



Stručno naučna konferencija TOPS

UNIVERSITY OF BELGRADE
FACULTY OF MINING AND GEOLOGY
DEPARTMENT OF HYDROGEOLOGY

 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EAER
State Secretariat for Economic Affairs SECO



GEOTHERMAL DISTRICT HEATING POSSIBILITIES IN SERBIA

POTENTIAL, CURRENT STATE AND PERSPECTIVES

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Head of Center for Renewable water energy resources

LAYOUT

1. GEOTHERMAL ENERGY/DHS/GTE CONTEXT

2. GEOTHERMAL POTENTIAL OF SERBIA

3. REPRESENTATIVE CASE STUDIES

4. CHALLENGES AND OPPORTUNITIES

5. Time for questions



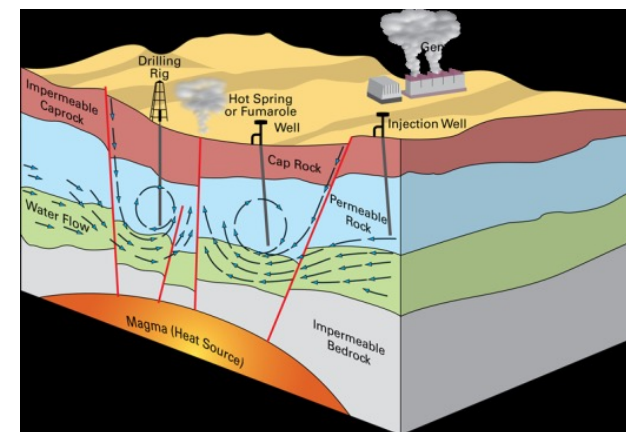
1. GEOTHERMAL ENERGY

GEOTHERMAL DECADE

Geothermal Energy - Heat Beneath Our Feet

WHAT IS THE GEOTHERMAL ENERGY AND ITS ADVANTAGIES?

- RENEWABLE SOURCE OF ENERGY
- CLEAN SOURCE OF ENERGY
- AVAILABLE 24/7
- ENERGY PRODUCTION WITHOUT FLUCTUATION
- HIGHT CAPACITY FACTOR
- ENERGY PRODUCTION FLEXIBILITY
- CASCADE ENERGY PRODUCTION



FOR WHAT CAN WE USE?

- HEATING PURPOSES
- COOLING PURPOSES
- ELECTRICITY PRODUCTION
- COGENERATION

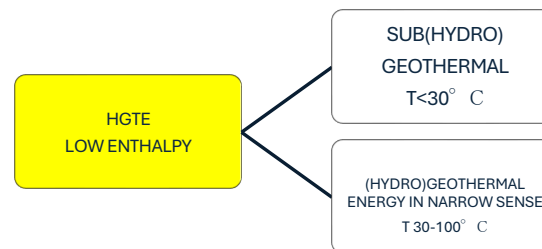
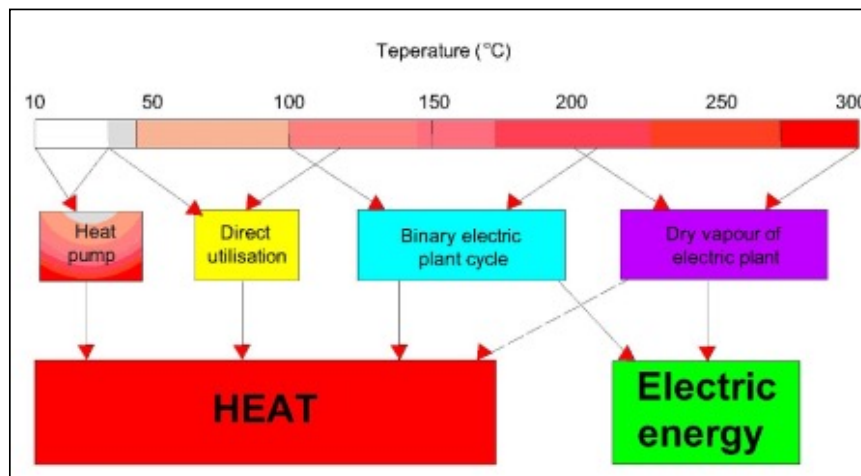
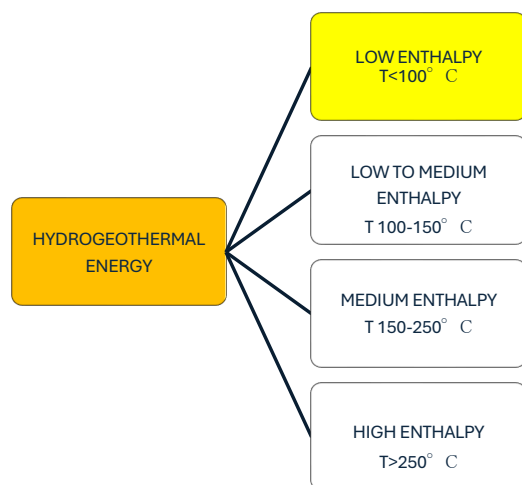
WHERE CAN WE USE?

BUILDING SECTOR
INDUSTRY SECTOR
AGRICULTURE SECTOR
SUPPORTING CRITICAL MINERALS PRODUCTION



1. GEOTHERMAL ENERGY

Geothermal Energy - Heat Beneath Our Feet

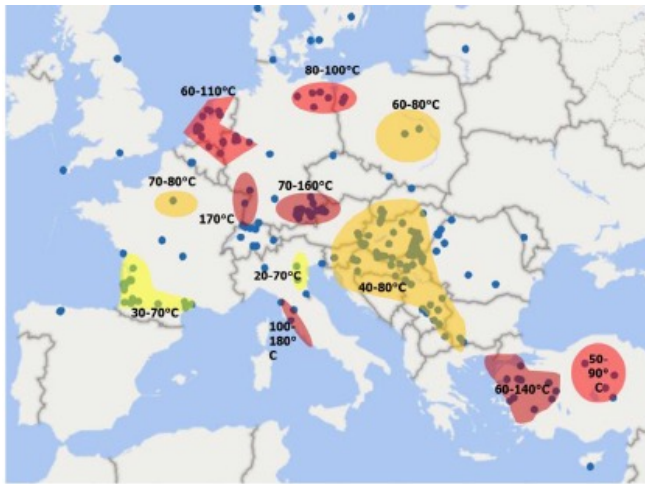


MILENIC, D., et al., 2010: Criteria for use of groundwater as renewable energy source in geothermal heat pump systems for building heating/cooling purposes, *Energy and Buildings*, Vol. 42, pp. 649-657

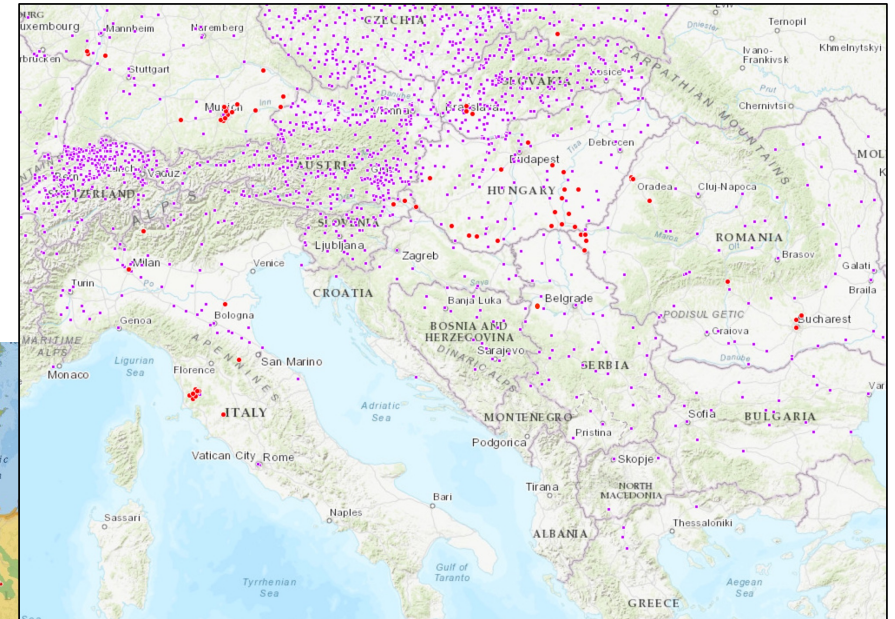
1. GEOTHERMAL ENERGY - GEO DH BASIC SETTINGS 1



GEOTHERMAL POTENTIAL IN EUROPE GEODH – Geothermal District Heating Systems



Map of main geothermal district heating and cooling reservoirs with existing systems and temperatures (EGEC, 2025)



Source: EGEC GEOTHERMAL MARKET REPORT
Key Findings, 2025

Potential territory for geothermal heat production

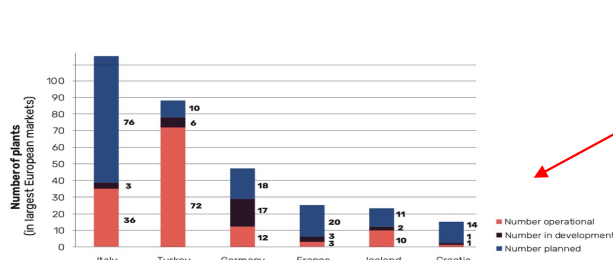
Source: Geothermal DH Potential in Europe, 2014

in Europe

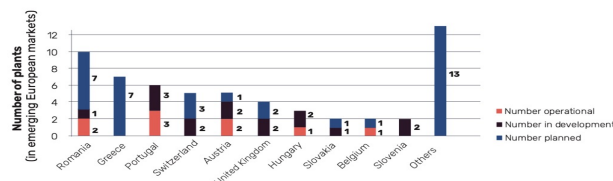
TOPS 2026

02-03. jun 2026. Zlatibor, Hotel Palisad

1. GEOTHERMAL ENERGY - CURRENT STATE: AN OVERVIEW



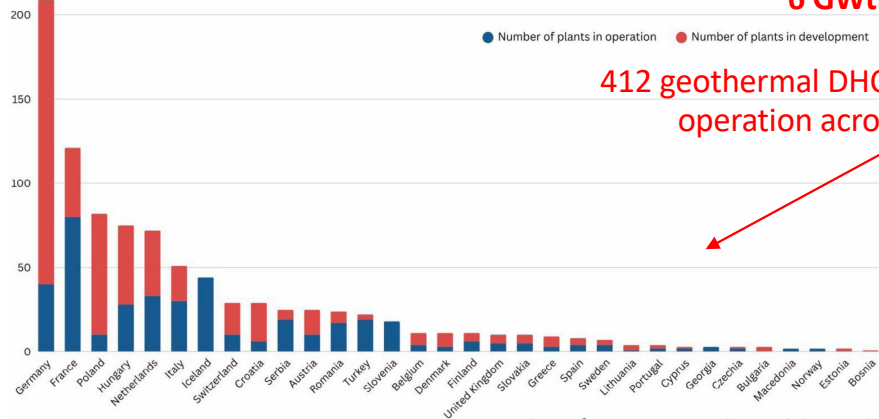
Geothermal power generation capacity in Europe
3.5 GW_e



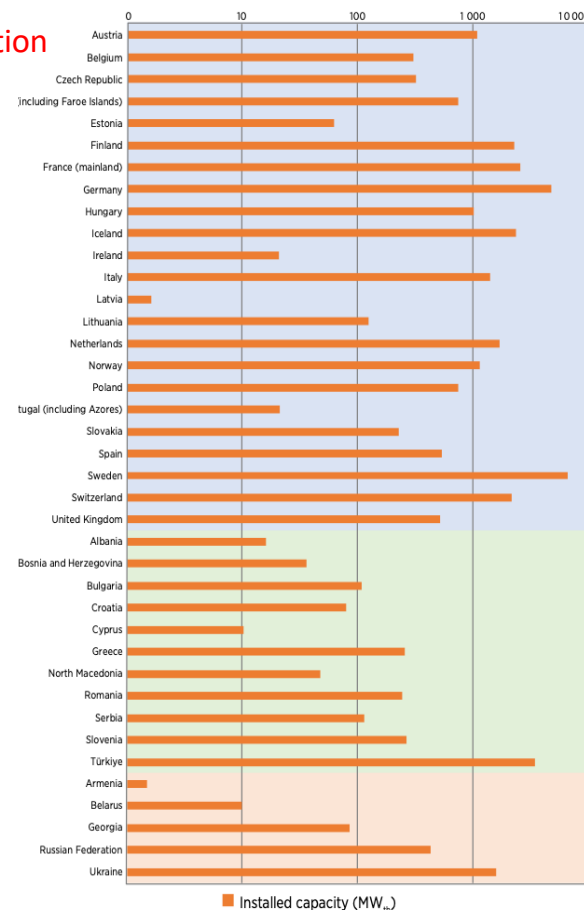
Number of geothermal power plants: installed, planned and under investigation (EGEC, 2023)

Across Europe installed:
Geothermal district heating/cooling
6 GW_{th}

412 geothermal DHC plants were in operation across Europe



Number of emerging geothermal district heating and cooling operating and in development (EGEC, 2025)



Global geothermal power generation capacity
16,355 MW

Global geothermal heating/cooling capacity
107,700 MW

Think Geoenergy, 2023

(Lund and Toth, 2021)

Geothermal Heat Pumps (GHPs)
2.3 million units

1. GEOTHERMAL ENERGY - CURRENT STATE IN SERBIA: AN OVERVIEW

GEOTHERMAL POWER

- No electricity production from geothermal energy yet

HEATING/COOLING

- Space heating ≈200 MW
- (4.000 geothermal systems in use) (direct use +GHP+BHTE)

GEOTHERMAL DISTRICT HEATING

- 1 system – 2.1 MW

OTHER USE

- Balneological purposes ≈60 MW
- Agriculture sector ≈20 MW

GEOTHERMAL OBJECTS IN SERBIA TO DATE — ESTIMATION IN BUILDING SECTOR

- GROUNDWATER AS A SOURCE

- Installed systems: approx. 3.000
- Installed capacities: approx. 40MW

- GROUND SOURCE

- Installed systems: approx. 1.000
- Installed geoprobes: approx. 4.000
- Installed capacities: approx. 10MW

- **TOTAL INSTALLED SYSTEMS: approx. 4.000**

- **TOTAL INSTALLED CAPACITIES: approx. 50MW**



The total estimated capacity of existing geothermal wells in Serbia (2000-2016) is 190 MWth, out of which 80 MW this in northern Serbia - Vojvodina (Panonian basin).

The total quantities of thermal water in Vojvodina is 350 l/s (50-60 C)

WHAT ABOUT GEOTHERMAL POTENTIAL?

2.

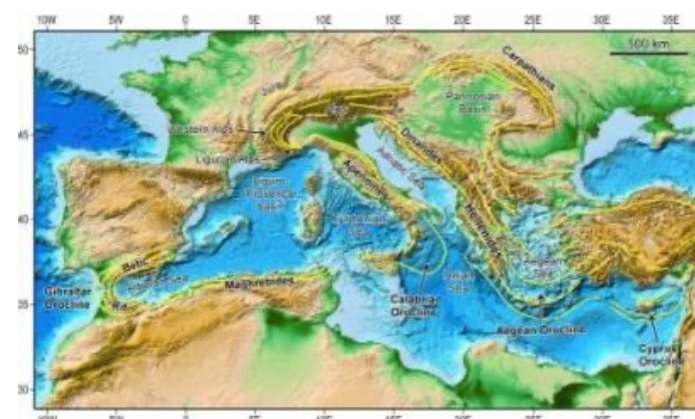
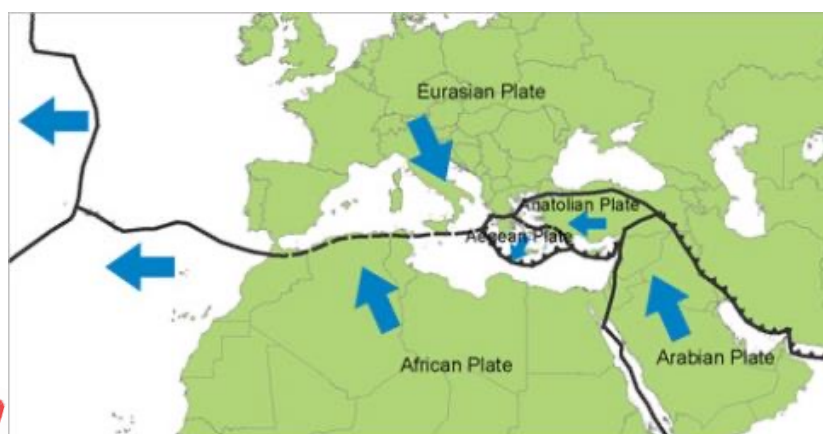
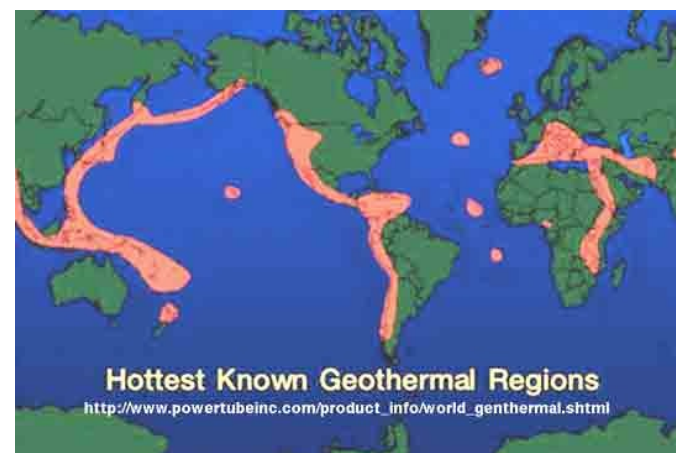
GEOHERMAL RESOURCES POTENTIAL OF SERBIA



2. GEOTHERMAL POTENTIAL OF SERBIA

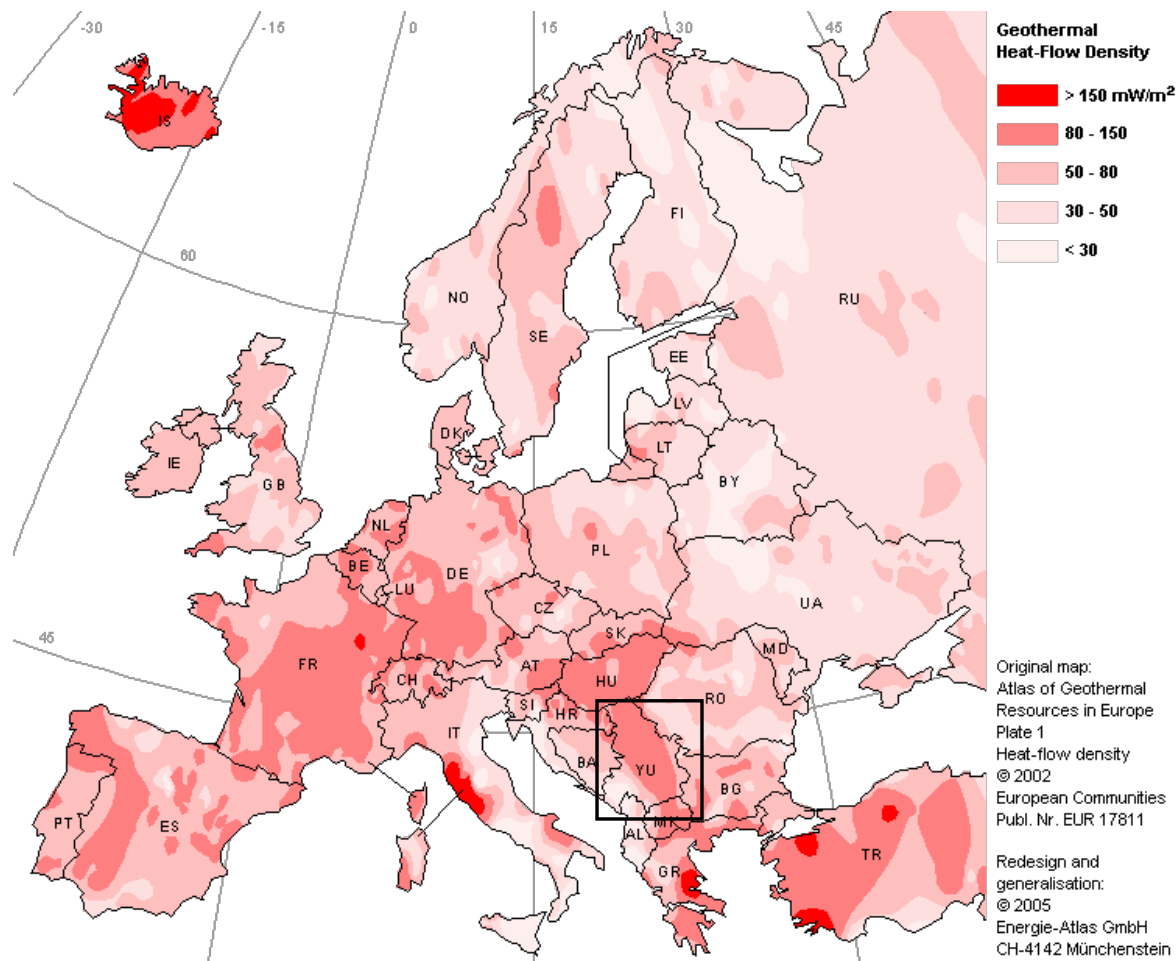


GEOTHERMAL POSITION



2. GEOTHERMAL POTENTIAL OF SERBIA

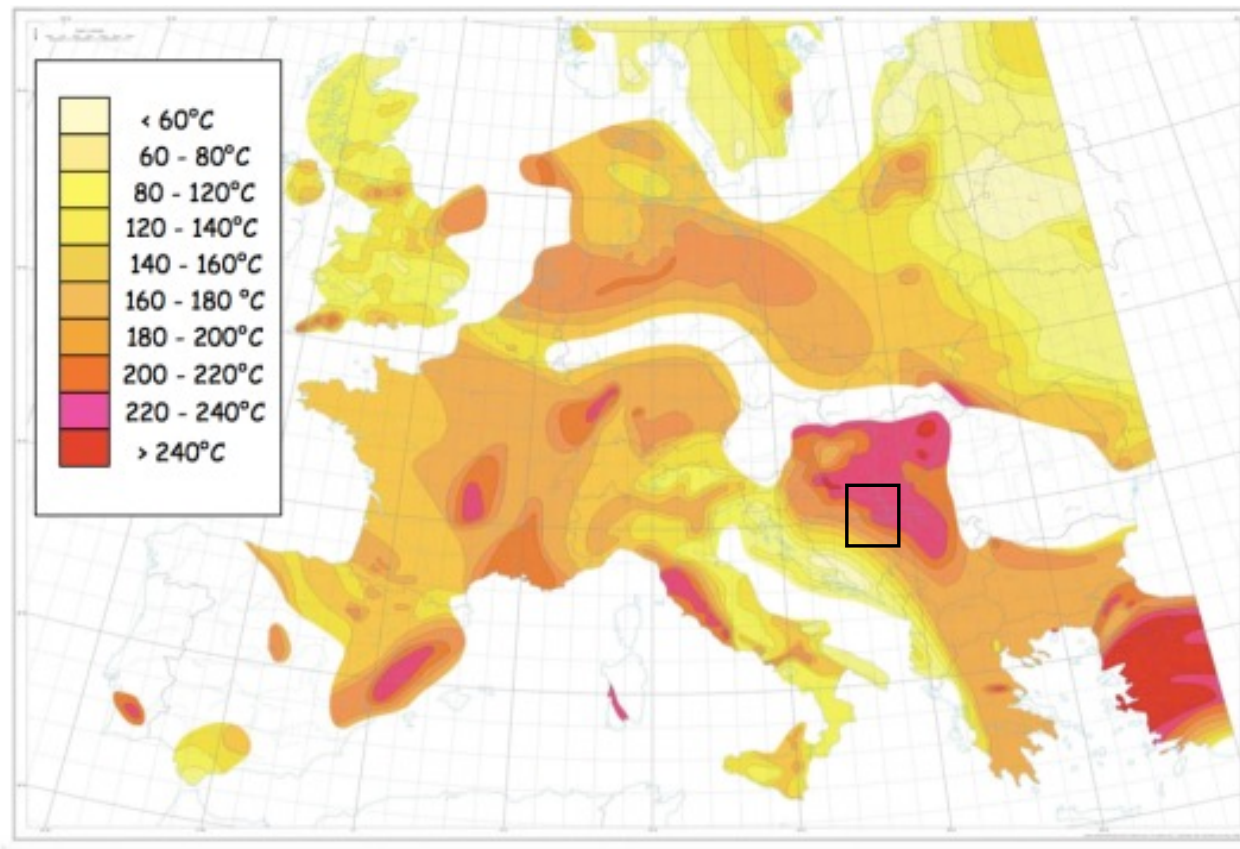
GEOTHERMAL POSITION 2



2. GEOTHERMAL POTENTIAL OF SERBIA TEMPERATURE

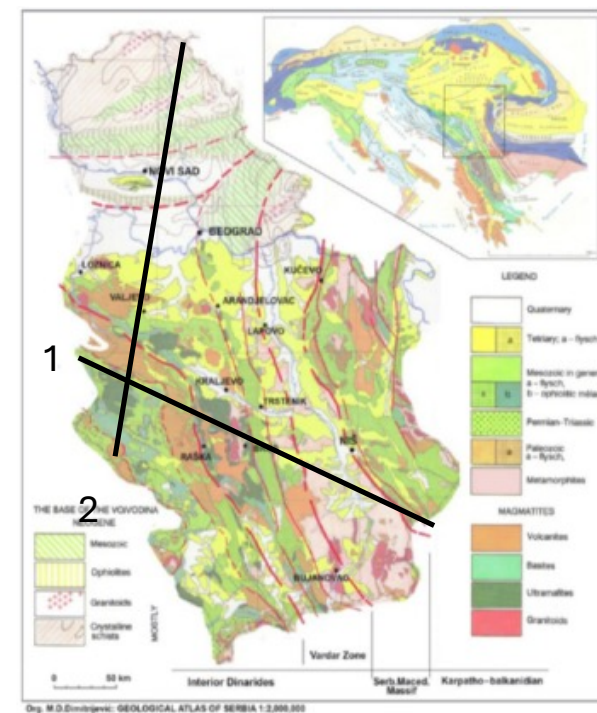
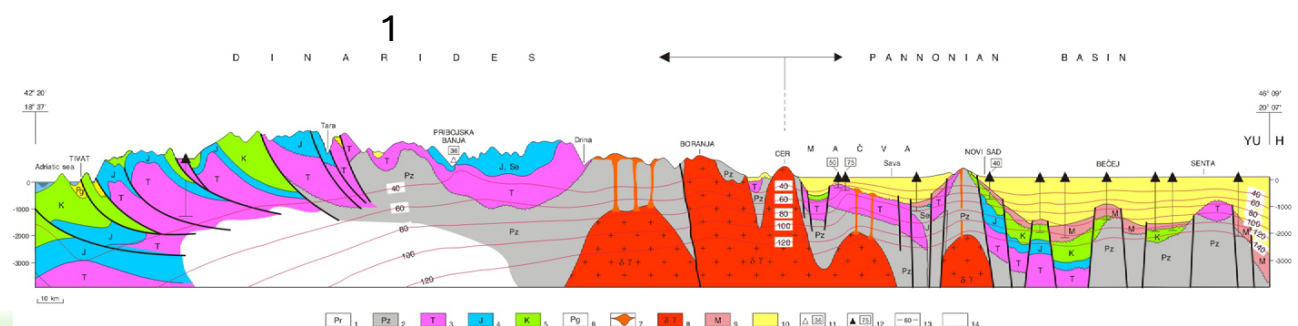
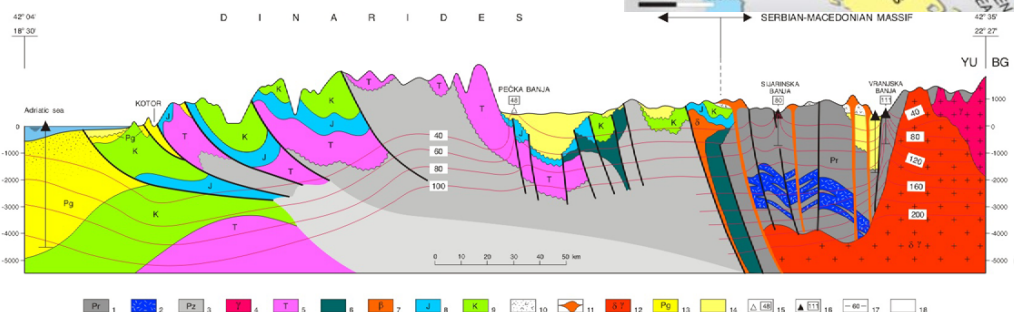
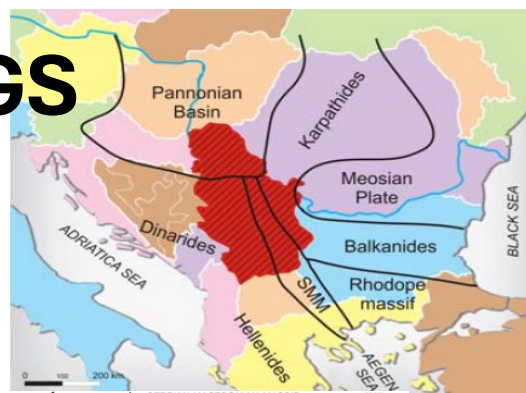


Map of the temperatures extrapolated at 5 km depth



2. GEOTHERMAL POTENTIAL OF SERBIA

GEOLOGICAL SETTINGS



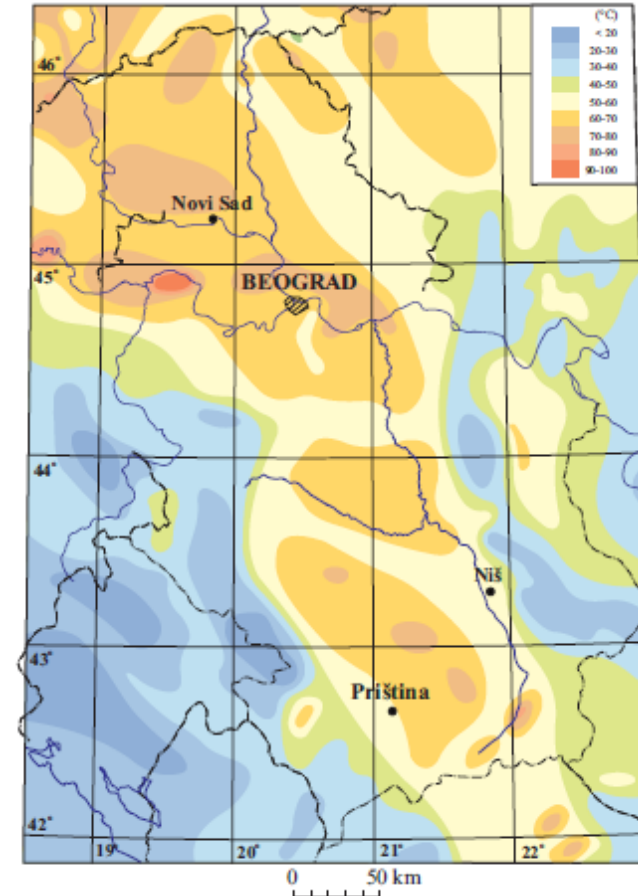
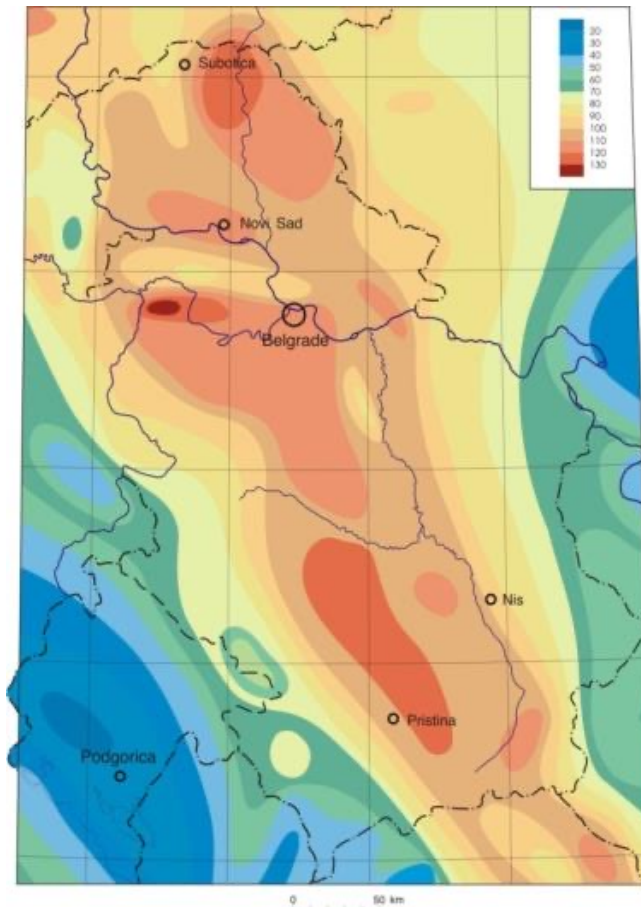
2. GEOTHERMAL POTENTIAL OF SERBIA

GEOTHERMAL SETTINGS



Heat-flow density map

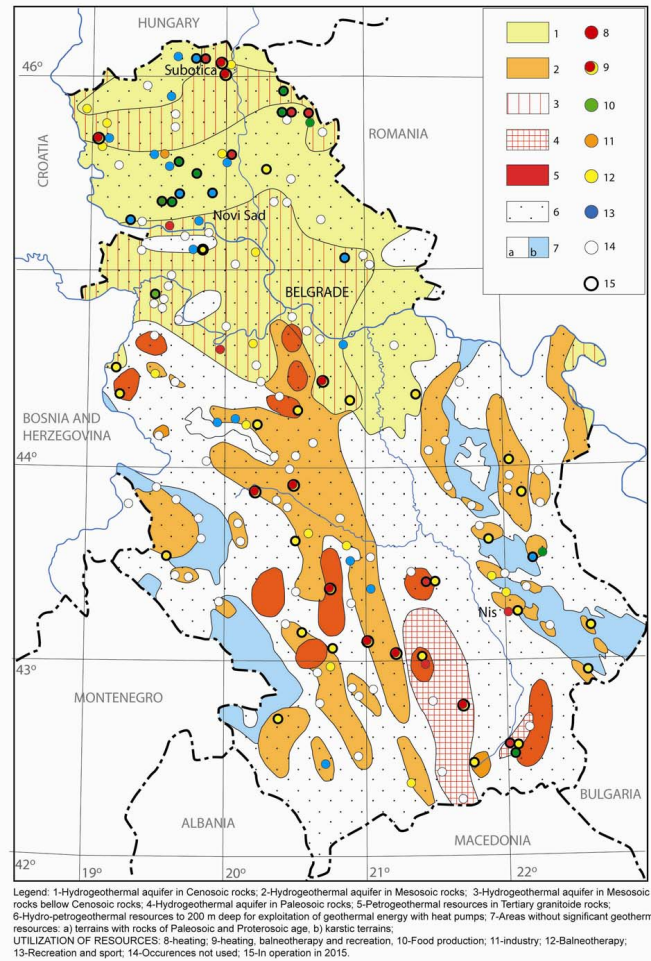
Temperature Map at 1 km depth



3 main zones

2. GEOTHERMAL POTENTIAL OF SERBIA

POTENTIAL PROVINCES 1 – NEOGENE MAGMATISM



RED AREAS!!!

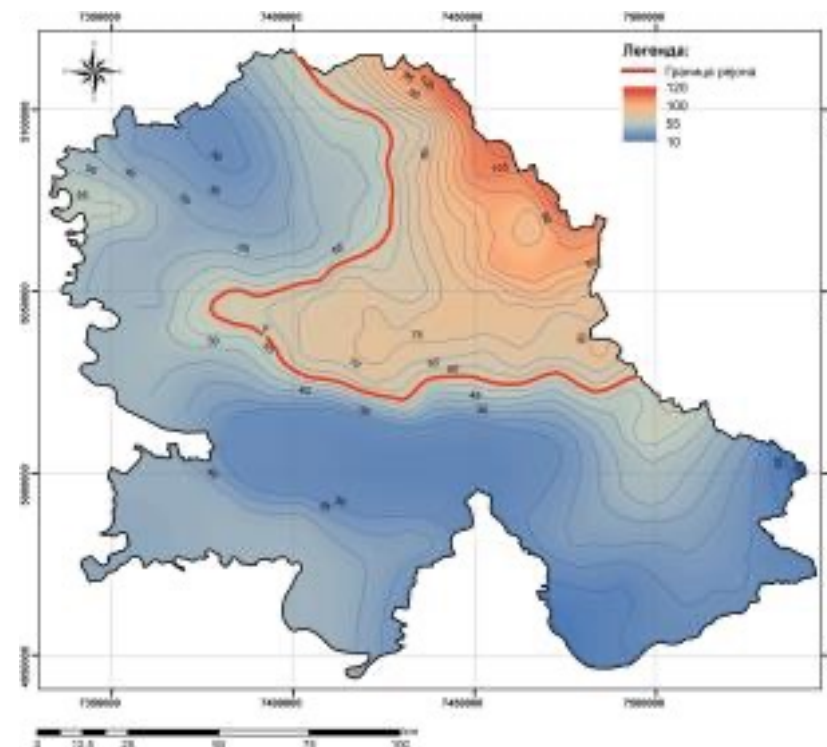
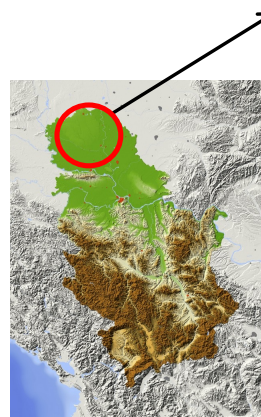
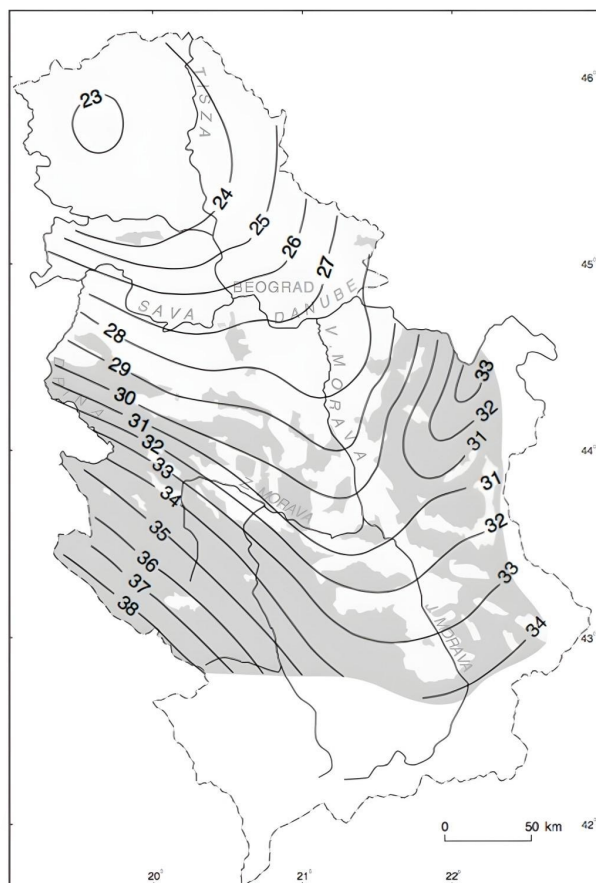
TEMPERATURES: UP TO 110°C

**OVER 100 NATURAL OCCURENCES
WITH TEMPERATURE OVER 20°C**



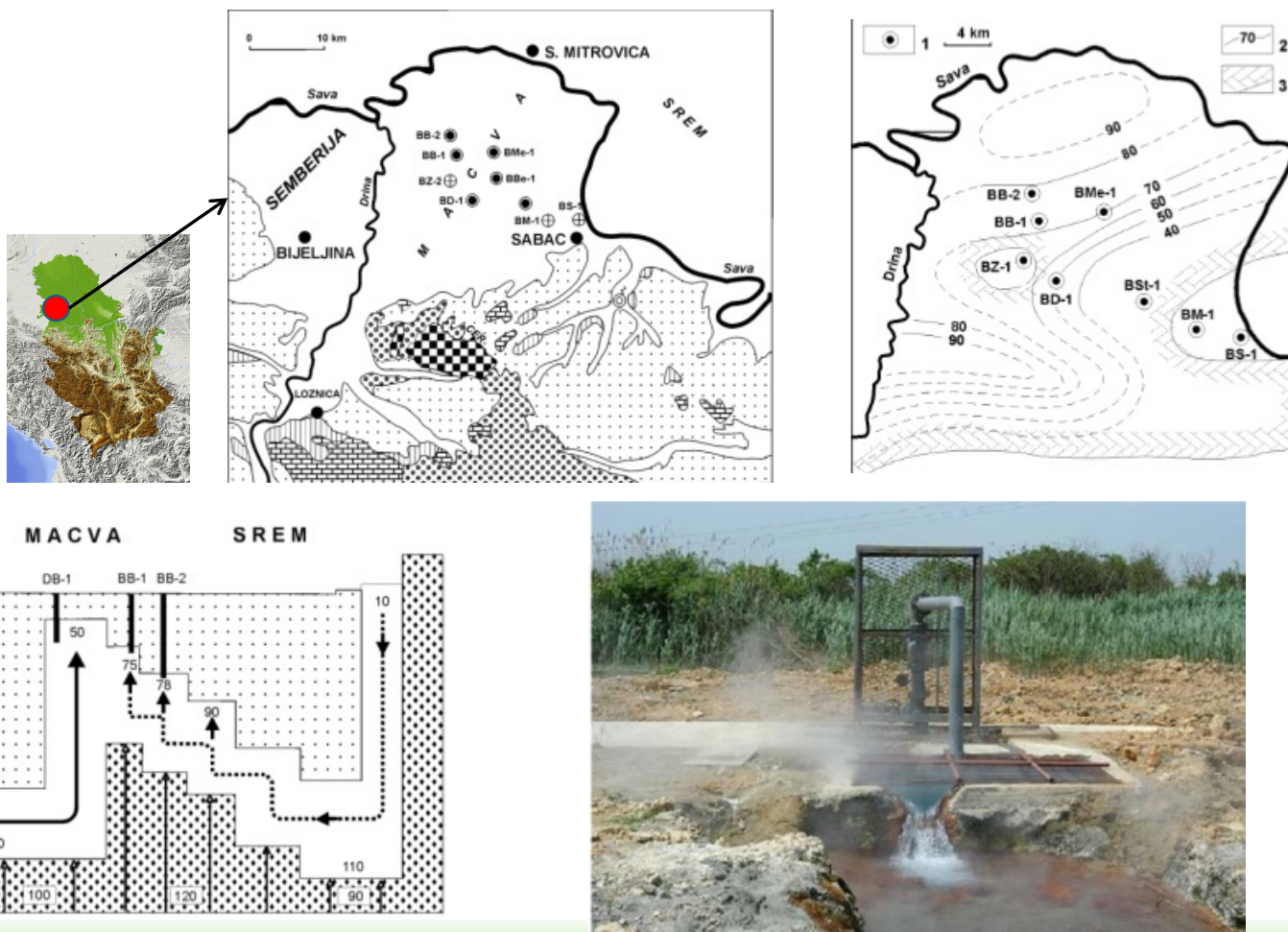
2. GEOTHERMAL POTENTIAL OF SERBIA

POTENTIAL PROVINCES 2 – PANONIAN BASIN



2. GEOTHERMAL POTENTIAL OF SERBIA

POTENTIAL PROVINCES 3 – MACVA REGION



2. GEOTHERMAL POTENTIAL OF SERBIA

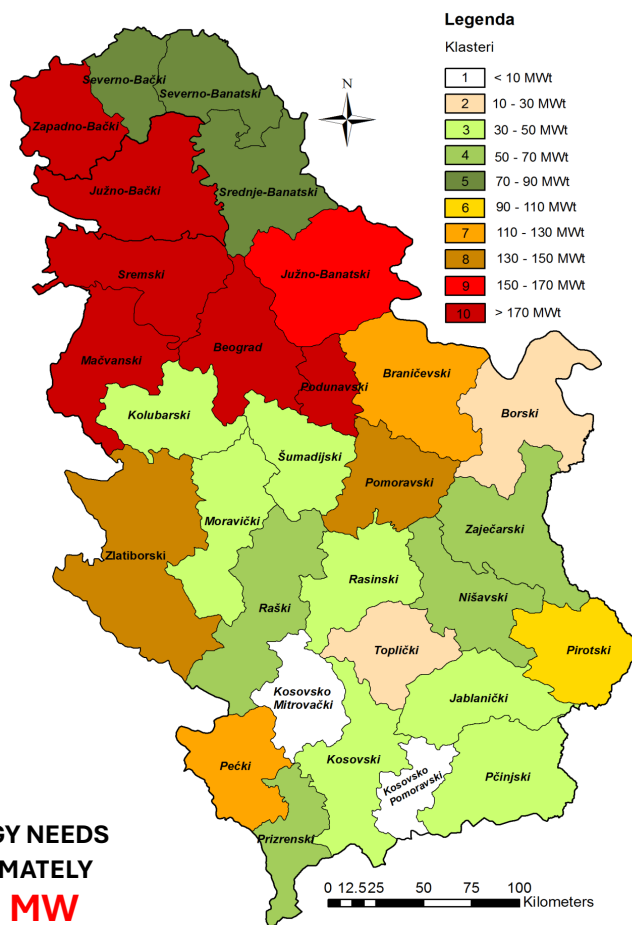
GEOTHERMAL DEEP WEELS/GEOTHERMAL OCCURRENCES



Br.	Okrug	Lokalitet	Tip	T	Q	Termalna snaga
		Banja		°C	l/s	MWt
1.	Severno-banatski	Kanjiža	bunar	27-63	19	2.38
2.	Zapadno-bački	Junaković	bunar	46-49	20	2.26
3.	Severno-banatski	Bečej	bunar	65	25	4.71
4.	Sremski	Vrdnik	bunar	33	45	2.45
5.	Beograd	Selters	bunar	32-60	20	2.09
6.	Podunavski	Palanački kiseljak	bunar	50	4	0.50
7.	Kolubarski	Ljig	bunar	33	4	0.22
8.	Mačvanski	Koviljača	bunar	30	20	0.84
9.	Šumadijski	Bukovička	bunar	31-34	3	0.18
10.	Moravički	Gornja Trepča	izvor i bunar	27-31	21	0.97
11.	Moravički	Ovčar	izvor i bunar	36-38	50	3.77
12.	Pčinjski	Vrnjačka	izvor i bunar	36	6	0.40
13.	Raški	Mataruška	bunar	25-51	72	6.02
14.	Raški	Bogutovac	bunar	25	10	0.21
15.	Rasinski	Ribarska	izvor i bunar	44	37	3.72
16.	Borski	Brestovac	izvor i bunar	20-41	7	0.44
17.	Zaječarski	Garnizgrad	izvor i bunar	30-42	10	0.63
18.	Zaječarski	Soko	izvor i bunar	22-46	25	2.09
19.	Zlatiborski	Priboj	izvor	36	70	4.69
20.	Toplički	Lukovska	bunar	64-67	12	2.31
21.	Nišavski	Niška	izvor	37	35	2.49
22.	Raški	Jošanička	izvor	50-77	19	3.58
23.	Tolički	Kuršumlijska	bunar	64	16	2.95
24.	Tolički	Prohom	bunar	31	10	0.46
25.	Jablanički	Stijarska	izvor i bunar	61-76	36	7.53
26.	Raški	Novopazarska	izvor	51	5	0.65
27.	Pirotski	Zvonačka	izvor	28	5	0.17
28.	Pčinjski	Vranjska	izvor i bunar	63-95	80	19.08
29.	Pčinjski	Bujanovac	bunar	42	7	0.64
UKUPNO					693	78.40

2. GEOTHERMAL POTENTIAL OF SERBIA

SUBGEOTHERMAL POTENTIAL - SERBIA

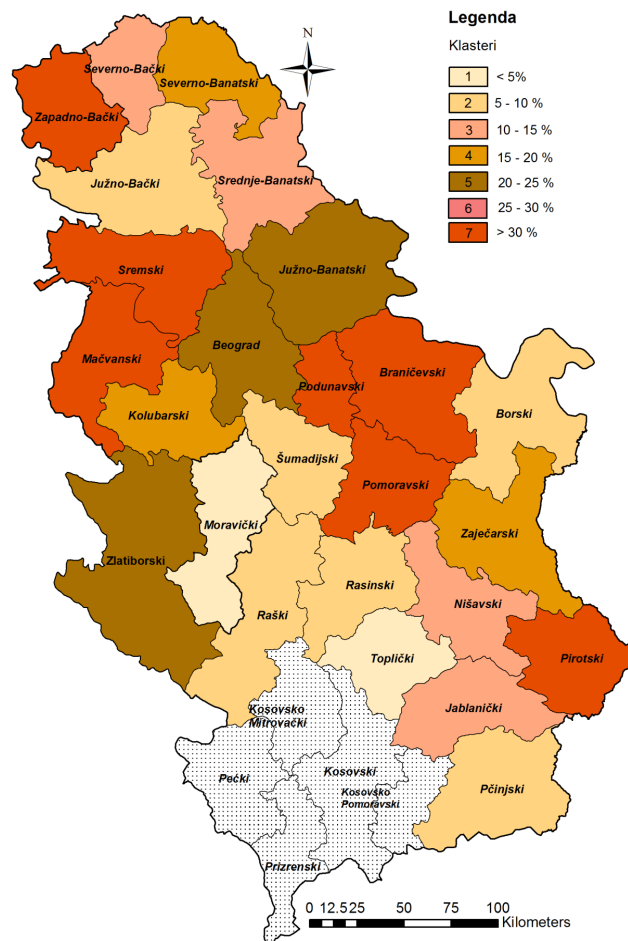


TOTAL ENERGY NEEDS
IS APPROXIMATELY
20,000 MW

Region	Districts	Potential thermal power	Effective thermal power	Total thermal power
		1	2	3=1+2
		MW _t	MW _t	MW _t
Beograd	Urban area	1.200		1.200
	City area	1.100		1.100
Vojvodina	Severno bački	37.4	45.9	83.3
	Zapadno bački	28.5	157.1	185.6
	Južno bački	65.6	139.0	204.6
	Severno banatski	36.3	46.2	82.5
	Srednje banatski	29.9	57.3	87.2
	Južno banatski	41.8	126.4	168.2
Šumadija i Zapadna Srbija	Sremski	37.3	250.6	287.9
	Mačvanski	37.1	233.7	270.8
	Kolubarski	9.2	32.8	42.0
	Zlatiborski	15.7	120.9	136.6
	Moravički	11.2	21.7	32.9
	Šumadijski	12.2	28.9	41.1
Južna i Istočna Srbija	Rasinski	11.1	20.7	31.8
	Raški	10.5	57.4	67.9
	Pomoravski	29.7	106.7	136.4
	Podunavski	21.5	160.1	181.6
	Braničevski	20.1	98.0	118.1
	Borski	7.2	18.7	25.9
Kosovo	Zaječarski	28.0	32.6	60.6
	Nišavski	24.4	45.3	69.7
	Pirotski	27.2	76.3	103.5
	Toplički	3.7	10.1	13.8
	Jablanički	17.8	28.6	46.4
	Pčinjski	14.7	22.9	37.6
Kosovo	Kosovsko-Mitrovački	3.6	4.2	7.8
	Kosovski	8.9	26.0	34.9
	Pečki	28.2	92.7	120.9
	Kosovsko-pomoravski	1.8	1.8	3.6
TOTAL	Prizrenski	10.5	43.4	53.9
		631.1	4.414	5.045

2. GEOTHERMAL POTENTIAL OF SERBIA

SUBGEOTHERMAL POTENTIAL 2 - SERBIA



Region	District	Total thermal power	Estimated spec. heat load of residential units	Surface of residential units there can be heated to SGTE	% of total residential units surface in district
		1 MW _t	2 W/m ²	3=1/2 m ²	4 %
Beograd	GUP	1.200	135	8.888.888	24
Vojvodina	Severno bački	83.3	148	562.837	14
	Zapadno bački	185.6	109	1.702.752	52
	Južno bački	204.6	158	1.294.936	9
	Severno banatski	82.5	124	665.322	20
	Srednje banatski	87.2	179	487.150	15
	Južno banatski	168.2	137	1.227.737	23
	Sremski	287.9	150	1.919.333	46
Sumadija i Zapadna Srbija	Mačvanski	270.8	128	2.115.626	82
	Kolubarski	42.0	127	330.708	15
	Zlatiborski	136.6	168	813.095	21
	Moravički	32.9	170	140.588	4
	Šumadijski	41.1	154	266.883	5
	Rasinski	31.8	138	230.434	9
	Raški	67.9	203	334.482	8
	Pomoravski	136.4	115	1.186.086	35
	Podunavski	181.6	161	1.127.950	36
	Braničevski	118.1	137	862.043	33
Južna i Istočna Srbija	Borski	25.9	179	144.692	6
	Zaječarski	60.6	151	401.324	18
	Nišavski	69.7	147	474.149	12
	Pirotski	103.5	154	672.077	40
	Toplički	13.8	354	38.983	3
	Jablanički	46.4	178	260.674	11
	Pčinjski	37.6	274	137.226	6
Kosovo i Metohija	Kosovsko-Mitrovački	7.8	/		
	Kosovski	34.9			
	Pečki	120.9			
	Kosovsko-pomoravski	3.6			
	Prizrenski	53.9			

3.

REPRESENTATIVE CASE STUDIES



- Case study 1.

BOGATIC MUNICIPALITY

(finished)

- Case study 2.

CITY OF BELGRADE

(in progress)

- Case study 3.

CITY OF VALJEVO

(in progress)

- OTHER CITIES OF DHS INTEREST



Case study 1.

BOGATIC MUNICIPALITY

(finished)



3. REPRESENTATIVE CASE STUDIES

FIRST PUBLIC DISTRICT HEATING SYSTEM IN SERBIA

PHASE 1 (FINISHED):

Total area covered: 15.000 m²

Total capacity used: 2-3MW

Groundwater temperature: 75°C

PHASE 2:

Total area covered: 5.000 m²

Total capacity used: 1MW

Groundwater temperature: 75°C

PHASE 3:

Total area covered: 100.000 m²

Total capacity used: 10MW

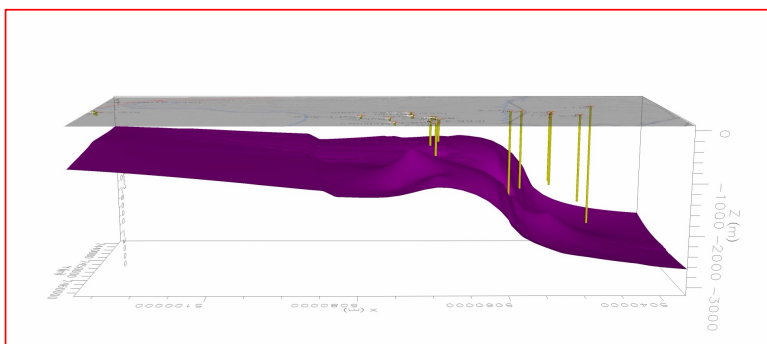
Groundwater temperature: 80°C

MUNICIPALITY OF BOGATIC

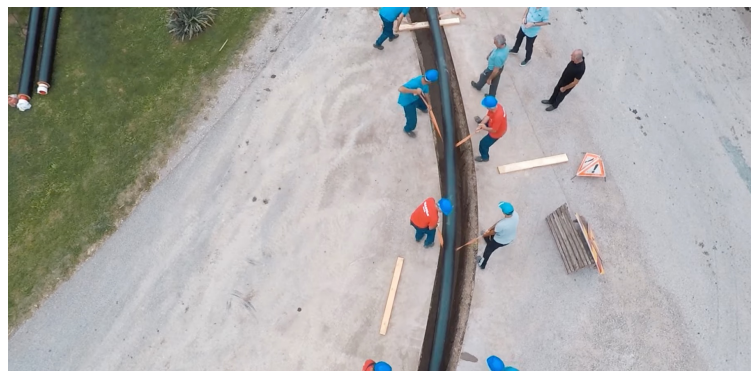
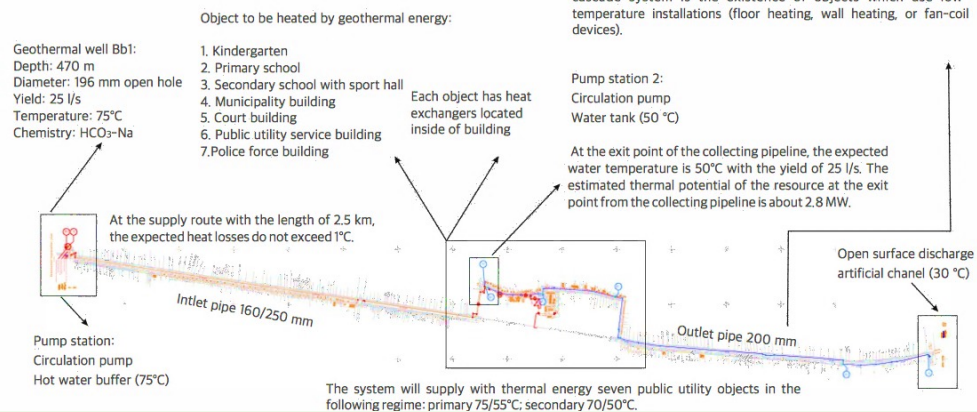


3. REPRESENTATIVE CASE STUDIES

BOGATIC GEOTHERMAL DISTRICT HEATING SYSTEM



The district heating system is projected in the variant of bivalence as indirect, open geothermal system with cascade use. The installed thermal power of the district geothermal heating system is 2.1 MW.



3. REPRESENTATIVE CASE STUDIES



BOGATIC PROJECT SAVINGS AND ROI

OPEX UNTIL 2019 i.e. GTE DISTRICT HEATING SYSTEM:
160.000EUR/YEAR

OPEX AFTER 2019 i.e. GTE DISTRICT HEATING SYSTEM:
2.000EUR/YEAR

CAPEX / ROI:
1.000.000 EUR 8YRS.

CO₂ SAVINGS:
1.300 TONNES/YEAR



Case study 2.

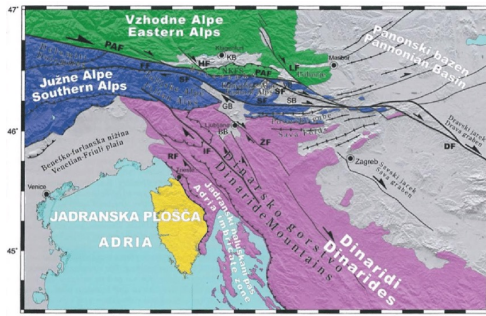
CAPITAL CITY OF BELGRADE

(in progress)



3. REPRESENTATIVE CASE STUDIES

BELGRADE HEATING PLANTS GTE POTENTIAL 1



STRUCTURAL
CROSS
SECTION
MODEL



3. REPRESENTATIVE CASE STUDIES

BELGRADE HEATING PLANTS GTE POTENTIAL 2



3. REPRESENTATIVE CASE STUDIES

BELGRADE HEATING PLANTS

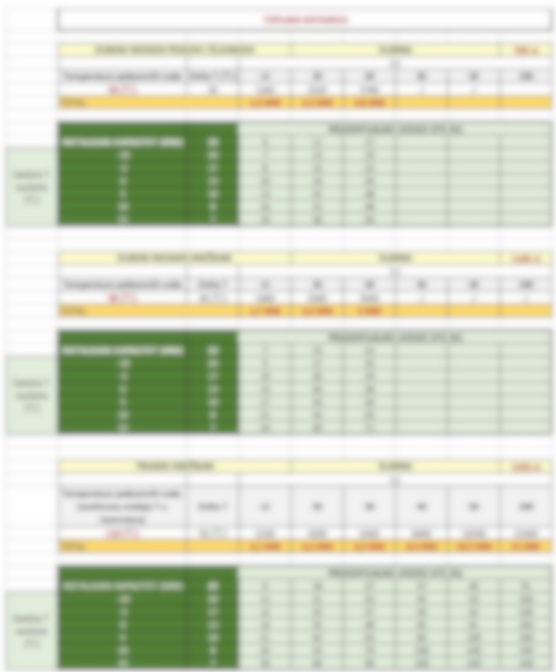
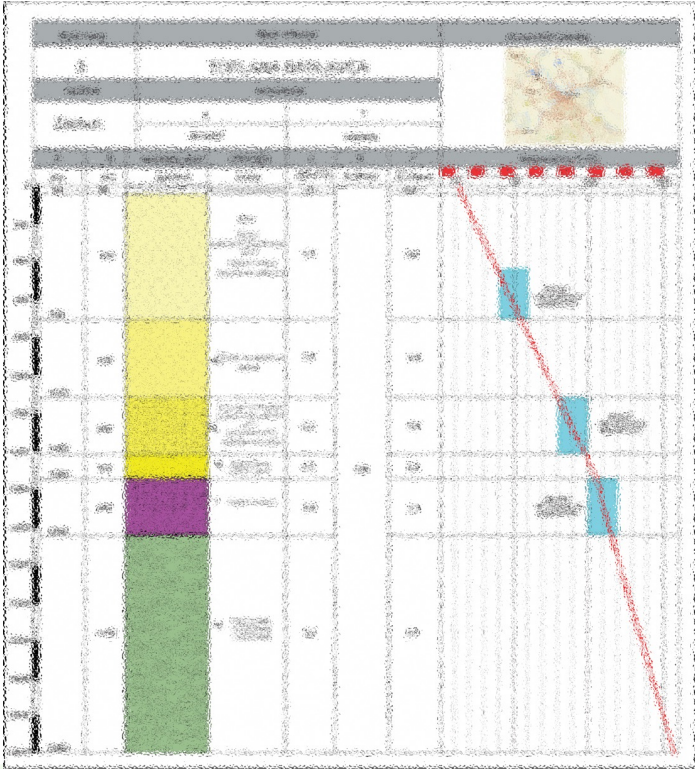
GTE POTENTIAL 3



3. REPRESENTATIVE CASE STUDIES

BELGRADE HEATING PLANTS
GTE POTENTIAL 4

BATAJNICA HEATING PLANT



3. REPRESENTATIVE CASE STUDIES



BELGRADE HEATING PLANTS

GTE POTENTIAL 5

Supstitution potential/one stage system



BATAJNICA HEATING PLANT

Supstitution potential/two stage system

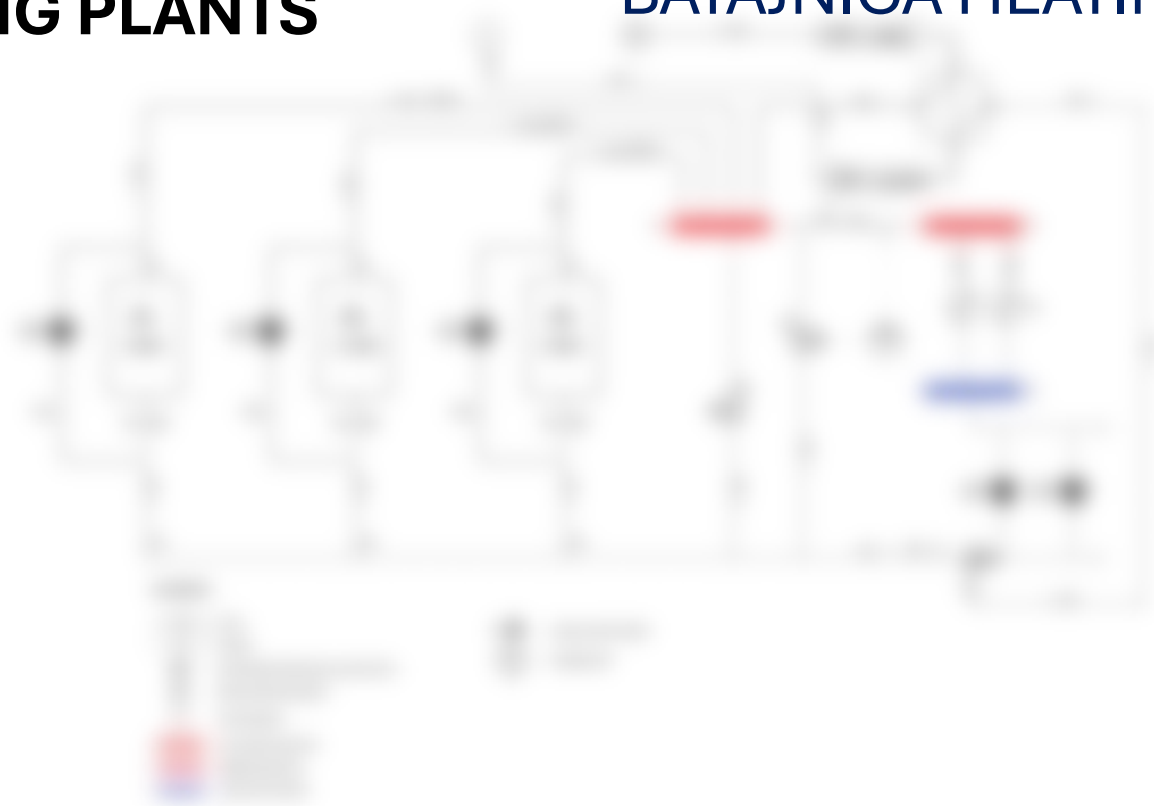


3. REPRESENTATIVE CASE STUDIES



BELGRADE HEATING PLANTS GTE POTENTIAL 6

BATAJNICA HEATING PLANT



Schematic of a proposed solution for integrating geothermal energy into an existing district heating system – ONE STAGE

3. REPRESENTATIVE CASE STUDIES



BELGRADE HEATING PLANTS GTE POTENTIAL 7

BATAJNICA HEATING PLANT



Schematic of a proposed solution for integrating geothermal energy into an existing district heating system – TWO STAGE

3. REPRESENTATIVE CASE STUDIES

BATAJNICA HEATING PLANT PROJECT SAVINGS AND ROI (ESTIMATIONS)

CURRENT OPEX (FOSSIL FUELL) DISTRICT HEATING SYSTEM:
1.200.000EUR/YEAR

ESTIMATED OPEX - GTE DISTRICT HEATING SYSTEM:
60.000EUR/YEAR

CAPEX / ROI:
5.000.000 EUR 5YRS.

CO₂ SAVINGS:
6.700 TONNES/YEAR



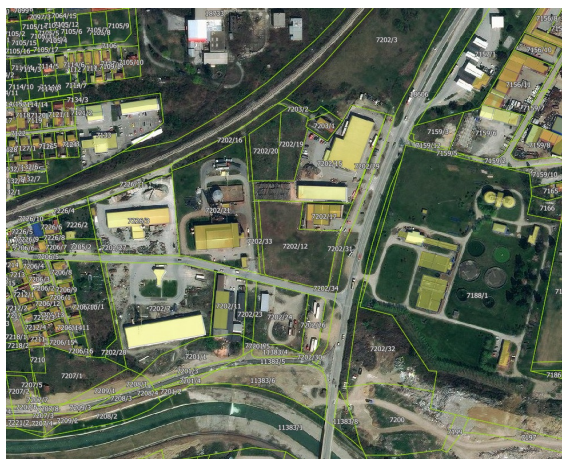
Case study 3.

CITY OF VALJEVO

(in progress)



3. REPRESENTATIVE CASE STUDIES



Location of the complex of TO Valjevo

GTE INTEGRATION INTO THE DHS OF VALJEVO

DHS Valjevo technical info.

Number of households (city)	Number of households (other)	Households connected to the DHS	Commercial space connected to DHS	Heating area of the household (m ²)
24.745	11.302	5.197	478	279.985
Heating area office space (m ²)	Percentage of household connection (%)	Total heating area (m ²)	The number of days in the heating period	Average T in the heating period in 2024 (C)
162.237	21	442.222	192	7.9

The heating plant is designed to operate at 130 °C/75 °C on the primary side and 90 °C/70 °C on the secondary side. The average return-water temperature is 45 °C.

Fuel	Consumption
Natural gas	449.051 MWh/year

STUDY AIM

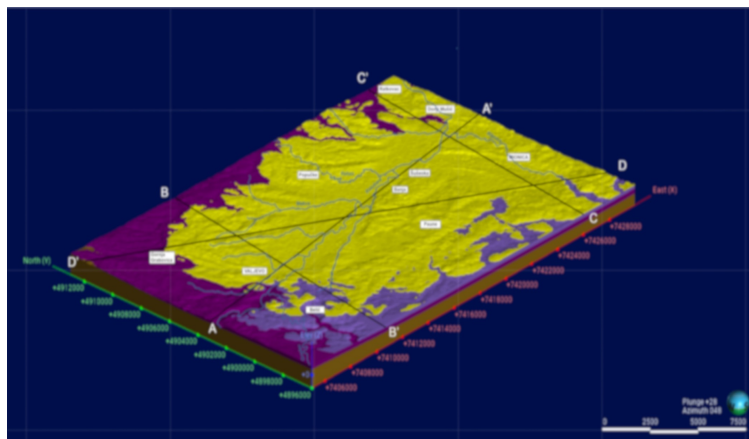
- To Develop conceptual solutions for the exploitation of hydrogeothermal resources
- To develop optimal exploitation system from a technological perspective
- To Estimate and analyze CAPEX/OPEX + RoI, in line with the proposed solutions.



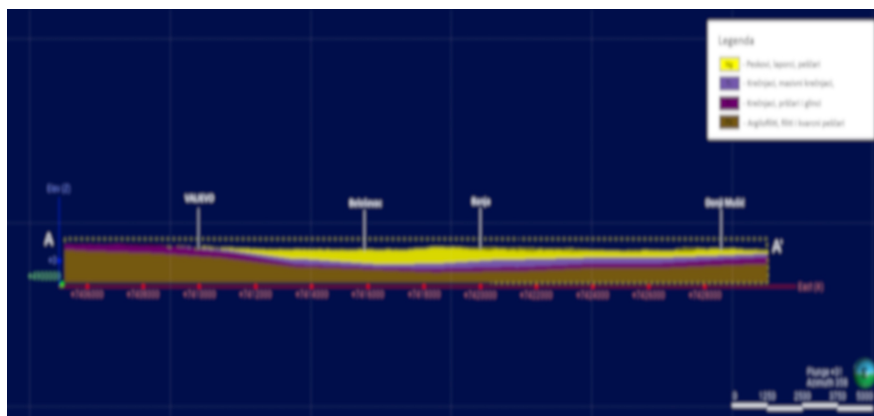
IN ASSOCIATION WITH:



3. REPRESENTATIVE CASE STUDIES



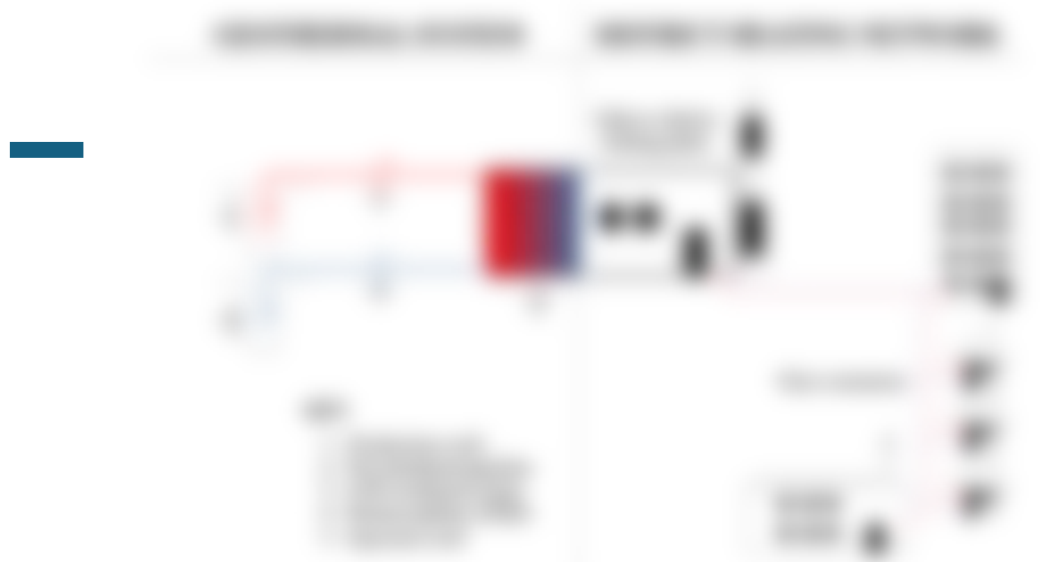
Three-dimensional view of the geological structure of the terrain



Cross-section of terrain A-A'

TOPS 2026

Connection of geothermal energy to the district heating system is planned on the return pipeline DN500, just before the boiler room, where the water from the distribution heating pipeline enters for heating.



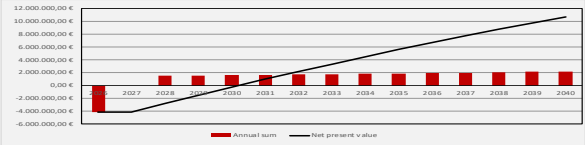
A comparative analysis of potential zones indicates their similar characteristics:

- The development of the geothermal reservoir is expected within the carbonate rocks of Triassic age
- The depth of Triassic carbonates is relatively uniform, i.e. it increases in the central parts of the observed terrain (east of the city of Valjevo and south of the Kolubara stream)
- The forecast average maximum amount of geothermal water per well is around 30 l/s
- forecast maximum temperatures of geothermal waters do not exceed 60 °C.

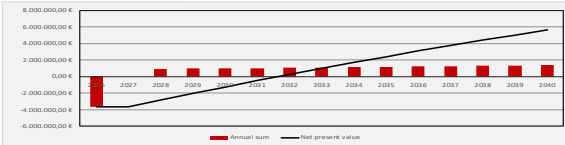
3. REPRESENTATIVE CASE STUDIES - GTE INTEGRATION INTO THE DHS OF VALJEVO



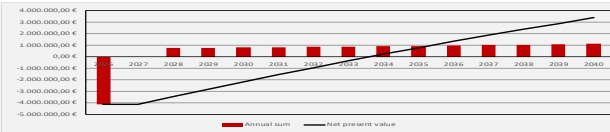
Net Energy Efficiency (kWh/m²)	2027	2028	2029	2030	2031	2032
Net present value (NPV) (€)	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Internal rate of return (IRR) (%)	10.00	10.00	10.00	10.00	10.00	10.00
The period of return in years	10	10	10	10	10	10
Investment	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Net present value (NPV) (€)	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Internal rate of return (IRR) (%)	10.00	10.00	10.00	10.00	10.00	10.00
The period of return in years	10	10	10	10	10	10
Investment	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00



Net Energy Efficiency (kWh/m²)	2027	2028	2029	2030	2031	2032
Net present value (NPV) (€)	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Internal rate of return (IRR) (%)	10.00	10.00	10.00	10.00	10.00	10.00
The period of return in years	10	10	10	10	10	10
Investment	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Net present value (NPV) (€)	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Internal rate of return (IRR) (%)	10.00	10.00	10.00	10.00	10.00	10.00
The period of return in years	10	10	10	10	10	10
Investment	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00



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The period of return in years	10	10	10	10	10	10
Investment	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Net present value (NPV) (€)	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00
Internal rate of return (IRR) (%)	10.00	10.00	10.00	10.00	10.00	10.00
The period of return in years	10	10	10	10	10	10
Investment	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00	100,000,000.00



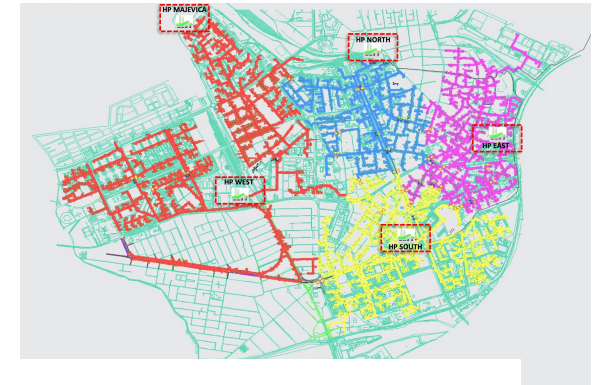
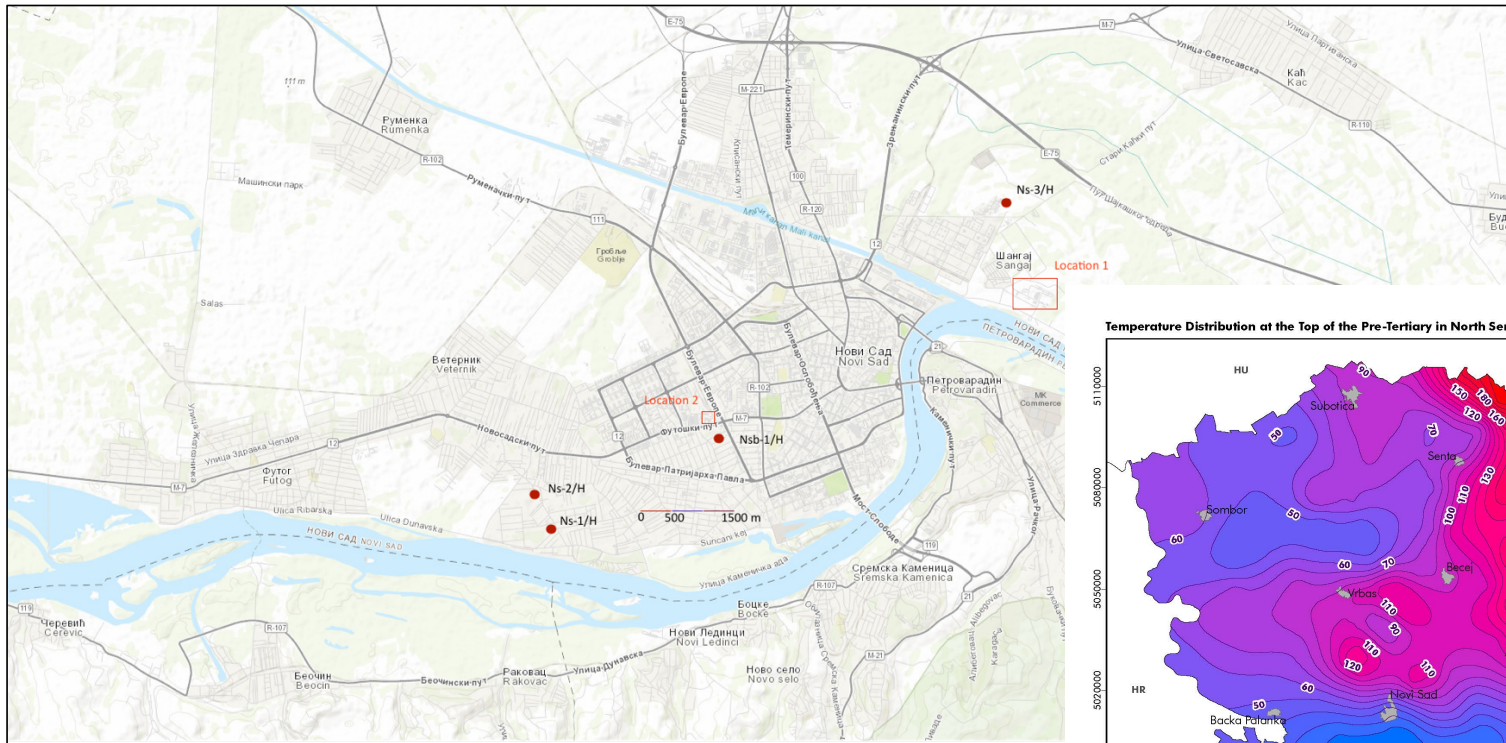
Case study 4.

CITY OF NOVI SAD

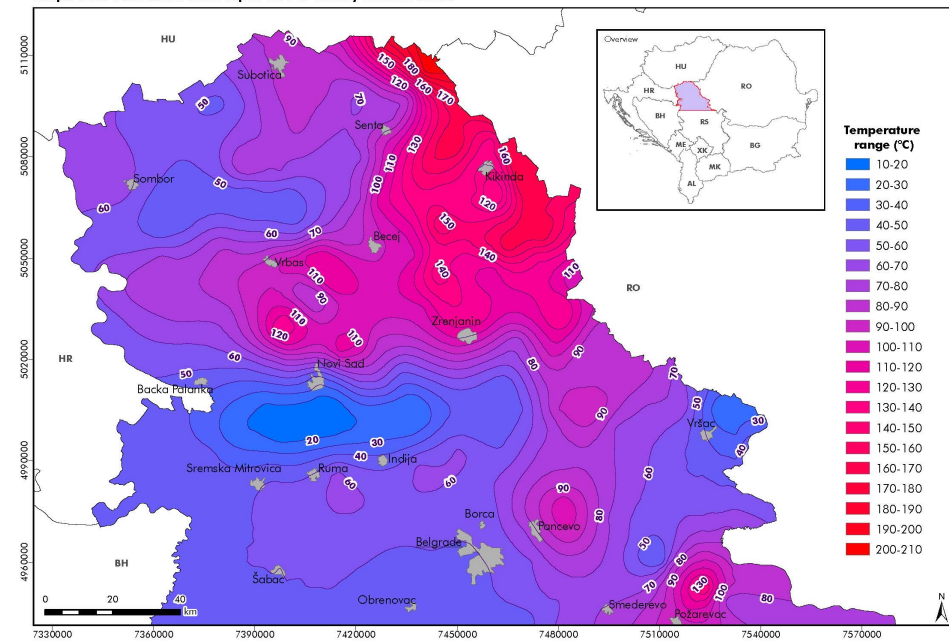
(in progress)



TO NOVI SAD

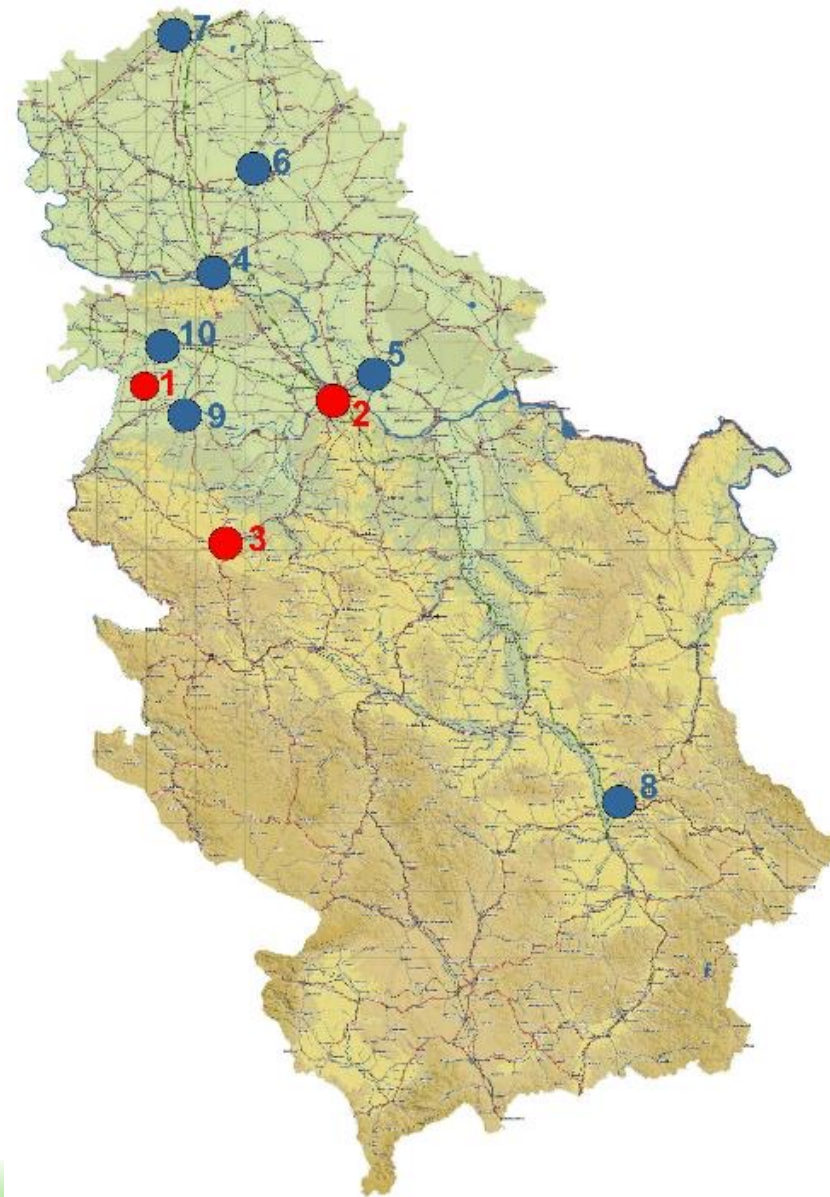


Temperature Distribution at the Top of the Pre-Tertiary in North Serbia



OTHER CITIES OF INTEREST

- 5. Pancevo
- 6. Becej
- 7. Subotica
- 8. Nis
- 9. Sabac
- 10. Sremska Mitrovica



4.

CHALLENGES AND OPPORTUNITIES



4. CHALLENGES AND OPPORTUNITIES

CHALLENGES AND OPPORTUNITIES 1

1. National legislative and incentives

2. Contract forms

- PPP
- PPA
- ESCO

3. Financial Markets

4. Energy diversification

5. Stability instead of Feasibility



4. CHALLENGES AND OPPORTUNITIES

CHALLENGES AND OPPORTUNITIES 2

6. Geological risk of first test drilling

7. Insurance issues

8. Technology issues

9. Environmental issues

10. Labour Force





THANK YOU

UNIVERSITY OF BELGRADE
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DEPARTMENT OF HYDROGEOLOGY

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