gozd Martuljek***
Location	In the northwestern part of the country
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	9
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1993 - Thermal gradient well drilled to 150 m; pumped well produced 8.6ºC water (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Koprivica***
Location	45º Latitude, 16º Longitude
Status	Direct use -- developed
Temperature (ºC) from	131
Temperature (ºC) to	0

Slovenia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology. Measured temperature is 131ºC (Dimitrov et al., 1990).

Site/Project Name	***Kostanjevica***
Location	In eastern Slovenia; in the Krsko basin
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1985 and 1986 - Exploration continued; a 800 m-deep well drilled northeast of the Toplicnik thermal spring. It is an artesian well with a flow rate of about 10 l/s, however, 45 l/s of thermal water with 35.5ºC can be pumped from the Jurassic limestone aquifer reached by the well at a depth of 633 m.
Notes	Hydrogeological structure around the Toplicnik thermal spring at Kostanjevica has been investigated

in detail. Six structural- exploitation wells have been drilled nearby with depths from 45 to 192 m, and two thermometric gradient boreholes northerly, both 100 m deep. The well V-6 (45-m deep) has proved the yield of 40 l/s with 27ºC from Jurassic limestone, which is the highest temperature at Toplicnik. Wells are located along the left and the right bank of Krka river. The contact of Tertiary clastic sediments with Mesozoic carbonates dips steeply to the north (Rajver, 2000).

Site/Project Name	***Krsko***
Location	In eastern Slovenia
Status	Direct use -- developed
Temperature (ºC) from	23
Temperature (ºC) to	64
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing, space heating, and greenhouses. Numerous thermal springs appear on the southern and western margins of the Krsko basin.

Site/Project Name	***Lasko***
Location	In central Slovenia, east of Ljubljana

Slovenia

Status	Direct use -- developed
Temperature (ºC) from	30
Temperature (ºC) to	41
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.17
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and space heating. The geothermal resource has a maximum flow rate of 40 kg/s, a capacity of 0.17 MWt, produces 2.6 TJ/yr, and has a capacity factor of 5% (Kralj and Rajver, 2000).

Site/Project Name	***Lendava***
Location	In northeastern Slovenia, near the borders with Hungary and Croatia
Status	Construction underway
Temperature (ºC) from	14
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	10
Installed capacity (MWt)	2.11
Potential (MWt)	11

Slovenia

Chronology	1994 - Exploration well drilled to 1504 m; artesian well produced water of 65ºC at 13 kg/s (Rajver et al., 1995). 2000 - Construction of a geothermal power plant (probably binary) began. 2002 - Geothermal power plant expected to go online.
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource used for Terme Lendava has a maximum flow rate of 9 kg/s, a capacity of 0.94 MWt, produces 21.4 TJ/yr, and has a capacity factor of 72%. Lendava Ing-Gra has a maximum flow rate of 14 kg/s, a capacity of 1.17 MWt, produces 7.9 TJ/yr, and has a capacity factor of 21% (Kralj and Rajver, 2000). (Kralj and Rajver, 2000). The cascaded geothermal project is composed of a geothermal power plant with installed capacity of 10 MWe (80 GWh/yr), district heating with 6 MWt (9 GWh/yr), cooling with 3 MWt (2.5 GWh/yr), aquaculture (1 ha – area, 200 t/yr of fish), agriculture (2 ha of greenhouses), tourism (2 MWt, up to 16 GWh/yr). The project is registered with the European Commission Research Directorates (Kralj and Rajver, 2000).

Site/Project Name	***Ljubljana***
Location	In central Slovenia, the capital of the country
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0

Slovenia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1990 - Thermal gradient well drilled to 171 m; pumped well produced 21ºC water (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Ljutomer***
Location	In the eastern part of the country, north of Zagreb
Status	Feasibility study
Temperature (ºC) from	175
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	1
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - The first project for the power generation using geothermal resources, which also included direct uses, was designed for the town of Ljutomer. It has not been implemented.
Notes	Temperature of 175ºC at 4000 m.

Site/Project Name	***Lucija***
Location	

Slovenia

Status	Well(s) or hole(s) drilled
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Exploration well drilled to 801 m; artesian well produced 27.5ºC water (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Marezige***
Location	In the southwestern part of the country
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	30
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Exploration well drilled to 4700 m; pumped well produced 30ºC water (Rajver et al., 1995).

Slovenia

Notes	N/A

Site/Project Name	***Maribor***
Location	In eastern Slovenia
Status	Direct use -- developed
Temperature (ºC) from	21
Temperature (ºC) to	69
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.8
Potential (MWt)	0
Chronology	1990 to 1994 - Seven exploration wells drilled to combined depth of 8063 m; pumped wells produced water with a maximum temperature of 68.7ºC at 9 kg/s (Rajver et al., 1995).
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 10 kg/s, a capacity of 0.8 MWt, produces 3.8 TJ/yr, and has a capacity factor of 15% (Kralj and Rajver, 2000).

Site/Project Name	***Medija***
Location	In the east-central part of the country, west of Zagreb
Status	Direct use -- developed

Slovenia

Temperature (ºC) from	21
Temperature (ºC) to	24
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.42
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 35 kg/s, a capacity of 0.42 MWt, produces 5.8 TJ/yr, and has a capacity factor of 44% (Kralj and Rajver, 2000).

Site/Project Name	***Moravci***
Location	In the northeastern part of the country
Status	Direct use -- developed
Temperature (ºC) from	36
Temperature (ºC) to	66
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	6.1
Potential (MWt)	0
Chronology	1993 - Injection well drilled to 991 m; artesian well produced water of 62ºC at 12 kg/s (Rajver et al.,

	1995).
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 52.1 kg/s, a capacity of 6.10 MWt, produces 113.9 TJ/yr, and has a capacity factor of 59% (Kralj and Rajver, 2000).

Site/Project Name	***Moravci-Buckovci***
Location	In the northeastern part of the country
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	43
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.44
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 7 kg/s, a capacity of 0.44 MWt, produces 0.5 TJ/yr, and has a capacity factor of 4% (Kralj and Rajver, 2000).

Site/Project Name	***Murska Sobota***
Location	In the northeastern part of the country

Slovenia

Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	51
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.78
Potential (MWt)	0
Chronology	1987 and 1988 - Two exploitation wells (Sob-1 and Sob-2) were drilled, to 870 m and 887 m, respectively. The wells penetrated Upper Pliocene intergranular acquifer, Termal I, and some underlying Lower Pliocene acquifers. Water levels in the wells constantly decreased, as did total dissolved solids (Kralj and Kralj, 2000).
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. Three-hundred dwellings are heated through heat exchangers, especially from October to April. The geothermal resource has a maximum flow rate of 25 kg/s, a capacity of 1.78 MWt, produces 24.7 TJ/yr, and has a capacity factor of 44% (Kralj and Rajver, 2000). The town of Murska Sobota (pop. 15,000) is located in the Mura basin which is part of the widespread system of the Pannonian basins. The most important thermal acquifer in the region is Termal I which formed in Upper Pliocene by the stacking of braided river deposits. It consists of up to a 100-meters thick sedimentary sequence of interbedded sands, silts, and clays, in which the thickness of beds with good permeability varies from 20-50 meters (Kralj and Kralj, 2000). Intensive exploitation of Sob-1 and Sob-2 is reflected in a very decreased yield of thermal water, changing hydrodynamic pressures in Termal I near both wells, and the changing chemical composition of the water. Reinjection is necessary (Kralj and Kralj, 2000).

Slovenia

The Murska Sobota geothermal field has an area of 12.57 km2. The potential of the field is estimated at 300,000 t.o.e. (tons of oil equivalents). The town has developed into the most important urban center of the overpopulated Pomurje agricultural region (Kralj, 1999).

Site/Project Name	***Nova Gorica***
Location	In the western part of the country
Status	Direct use -- developed
Temperature (ºC) from	16
Temperature (ºC) to	28
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1993 - Two thermal gradient wells drilled to combined depth of 388 m; pumped wells produced water with a maximum temperature of 16ºC (Rajver et al., 1995).
Notes	The geothermal resource is used for therapeutic uses.

Site/Project Name	***Okonina***
Location	In the central part of the country
Status	Well(s) or hole(s) drilled

Slovenia

Temperature (ºC) from	18
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Thermal gradient well drilled to 201 m; pumped well produced 18.5ºC water at 0.3 kg/s (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Osp***
Location	In the southwestern part of the country
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	20
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1991 - Thermal gradient well drilled to 653 m; artesian well produced 20ºC water at 4 kg/s (Rajver et al., 1995).

Slovenia

<u>Notes</u> N/A

Site/Project Name	***Otocec***
Location	In the southeastern part of the country; 100 km southeast of Ljubljana
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	15
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1993 - Production well drilled to 300 m; pumped well produced 15ºC water at 15 kg/s (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Podcektrek***
Location	In northeastern Slovenia, about 100 km from Ljubljana
Status	Direct use -- developed
Temperature (ºC) from	15
Temperature (ºC) to	35
Installed capacity (MWe)	0

Slovenia

Potential (MWe)	0
Installed capacity (MWt)	1.09
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 50 kg/s, a capacity of 1.09 MWt, produces 20.1 TJ/yr, and has a capacity factor of 58% (Kralj and Rajver, 2000).

Site/Project Name	***Portoroz***
Location	In western Slovenia
Status	Direct use -- developed
Temperature (ºC) from	16
Temperature (ºC) to	23
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.02
Potential (MWt)	0
Chronology	1994 - Production well drilled to 705 m; pumped well produced water at 1.4 kg/s (Rajver et al., 1995).
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 0.8 kg/s, a capacity of 0.02 MWt, produces 0.5 TJ/yr, and has a capacity factor of 67% (Kralj and Rajver, 2000).

Slovenia

Site/Project Name	***Posavje's Faults (Ljubljana's Hollow)***
Location	In central Slovenia, the capital of the country
Status	Direct use -- developed
Temperature (ºC) from	18
Temperature (ºC) to	23
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and industrial uses.

Site/Project Name	***Ptuj***
Location	In the northeastern part of the country
Status	Direct use -- developed
Temperature (ºC) from	29
Temperature (ºC) to	39
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.23

Slovenia

Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 5.5 kg/s, a capacity of 0.23 MWt, produces 7.3 TJ/yr, and has a capacity factor of 100% (Kralj and Rajver, 2000).

Site/Project Name	***Radenci***
Location	In the northeastern part of the country
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming.

Site/Project Name	***Rimske Toplice***
Location	In the central part of the country
Status	Direct use -- developed

Slovenia

Temperature (ºC) from	32
Temperature (ºC) to	38
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.18
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 7.3 kg/s, a capacity of 0.18 MWt, produces 4.1 TJ/yr, and has a capacity factor of 71% (Kralj and Rajver, 2000).

Site/Project Name	***Rogaska Slatina***
Location	In eastern Slovenia
Status	Direct use -- developed
Temperature (ºC) from	30
Temperature (ºC) to	55
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.63
Potential (MWt)	0
Chronology	1990 to 1992 - Two exploration wells drilled to combined depth of 1954 m; artesian wells produced

water with a maximum temperature of 63ºC at 5.7 kg/s (Rajver et al., 1995).

Notes: The geothermal resource is used for bathing and swimming.

The geothermal resource has a maximum flow rate of 6 kg/s, a capacity of 0.63 MWt, produces 8.2 TJ/yr, and has a capacity factor of 41% (Kralj and Rajver, 2000).

Site/Project Name	***Secovlje***
Location	In southwestern Slovenia, near the Croatian border, about 135 km from Ljubljana
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	22
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1993 - Thermal gradient well drilled to 370 m; pumped well produced 21.5ºC water (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Sempeter***
Location	In eastern Slovenia, 60 km from Ljubljana
Status	Well(s) or hole(s) drilled

Slovenia

Temperature (ºC) from	32
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Exploration well drilled to 1563 m; pumped well produced 32ºC water at 1 kg/s (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Slovenj Gradec***
Location	In northeastern Slovenia, near the Austrian border, about 115 km from Ljubljana
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	38
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1990 - Thermal gradient well drilled to 1000 m; pumped well produced 38ºC water at 1 kg/s (Rajver et al., 1995).

Slovenia

Notes	N/A

Site/Project Name	***Smarjeske Toplice***
Location	In eastern Slovenia; in the Krsko basin
Status	Direct use -- developed
Temperature (ºC) from	17
Temperature (ºC) to	34
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.51
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 40 kg/s, a capacity of 2.51 MWt, produces 59.4 TJ/yr, and has a capacity factor of 75% (Kralj and Rajver, 2000). Detailed investigations of the larger Smarjeta Spa area have been followed by drilling of 11 wells with a maximum depth of 495 m. Thermal water of maximum temperature of 34.5ºC flows from Mesozoic, mostly Triassic, carbonate aquifers (Rajver, 2000).

Site/Project Name	***Snovik***
Location	In central Slovenia

Slovenia

Status	Direct use -- developed
Temperature (ºC) from	18
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.15
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 15 kg/s, a capacity of 0.15 MWt, produces 1.6 TJ/yr, and has a capacity factor of 33% (Kralj and Rajver, 2000).

Site/Project Name	***Topolsica***
Location	In northeastern Slovenia, about 90 km from Ljubljana
Status	Direct use -- developed
Temperature (ºC) from	20
Temperature (ºC) to	32
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.51
Potential (MWt)	0

Slovenia

Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. The geothermal resource has a maximum flow rate of 30 kg/s, a capacity of 1.51 MWt, produces 34.8 TJ/yr, and has a capacity factor of 73% (Kralj and Rajver, 2000).

Site/Project Name	***Trbovlje***
Location	In central Slovenia, about 60 km from Ljubljana
Status	Direct use -- developed
Temperature (ºC) from	20
Temperature (ºC) to	25
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.08
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and to supply industrial process heat. Thermal water of 25ºC is used for cooling at the cement plant. The geothermal resource has a maximum flow rate of 10 kg/s, a capacity of 0.08 MWt, produces 1.1 TJ/yr, and has a capacity factor of 4% (Kralj and Rajver, 2000).

Site/Project Name	***Trebavle***

Slovenia

Location	In the central part of the country
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Tuhnije Valley***
Location	In northeastern Slovenia, about 50 km from Ljubljana
Status	Direct use -- developed
Temperature (ºC) from	22
Temperature (ºC) to	28
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Slovenia

Chronology	N/A
Notes	The geothermal resource is used for bathing.

Site/Project Name	***Vaseno***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	22
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1990 - Production well drilled to 983 m; pumped well produced 22ºC water at 15 kg/s (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Vihnitka***
Location	In the west-central part of the country
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0

Slovenia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Vrhnika***
Location	In central Slovenia, 20 km from Ljubljana
Status	Direct use -- developed
Temperature (ºC) from	15
Temperature (ºC) to	22
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.54
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used to supply industrial process heat. Thermal water of 21.5ºC is heated to 55-60ºC and used in the leather industry. The geothermal resource has a maximum flow rate of 20 kg/s, a capacity of 0.54 MWt, produces 10.3 TJ/yr, and has a capacity factor of 6% (Kralj and Rajver, 2000).

Slovenia

Site/Project Name	***Zagorje Valley***
Location	In central Slovenia, about 50 km from Ljubljana
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing, space heating, and industrial uses.

Site/Project Name	***Zalec***
Location	In eastern Slovenia, 60 km from Ljubljana
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	40
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Slovenia

Potential (MWt)	0
Chronology	1991 - Thermal gradient well drilled to 1500 m; pumped well produced 40ºC water at 0.1 kg/s (Rajver et al., 1995).
Notes	N/A

Site/Project Name	***Zrece***
Location	In northeastern Slovenia, about 100 km from Ljubljana
Status	Direct use -- developed
Temperature (ºC) from	22
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.54
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for space and district heating, bathing, and swimming. The geothermal resource has a maximum flow rate of 22 kg/s, a capacity of 0.54 MWt, produces 11.7 TJ/yr, and has a capacity factor of 68% (Kralj and Rajver, 2000).

Yugoslavia

Site/Project Name	***"VRMAC"-Prcanj***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Arandjelovac***
Location	44º00' latitude, 20º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	34
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Yugoslavia

Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Limestone rock, 4293 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Avala***
Location	In northern Serbia, south of Belgrade
Status	Preliminary identification/repo
Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Backi Manastir***
Location	46º Latitude, 19º Longitude
Status	Prefeasibility study

Yugoslavia

Temperature (ºC) from	73
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Banja "Junakovic"-Apatin***
Location	In western Vojvodina, near the Croatian border
Status	Direct use -- developed
Temperature (ºC) from	56
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Yugoslavia

Site/Project Name	***Banja Istok***
Location	In northwestern Kosovo
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Banja Rusanda-Melenci***
Location	In eastern Vojvodina
Status	Direct use -- developed
Temperature (ºC) from	92
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Yugoslavia

Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Banja Topilo***
Location	
Status	Direct use -- developed
Temperature (ºC) from	37
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Banja Vuca***
Location	
Status	Direct use -- developed
Temperature (ºC) from	30
Temperature (ºC) to	0

Yugoslavia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Banjska***
Location	43º00' latitude, 21º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	54
Temperature (ºC) to	120
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Limestone and volcanic rock, 1780 mg/kg dissolved solids, estimated reservoir temperature is 120ºC (Milivojevic and Martinovic, 1995).

Yugoslavia

Site/Project Name	***Becej***
Location	45º30' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating. Average flow rate is 19.4 kg/s; annual energy use is 104.91 TJ/yr. Sand rock, 4012 mg/kg dissolved solids, measured reservoir temperature is 63ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Bioska Banja***
Location	In southwestern Serbia, near the border with Bosnia-Herzegovinia
Status	Direct use -- developed
Temperature (ºC) from	36
Temperature (ºC) to	0
Installed capacity (MWe)	0

Yugoslavia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Biostanska Banja***
Location	
Status	Direct use -- developed
Temperature (ºC) from	37
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Bogatic***
Location	45º00' latitude, 19º30' longitude
Status	Prefeasibility study

Yugoslavia

Temperature (ºC) from	75
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1986 - Thermal artesian well drilled to 470 m; encountered a maximum temperature of 75.5ºC; flowing enthalpy of 316 kJ/kg (Dimitrov et al., 1990). 1990 - Exploratory artesian well drilled to 618 m. Encountered a maximum temperature of 80ºC, flow rate of 61 kg/s, and 2.70 WHP bar (Milivojevic and Martinovic, 1995).
Notes	The municipal area of Bogatic is the richest geothermal area in the Republic of Serbia. Limestone rock, 860 mg/kg dissolved solids, estimated reservoir temperature is 90ºC (Milivojevic and Martinovic, 1995). Six bore holes have been drilled; mineralization is 0.531 gm/l; chemical composition is HCO3, Na (Lawrence and Stoyanov, 1996).

Site/Project Name	***Bogutovac***
Location	In south-central Serbia
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0

Yugoslavia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Brestovacka Banja***
Location	44º00' latitude, 22º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	30
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 3 kg/s; annual energy use is 3.96 TJ/yr. Volcanic rock, 714 mg/kg dissolved solids, estimated reservoir temperature is 100ºC (Milivojevic and Martinovic, 1995).

Yugoslavia

Site/Project Name	***Bujanovacka Banja***
Location	42º30' latitude, 22º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. Average flow rate is 7 kg/s; annual energy use is 17.54 TJ/yr. Sand and granite rocks, 4839 mg/kg dissolved solids, estimated reservoir temperature is 70ºC (Milivojevic and Martinovic, 1995). Two springs; seven bore holes drilled; flow rate is 6 l/s; mineralization is 4.98 gm/l; chemical composition is HCO3, Na (Lawrence and Stoyanov, 1996).

Site/Project Name	***Bukovicka Banja***
Location	
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	34

Yugoslavia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 15 kg/s; annual energy use is 11.87 TJ/yr (Milivojevic and Martinovic, 1995).

Site/Project Name	***Cedovo***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Cibutkovica***

Yugoslavia

Location	
Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Dag***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	30
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Yugoslavia

Chronology	N/A
Notes	N/A

Site/Project Name	***Debrc***
Location	44º30' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	48
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1991 - Exploratory artesian well drilled to 1002 m. Encountered a maximum temperature of 58ºC, flow rate of 15 kg/s, and 1.08 WHP bar (Milivojevic and Martinovic, 1995).
Notes	The geothermal resource is used for district heating and agricultural drying, e.g., wheat and other cereals. Average flow rate is 15 kg/s; annual energy use is 9.89 TJ/yr. Limestone rock, 740 mg/kg dissolved solids, estimated reservoir temperature is 70ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Despotovac***
Location	In central-eastern Serbia
Status	Preliminary identification/repo

Yugoslavia

Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Donjobadanjska***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Yugoslavia

Site/Project Name	***Dublje***
Location	45º00' latitude, 19º30' longitude
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	44
Temperature (ºC) to	85
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1986 - Thermal artesian well drilled to 192 m; encountered a maximum temperature of 44ºC; flowing enthalpy of 184 kJ/kg (Dimitrov et al., 1990).
Notes	Four bore holes have been drilled; flow rate is 15 l/s (Lawrence and Stoyanov, 1996). Limestone rock, 986 mg/kg dissolved solids, estimated reservoir temperature is 85ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Dvorovi***
Location	In Semberia, near the town of Bijeljina; 120 km west of Belgrade; west of Macva; 45.5º Latitude, 19.5º Longitude
Status	Direct use -- developed
Temperature (ºC) from	50
Temperature (ºC) to	90

Yugoslavia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1957 - Thermal waters discovered during oil exploration; borehole S-1 drilled. 1960 - Olympic-size swimming pool constructed. 1992 - Two-star, 250-bed hotel with modern balneo-therapy facilities and closed swimming pools, was completed.
Notes	The geothermal resource is used for district heating, bathing and swimming, and greenhouses. On the southern part of the Pannonian Basin, Semberia is located in the area with the greatest geothermal anomaly in Serbia (Bodri, 1982).

Site/Project Name	***Gamzigradska Banja***
Location	44º00' latitude, 22º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Yugoslavia

Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. Three springs; 10 bore holes have been drilled; flow rate is 20 l/s; mineralization is 0.555 gm/l; chemical composition is HCO3, Ca, CO2 (Lawrence and Stoyanov, 1996). Average flow rate is 10 kg/s; annual energy use is 23.74 TJ/yr. Limestone rock, 651 mg/kg dissolved solids, estimated reservoir temperature is 80ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Gornja Trepca***
Location	44º00' latitude, 20º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 20 kg/s; annual energy use is 15.82 TJ/yr. Volcanic rock, 570 mg/kg dissolved solids, estimated reservoir temperature is 50ºC (Milivojevic and Martinovic, 1995).

Yugoslavia

Site/Project Name	***Grocka***
Location	In northern Serbia, southeast of Belgrade, on the Danube River
Status	Preliminary identification/repo
Temperature (ºC) from	30
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Indjija***
Location	45º00' latitude, 20º00' longitude
Status	Prefeasibility study
Temperature (ºC) from	60
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Yugoslavia

Potential (MWt)	0
Chronology	1990 - Exploratory artesian well drilled to 860 m. Encountered a maximum temperature of 60ºC, flow rate of 18 kg/s, and 1.50 WHP bar (Milivojevic and Martinovic, 1995).
Notes	Limestone rock, 953 mg/kg dissolved solids, estimated reservoir temperature is 70ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Josanicka Banja***
Location	43º30' latitude, 21º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	130
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. Average flow rate is 17 kg/s; annual energy use is 85.21 TJ/yr. Granite and metamorphic rock, 326 mg/kg dissolved solids, estimated reservoir temperature is 130ºC (Milivojevic and Martinovic, 1995). Two springs; nine bore holes have been drilled; flow rate is 36 l/s; mineralization is 0.287 gm/l; chemical composition is HCO3, Na (Lawrence and Stoyanov, 1996).

Yugoslavia

Site/Project Name	***Jugovo***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	42
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Kanjiza***
Location	46º00' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Yugoslavia

Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. Average flow rate is 5-14 kg/s; annual energy use is 81.91 TJ/yr. Sand rock, 3640 mg/kg dissolved solids, measured reservoir temperature is 41ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Kikinda***
Location	46º00' latitude, 20º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	51
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and fish and other animal farming. Average flow rate is 6.2-15.2 kg/s; annual energy use is 68.93 TJ/yr. Sand rock, 3910 mg/kg dissolved solids, estimated reservoir temperature is 50ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Klokot Banja***

Yugoslavia

Location	42º30' latitude, 21º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 15 kg/s; annual energy use is 17.80 TJ/yr. Volcanic and metamorphic rocks, 3480 mg/kg dissolved solids, estimated reservoir temperature is 80ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Knjazevac***
Location	300 km from Belgrade
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Yugoslavia

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1981 - Greenhouse (0.51 ha) built; produces 53,000 flowers and nursery plants annually.
Notes	The geothermal resource is for greenhouses.

Site/Project Name	***Koviljaca***
Location	44º30' latitude, 19º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 130 kg/s; annual energy use is 102.88 TJ/yr. Limestone rock, 1412 mg/kg dissolved solids, estimated reservoir temperature is 40ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Kravlje***
Location	43º30' latitude, 22º00' longitude

Yugoslavia

Status	Preliminary identification/repo
Temperature (ºC) from	32
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Limestone rock, 562 mg/kg dissolved solids, estimated reservoir temperature is 40ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Kula***
Location	45º30' latitude, 19º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	53
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Yugoslavia

Notes	The geothermal resource is used for industrial process heat and bathing and swimming. Average flow rate is 8.3-9.5 kg/s; annual energy use is 104.84 TJ/yr. Sand rock, 3619 mg/kg dissolved solids, measured reservoir temperature is 53ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Kupinovo***
Location	45º00' latitude, 20º00' longitude
Status	Prefeasibility study
Temperature (ºC) from	54
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Limestone rock, 835 mg/kg dissolved solids, estimated reservoir temperature is 70ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Kursumlijska Banja***
Location	43º00' latitude, 21º00' longitude
Status	Direct use -- developed

Yugoslavia

Temperature (ºC) from	25
Temperature (ºC) to	140
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. A large hotel and rehabilitation center with a swimming pool are heated in Kursumlijska Banja. Average flow rate is 20 kg/s; annual energy use is 113.43 TJ/yr. Limestone, metamorphic, and volcanic rocks; 3142 mg/kg dissolved solids; estimated reservoir temperature is 140ºC (Milivojevic and Martinovic, 1995). Five springs; seven bore holes have been drilled; flow rate is 8 l/s; mineralization is 2.065 gm/l; chemical composition is HCO3, Na (Lawrence and Stoyanov, 1996).

Site/Project Name	***Ljig***
Location	In central Serbia
Status	Direct use -- developed
Temperature (ºC) from	32
Temperature (ºC) to	0
Installed capacity (MWe)	0

Yugoslavia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Lukovska Banja***
Location	43º00' latitude, 21º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	35
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating, bathing and swimming, and industrial process heat (in the carpet industry). 20 springs, five bore holes have been drilled; flow rate is 4.5 l/s; mineralization is 1.559 gm/l; chemical composition is HCO3, Na, Ca (Lawrence and Stoyanov, 1996). Average flow rate is 12 kg/s; annual energy use is 50.65 TJ/yr. Limestone rock, 1980 mg/kg

	dissolved solids, estimated reservoir temperature is 90ºC (Milivojevic and Martinovic, 1995).
Site/Project Name	***Macva***
Location	About 80 km west of Belgrade; on the southern margin of the Pannonian Basin; east of Dvorovi
Status	Feasibility study
Temperature (ºC) from	80
Temperature (ºC) to	110
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	150
Chronology	1981 - First geothermal well BD-1 drilled to 400 m; yielded 50ºC water with a flow rate of 15 kg/s. 1982 - Hydrothermal system discovered when a high conductive geothermal anomaly was detected in deposits at Dublje, central Macva, by borehole DB-1. Since 1987 - 11 boreholes have been drilled in Semberia and Macva. Well BZ-1 is the deepest, with a depth of 1500 m. The reservoir depth is 400-600 m; water temperature is 80ºC.
Notes	Completed studies indicate that thermal water exploitation in Macva can provide district heating systems for Bogatic, Sabac, Sremska Mitrovica, and Loznica, with a population of 150,000. Macva is one of the best agricultural regions in Serbia, and Yugoslavia, which makes the geothermal resources in its convective hydrogeothermal system extremely important for food production, heating of homes and green-houses. The chemical composition of the thermal waters is suitable for direct use; for example, calcite scaling in BB-1 will be 900 g/day at a pumping rate of 37 kg/s and temperature

of 75ºC (Papic, 1992).

A design was prepared for 25 hectares of green houses for production of vegetables, fruits, and flowers. The project cost estimate is about US$43 million. However, the project ctivities have been discontinued due to the economic blockade of Serbia and Yugoslavia.

On the southern part of the Pannonian Basin, Macva is located in the area with the greatest geothermal anomaly in Serbia (Bodri, 1982).

A conductive geothermal anomaly, the highest in the Pannonian Basin (thermal water of 75ºC found in the borehole BB-1 at the depth of 412 m), was detected above the reservoir in central Macva (Milivojevic and Peric, 1987). This makes Macva the Yugoslavian, and Serbian, "Red Spot", as the Pannonian Basin is for Europe (Horvath et al., 1979).

Geothermal anomalies in Neogene sediments and previous hydrogeothermal investigations indicate thermal water-bearing
Triassic limestone beneath Neogene sediments throughout the whole Macva region. The highest measured temperature is 78ºC at a depth of 610 m in Triassic limestone. The highest temperature expected in the aquifer on the basis of hydrochemical geothermometers, is about 100-110ºC. Natural conditions in Macva are favorable for intensive exploitation of geothermal energy. Based on the local geology, hydrogeological and hydrothermal characteristics, the calculated thermal power potential of the Macva region is approximately 1500 kg/s of 75ºC water or 150 MWt, based on a reservoir surface area of 800 km² (Martinovic and Milivojevic, 2000).

The full extent of the geothermal anomaly has not been determined.

Site/Project Name	***Malo Laole***
Location	
Status	Well(s) or hole(s) drilled

Yugoslavia

Temperature (ºC) from	38
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	One bore hole has been drilled; flow rate is 19 l/s; mineralization is 0.624 gm/l; chemical composition is HCO3, Ca, Na (Lawrence and Stoyanov, 1996).

Site/Project Name	***Mataruge***
Location	44º00' latitude, 20º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	110
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming.

Average flow rate is 47 kg/s; annual energy use is 117.79 TJ/yr. Volcanic rock, 1495 mg/kg dissolved solids, estimated reservoir temperature is 110ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Mataruska Banja***
Location	
Status	Direct use -- developed
Temperature (ºC) from	43
Temperature (ºC) to	52
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology. Two springs; six bore holes have been drilled; flow rate is 5 l/s; mineralization is 1.33 gm/l; chemical composition is HCO3, Na (Lawrence and Stoyanov, 1996).

Site/Project Name	***Melenci***
Location	45º30' latitude, 20º30' longitude
Status	Direct use -- developed

Yugoslavia

Temperature (ºC) from	33
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Sand rock, 2680 mg/kg dissolved solids, measured reservoir temperature is 33ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Metkovic***
Location	45º00' latitude, 19º30' longitude
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	55
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1987 -Thermal artesian well drilled to 605 m; encountered a maximum temperature of 65ºC; flowing

	enthalpy of 272 kJ/kg (Dimitrov et al., 1990).
Notes	One bore hole has been drilled; flow rate is 11 l/s (Lawrence and Stoyanov, 1996). Sands, 1436 mg/kg dissolved solids, estimated reservoir temperature is 90ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Miljakovac***
Location	43º30' latitude, 22º00' longitude
Status	Preliminary identification/repo
Temperature (ºC) from	33
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Limestone rock, 586 mg/kg dissolved solids, estimated reservoir temperature is 40ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Milkovac***
Location	
Status	Preliminary identification/repo

Yugoslavia

Temperature (ºC) from	30
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Mladenovac***
Location	44º30' latitude, 21º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming.

Average flow rate is 19 kg/s; annual energy use is 70.17 TJ/yr. Limestone rock, 7182 mg/kg dissolved solids, estimated reservoir temperature is 90ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Mlakovac***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	28
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Mokrin***
Location	46º00' latitude, 20º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	51
Installed capacity (MWe)	0

Yugoslavia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for fish and other animal farming. Average flow rate is 10.5 kg/s; annual energy use is 34.62 TJ/yr. Sand rock, 2928 mg/kg dissolved solids, measured reservoir temperature is 51ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Nikolicevo***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	37
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Nikolocevska Banjica***

Yugoslavia

Location	
Status	Direct use -- developed
Temperature (ºC) from	34
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Niska Banja***
Location	43º00' latitude, 22º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Yugoslavia

Chronology	1988 - Thermal artesian well drilled to 500 m; encountered a maximum temperature of 38ºC; flowing enthalpy of 159 kJ/kg (Dimitrov et al., 1990).
Notes	The geothermal resource is used for district heating and bathing and swimming. In Niska Banja, a heating system is installed for the hotel and rehabilitation center, including heat pumps of 6 MW, which directly uses 25ºC thermal waters. Average flow rate is 60 kg/s; annual energy use is 94.97 TJ/yr. Limestone rock, 430 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Novopazarska Banja***
Location	
Status	Direct use -- developed
Temperature (ºC) from	52
Temperature (ºC) to	54
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology. Five springs; two bore holes have been drilled; flow rate is 4.5 l/s; mineralization is 1.726 gm/l; chemical composition is HCO3, Na, H2S (Lawrence and Stoyanov, 1996).

Yugoslavia

Site/Project Name	***Ovcar Banja***
Location	44º00' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	27
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. Average flow rate is 50 kg/s; annual energy use is 72.54 TJ/yr. Limestone rock, 713 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Palanacki Kiseljak***
Location	
Status	Direct use -- developed
Temperature (ºC) from	55
Temperature (ºC) to	0
Installed capacity (MWe)	0

Yugoslavia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Palic***
Location	46º00' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	48
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Sand rock, 3380 mg/kg dissolved solids, measured reservoir temperature is 48ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Pazar***

Yugoslavia

Location	44º00' latitude, 20º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	120
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 10 kg/s; annual energy use is 31.65 TJ/yr. Limestone rock, 1614 mg/kg dissolved solids, estimated reservoir temperature is 1200ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Pec***
Location	In northwestern Kosovo
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	48
Installed capacity (MWe)	0
Potential (MWe)	0

Yugoslavia

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 17.5 kg/s; annual energy use is 50.78 TJ/yr (Milivojevic and Martinovic, 1995).

Site/Project Name	***Pecka Banja***
Location	43º00' latitude, 20º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 4 kg/s; annual energy use is 5.8 TJ/yr. Limestone rock, 851 mg/kg dissolved solids, estimated reservoir temperature is 80ºC (Milivojevic and Martinovic, 1995). Four springs; three bore holes drilled; flow rate is 4.5 l/s; mineralization is 2.04 gm/l; chemical

composition is HCO_3, Na, CO_2 (Lawrence and Stoyanov, 1996).

Site/Project Name	***Petrovac***
Location	45º30' latitude, 19º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	46
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for greenhouses and agricultural drying. Average flow rate is 7.8-16.7 kg/s; annual energy use is 67.86 TJ/yr. Sand rock, 842 mg/kg dissolved solids, measured reservoir temperature is 46ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Pirotska Banjica***
Location	In Pirot, in southeastern Serbia, west of the Bulgarian border
Status	Direct use -- developed
Temperature (ºC) from	31
Temperature (ºC) to	0

Yugoslavia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Pozarevac***
Location	In northeastern Serbia, south of the Danube River
Status	Preliminary identification/repo
Temperature (ºC) from	36
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Pribojska Banja***
Location	43º30' latitude, 19º30' longitude

Yugoslavia

Status	Direct use -- developed
Temperature (ºC) from	30
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 70 kg/s; annual energy use is 55.40 TJ/yr. Limestone rock, 405 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Prigrevica***
Location	46º00' latitude, 19º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	54
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Yugoslavia

Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. Average flow rate is 21 kg/s; annual energy use is 80.33 TJ/yr. Sand rock, 6045 mg/kg dissolved solids, measured reservoir temperature is 54ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Prolom Banja***
Location	43º00' latitude, 21º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 15 kg/s; annual energy use is 13.84 TJ/yr. Volcanic rock, 245 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Radalj***
Location	44º30' latitude, 19º00' longitude

Yugoslavia

Status	Prefeasibility study
Temperature (ºC) from	28
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Granite rock, 152 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Rajcinovica Banja***
Location	43º00' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Yugoslavia

Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 8 kg/s; annual energy use is 8.44 TJ/yr. Limestone rock, 2910 mg/kg dissolved solids, estimated reservoir temperature is 100ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Rakovac***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	42
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Rgoska Banjica***
Location	
Status	Direct use -- developed
Temperature (ºC) from	32
Temperature (ºC) to	0

Yugoslavia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Rgoste***
Location	43º30' latitude, 22º00' longitude
Status	Feasibility study
Temperature (ºC) from	30
Temperature (ºC) to	45
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Limestone rock, 508 mg/kg dissolved solids, estimated reservoir temperature is 45ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Ribarska Banja***

Yugoslavia

Location	43º30' latitude, 21º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	110
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for district heating and bathing and swimming. Average flow rate is 37 kg/s; annual energy use is 92.73 TJ/yr. Metamorphic and granite rocks, 418 mg/kg dissolved solids, estimated reservoir temperature is 110ºC (Milivojevic and Martinovic, 1995). Eight springs, two bore holes have been drilled; flow rate is 9 l/s; mineralization is 0.307 gm/l; chemical composition is HCO3, Na, H2S (Lawrence and Stoyanov, 1996).

Site/Project Name	***Sabac***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0

Yugoslavia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1989 - Thermal artesian well drilled to 1019 m (Dimitrov et al., 1990).
Notes	N/A

Site/Project Name	***Sarbanovac***
Location	44º00' latitude, 22º00' longitude
Status	Preliminary identification/repo
Temperature (ºC) from	29
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Volcanic rock, 313 mg/kg dissolved solids, estimated reservoir temperature is 100ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Selo***
Location	46º00' latitude, 20º00' longitude

Yugoslavia

Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	43
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for fish and other animal farming. Average flow rate is 10 kg/s; annual energy use is 34.29 TJ/yr. Sand rock, 1718 mg/kg dissolved solids, measured reservoir temperature is 43ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Selters***
Location	
Status	Direct use -- developed
Temperature (ºC) from	50
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Yugoslavia

Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Sierinska Banja***
Location	
Status	Direct use -- developed
Temperature (ºC) from	68
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Sijarinska Banja***
Location	43º00' latitude, 21º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	72
Temperature (ºC) to	130
Installed capacity (MWe)	0

Yugoslavia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1992 - Exploratory artesian well drilled to 1200 m. Encountered a maximum temperature of 75ºC, flow rate of 21 kg/s, and 7.40 WHP bar (Milivojevic and Martinovic, 1995).
Notes	The geothermal resource is used for district heating and bathing and swimming. 13 springs; two bore holes have been drilled; flow rate is 30 l/s; mineralization is 4.767 gm/l; chemical composition is HCO3, Na, CO2 (Lawrence and Stoyanov, 1996). Average flow rate is 7.4 kg/s; annual energy use is 49.78 TJ/yr. Metamorphic rock, 4753 mg/kg dissolved solids, estimated reservoir temperature is 130ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Sisevac***
Location	44º00' latitude, 21º30' longitude
Status	Preliminary identification/repo
Temperature (ºC) from	26
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Yugoslavia

Notes	Limestone rock, 545 mg/kg dissolved solids, estimated reservoir temperature is 40ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Slanaca***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	37
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Smed. Palanka***
Location	44º30' latitude, 21º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	75
Installed capacity (MWe)	0

Yugoslavia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 13 kg/s; annual energy use is 53.16 TJ/yr. Limestone rock, 7960 mg/kg dissolved solids, estimated reservoir temperature is 75ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Soko Banja***
Location	44º00' latitude, 22º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	33
Temperature (ºC) to	42
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Three springs; six bore holes have been drilled; flow rate is 12 l/s; mineralization is 0.388 gm/l; chemical composition is HCO_3, Na (Lawrence and Stoyanov, 1996).

Limestone rock, 562 mg/kg dissolved solids, estimated reservoir temperature is 55ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Srbobran***
Location	45º30' latitude, 20º00' longitude; 100 km north of Belgrade
Status	Direct use -- developed
Temperature (ºC) from	24
Temperature (ºC) to	63
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1982 - Greenhouse complex "Elan" built; 6 ha heated by gas from nearby gas field; 0.5 ha heated by geothermal well.
Notes	The geothermal resource is used for greenhouses. Average flow rate is 11.7 kg/s; annual energy use is 60.18 TJ/yr. Sand rock, 3633 mg/kg dissolved solids, measured reservoir temperature is 63ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Stari Slankamen***
Location	
Status	Direct use -- developed

Yugoslavia

Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Sumrakovac***
Location	44º00' latitude, 22º00' longitude
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Volcanic rock, 425 mg/kg dissolved solids, estimated reservoir temperature is 100ºC (Milivojevic and Martinovic, 1995).

Yugoslavia

Site/Project Name	***Suva Cesma***
Location	43º00' latitude, 21º30' longitude
Status	Prefeasibility study
Temperature (ºC) from	22
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	Metamorphic rock, 4275 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Svackovci***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Yugoslavia

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	

Site/Project Name	***Temerin***
Location	45º30' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	41
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 20 kg/s; annual energy use is 39.57 TJ/yr. Sand rock, 3640 mg/kg dissolved solids, measured reservoir temperature is 41ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Vica***
Location	

Yugoslavia

Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Vranjska Banja***
Location	42º30' latitude, 22º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	50
Temperature (ºC) to	150
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	15.2
Potential (MWt)	0
Chronology	1960 - Space heating began.

1970 - First part of "Cvece" greenhouse complex was built (2 ha).

1985 - Second part of Cvece greenhouse complex was built (5 ha).

1988 - Exploratory artesian well drilled to 1000 m; encountered a maximum temperature of 91-135ºC; flowing enthalpy of 381-565 kJ/kg (Dimitrov et al., 1990).

1990 - Exploratory artesian well drilled to 1600 m. Encountered a maximum temperature of 126ºC, flow rate of 30 kg/s, and 9.50 WHP bar (Milivojevic and Martinovic, 1995).

Notes

The geothermal resource is used for industrial process heat, fish and other animal farming, district heating, balneology, and greenhouses.

Thermal water is used to heat flower greenhouses, a poultry farm, a textile workshop, the premises of a spa rehabilitation center, and a hotel.

The flowing geothermal waters come from gneiss and granodiorite of the Neogene period. The springs are captured and water taken to users through a covered concrete canal.

Eight springs; two bore holes have been drilled; flow rate is 70 l/s; mineralization is 1.1-1.22 gm/l; chemical composition is HCO_3, SO_4, Na (Lawrence and Stoyanov, 1996).

Average flow rate is 77 kg/s; annual energy use is 467.20 TJ/yr. Granite and metamorphic rock, 1418 mg/kg dissolved solids, estimated reservoir temperature is 150ºC (Milivojevic and Martinovic, 1995).

Site/Project Name: ***Vrbas***

Location: 45º30' latitude, 20º00' longitude

Status: Direct use -- developed

Yugoslavia

Temperature (ºC) from	23
Temperature (ºC) to	51
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for bathing and swimming. Average flow rate is 4.3 kg/s; annual energy use is 13.26 TJ/yr. Sand rock, 4520 mg/kg dissolved solids, measured reservoir temperature is 51ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Vrdnik***
Location	45º00' latitude, 20º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	35
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A

Yugoslavia

Notes	The geothermal resource is used for balneology. Limestone rock, 1040 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Vrnjacka Banja***
Location	43º30' latitude, 21º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	120
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1954 - The greenhouse complex "Rasadnici" (1.2 ha) built; the oldest greenhouse heated by geothermal energy in the country. Greenhouse uses waste water from the "Cvece" greenhouse.
Notes	The geothermal resource is used for greenhouses. Average flow rate is 5 kg/s; annual energy use is 7.25 TJ/yr. Metamorphic rock, 2870 mg/kg dissolved solids, estimated reservoir temperature is 120ºC (Milivojevic and Martinovic, 1995).

Site/Project Name	***Vrnjci***
Location	

Yugoslavia

Status	Preliminary identification/repo
Temperature (ºC) from	35
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	N/A

Site/Project Name	***Vrujci***
Location	
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology at Banja Vrujci.

Yugoslavia

Site/Project Name	***Zvonacka Banja***
Location	43º00' latitude, 22º30' longitude
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	N/A
Notes	The geothermal resource is used for balneology. Limestone rock, 416 mg/kg dissolved solids, estimated reservoir temperature is 60ºC (Milivojevic and Martinovic, 1995).