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Training on UNFC-2009 geothermal specifications, and case studies in the Central and SE-European region – DARLINGe project examples

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DARLINGe project area and goals

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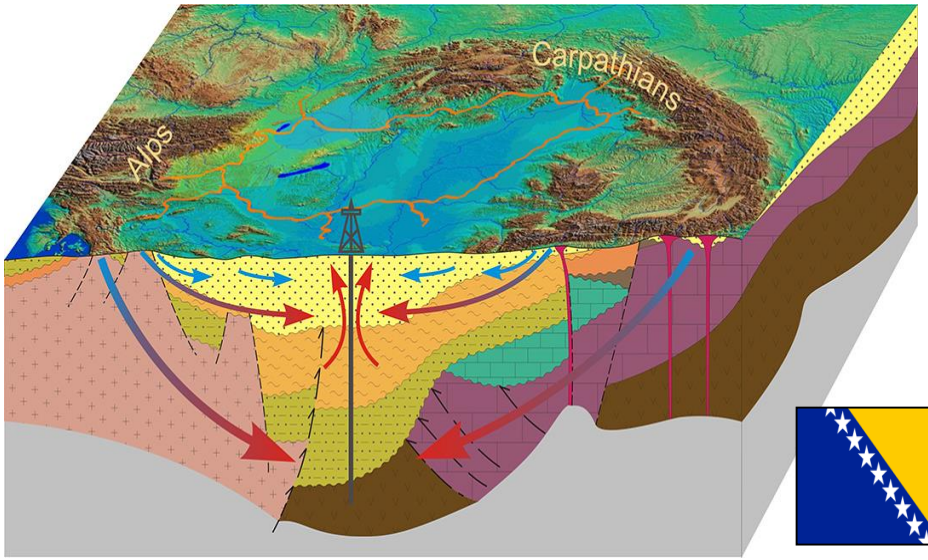
To contribute to energy security and energy efficiency in the Danube Region by enhancing the efficient use of deep and still untapped geothermal resources in the S-ern part of the Pannoninan basin *(a hot sedimentary aquifer in Central Europe)*

Interreg
EUROPEAN UNION
Danube Transnational Programme
DARLINGe



Application of UNFC-2009 in DARLINGe

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UNFC-2009 as a tool for management of transboundary geothermal resources: life-cycle project assessment from exploration to abandonment, measuring the progress

- **Policy formulation – Danube Region Geothermal Strategy**
- **Government – raising awareness on the national assets**
- **Industry – to make optimal investments**

Training of 15 partners from 6 countries (HU, SI, HR, BH, SRB, RO) on the application of the UNFC-2009 geothermal specifications – understand and properly apply the full process for key areas of the Danube Region

1) defining a project - link between a geothermal energy and the product (heat, electricity)

2) estimating the quantities of energy that can be recovered and delivered as 'products' by the given project

3) classifying the quantified geothermal energy resource based on the criteria defined by the E, F and G (sub-)categories

1. Project definition

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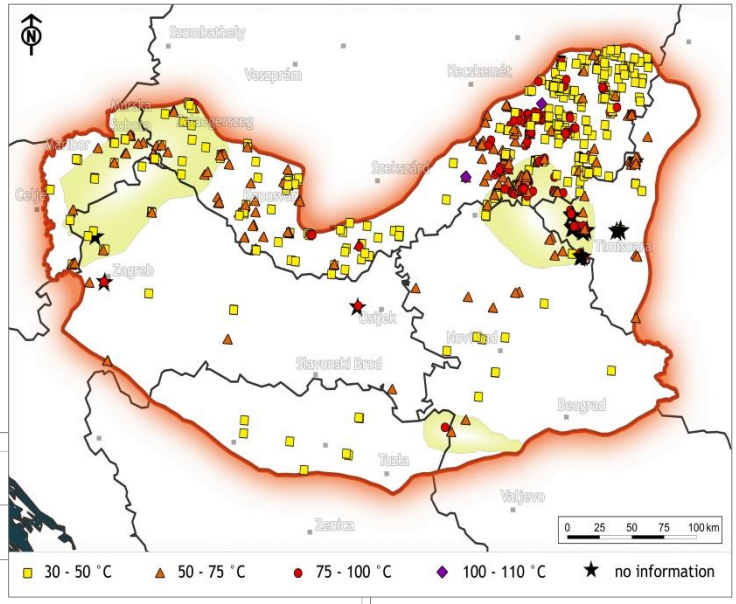
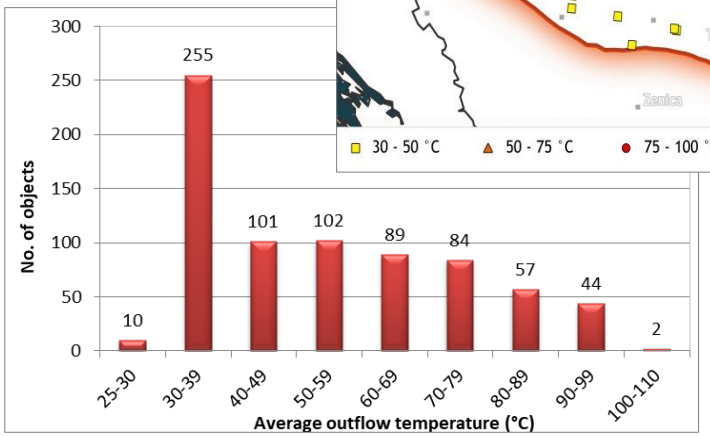
Selection of „projects" to be classified – aim is to cover the full granularity of the „UNFC Cube" (exploration, development *(green-field, brown-field),* expansion, full-operation commercial projects, etc.)

A great number of active thermal water users in the area (767 wells) in terms of:

- **use (balneology, individual and space heating, district heating, agriculture, etc.)**
- **temperature (30-100 ℃)**
- **geothermal reservoir (porous, fractured, karstified)**
- **operational issues**





1. Project definition - Challenges

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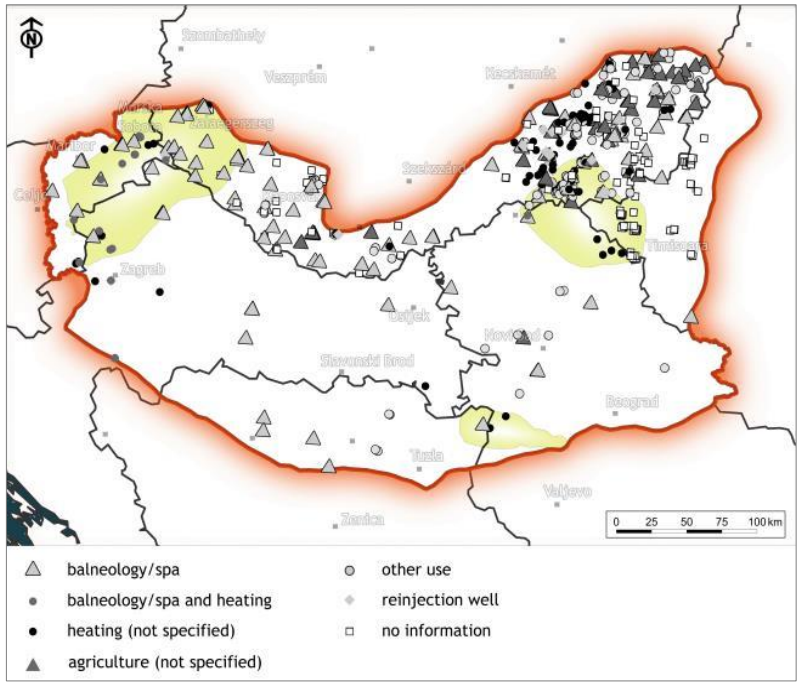
„Geothermal energy products are electricity and heat. Other products such as inorganic materials, gases, or water extracted from te Geothermal Energy source in the same extraction process do not qualify as Geothermal Energy products.” (ECE/ENERGY/GE.3/2016/6 A7)



No of objects	Type of use
155	balneology
130	drinking water
104	heating
70	agriculture (mostly heating)
58	unknown
39	reinjection
36	industrial
11	monitoring

SDG-s / FEW (water-energy nexus): groundwater resources in UNFC-2009?

1. Project definition - 15 case studies from 6 countries

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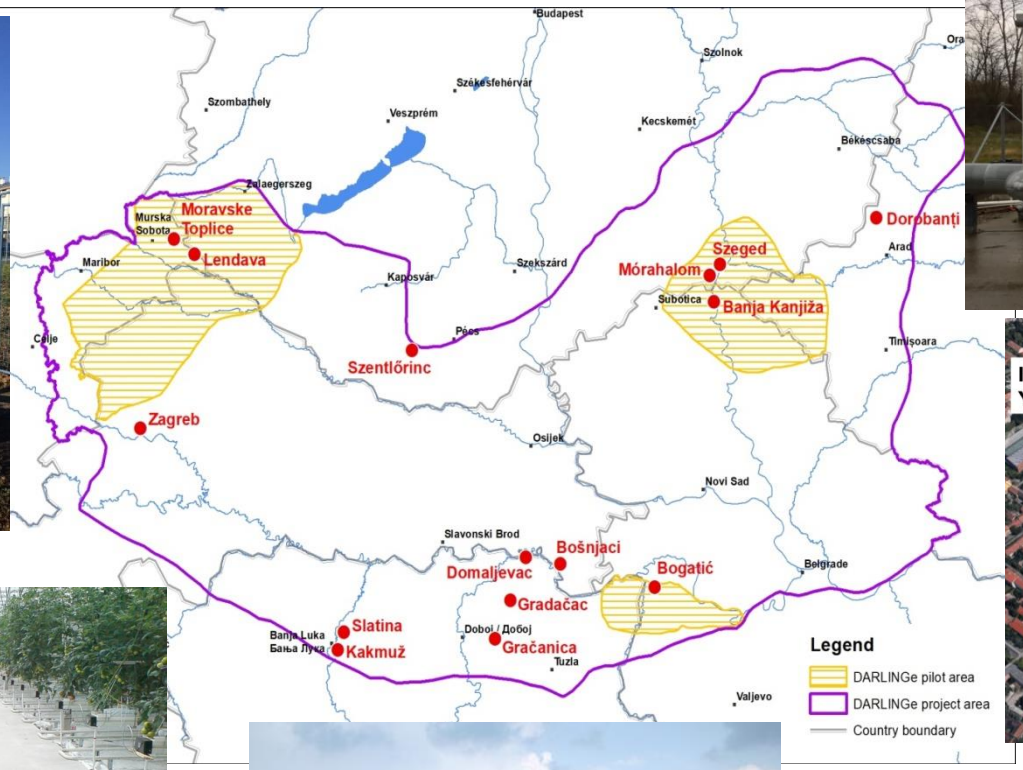

1. Project definition - Challenges

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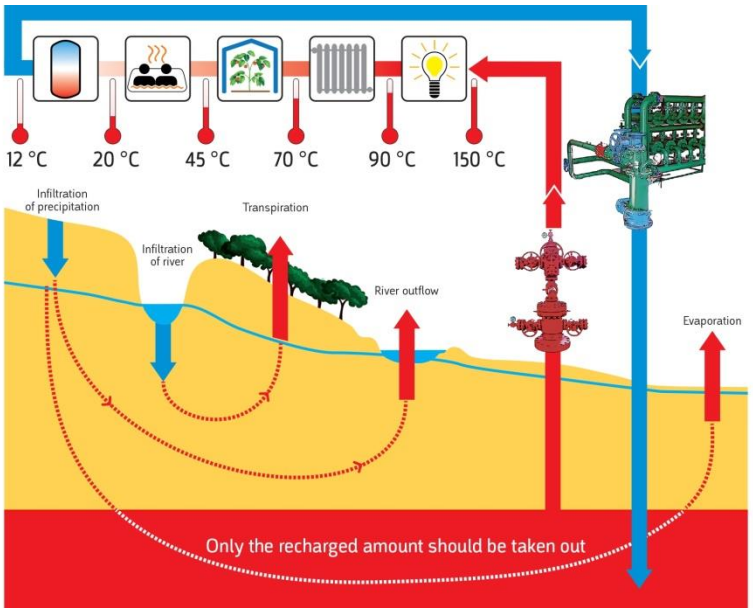

Thermal cascaded systems (users suquentially linked according to decreasing heat demand)

↓

Efficient use to be promoted, several systems in the project area (mostly combo of district/individul space heating + sanitary hot water suply + baleneology) : single vs. aggregated project? Reference points of evaluation? Quantities disclosed together?

2. Resource estimation - Challenges

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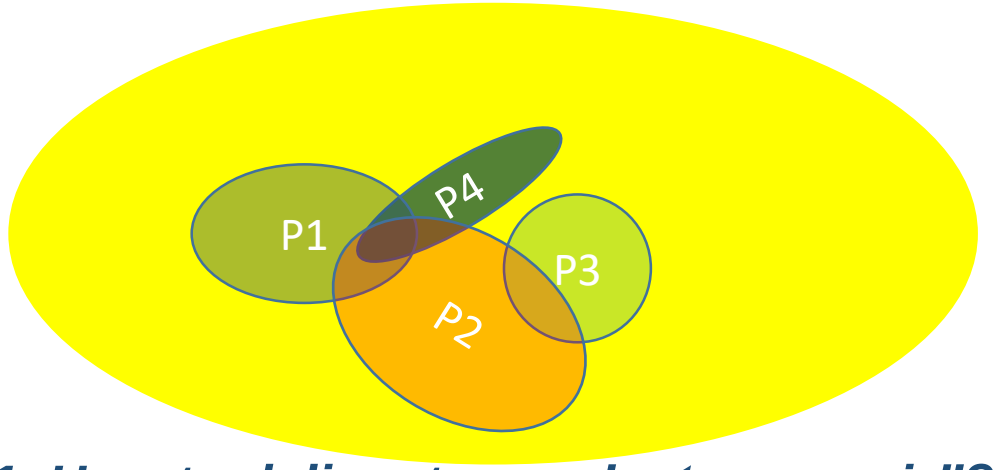
QUANTIFICATION (resource estimation) ≠ QUALIFICATION (UNFC-2009 classification)

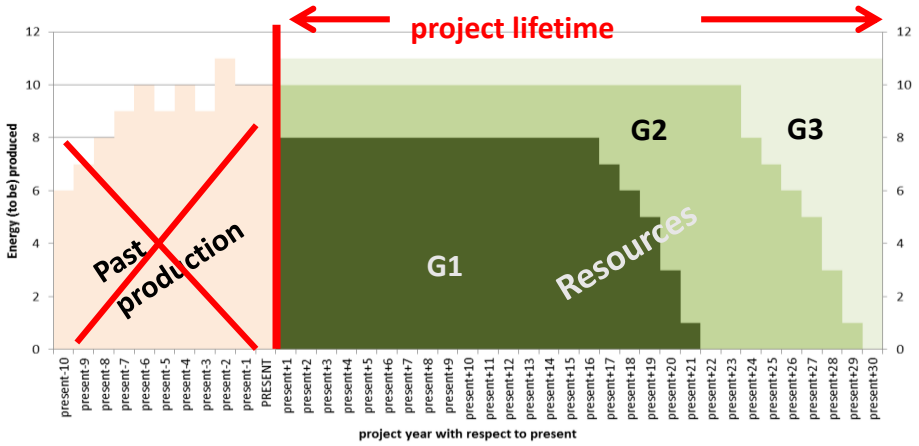
Estimation methods (deterministic / probabilistic):

- **extrapolation of production history**
- **thermodynamic simulation**
- **volumetric heat assessment based on uncertainity of reservoir parameters**



1. How to delineate „project reservoir"? (production zone of wells)

2. Define the effective date of evaluation, forward evaluation



3. Define the reference point (heat exchanger)

3. Classification (E, F, G)

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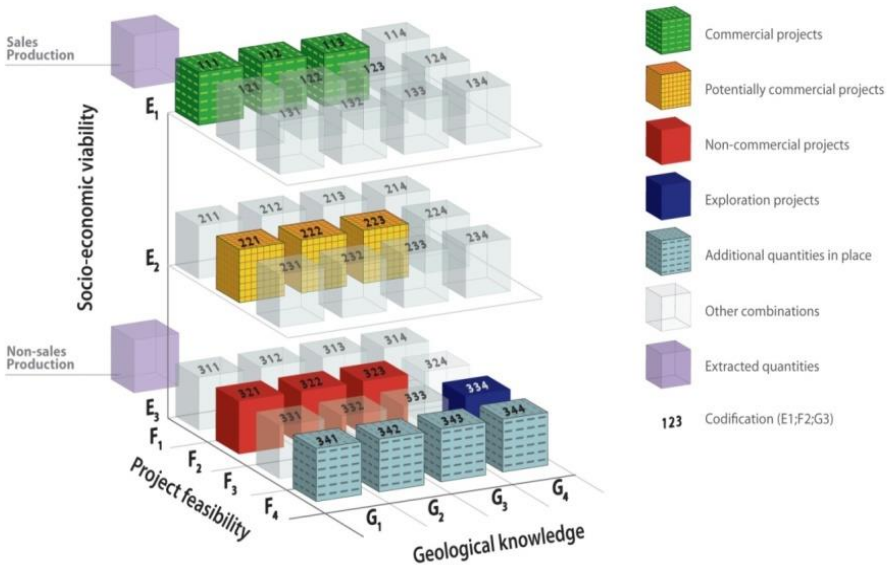
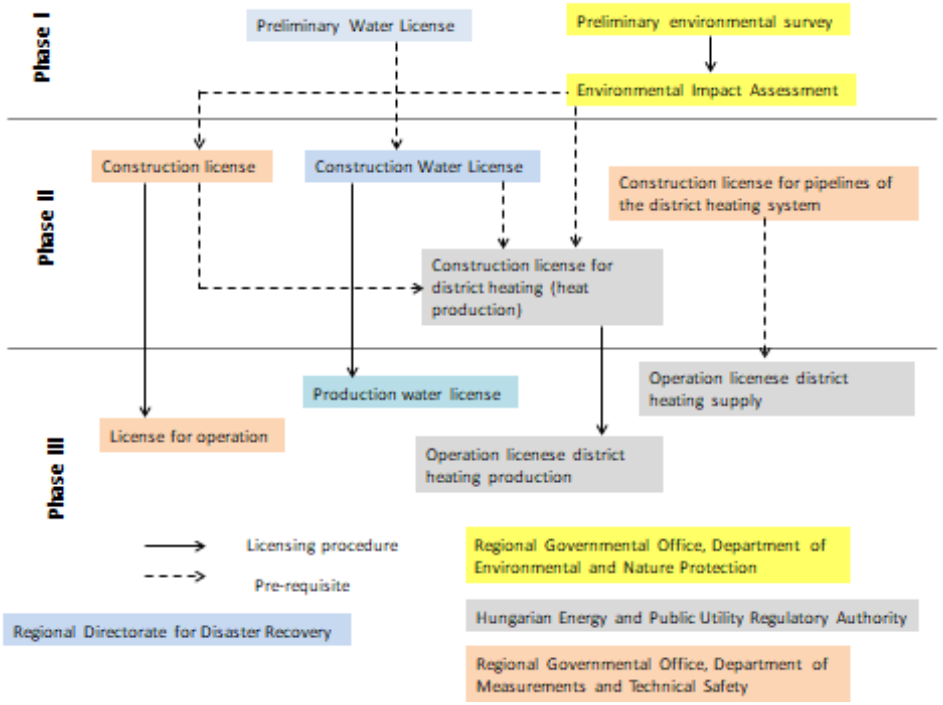
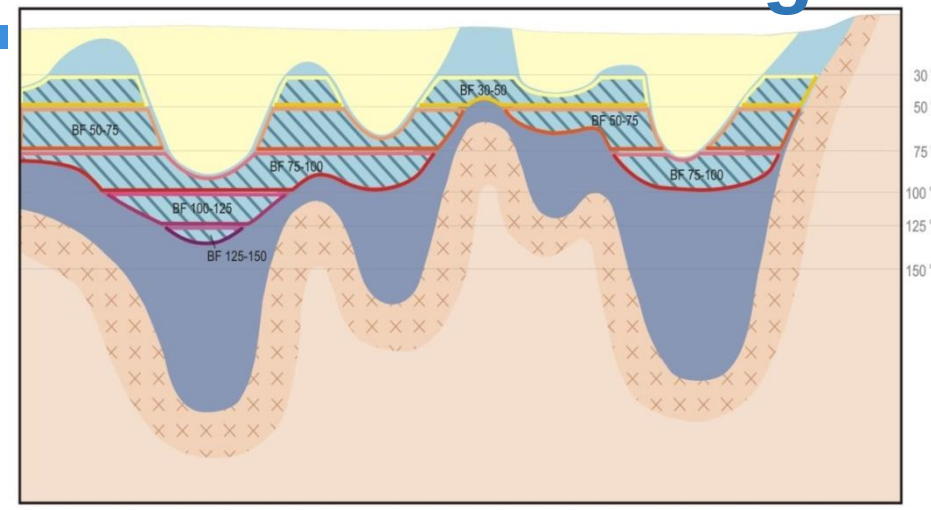


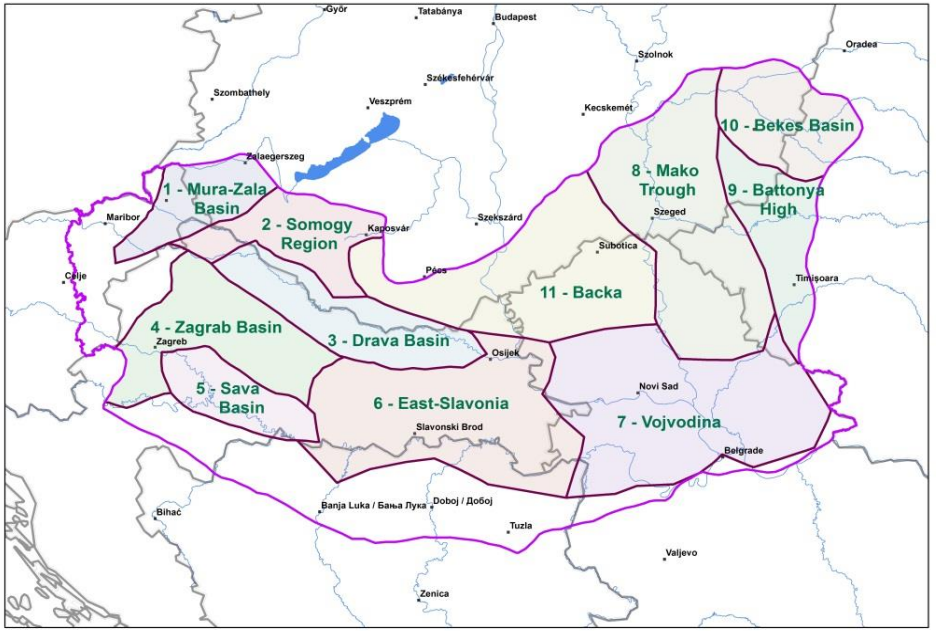
Inputs for E and F categories: comprehensive assessment of „non-technical aspects" (e.g. legislation charts, heat sector analyses, *etc.)*

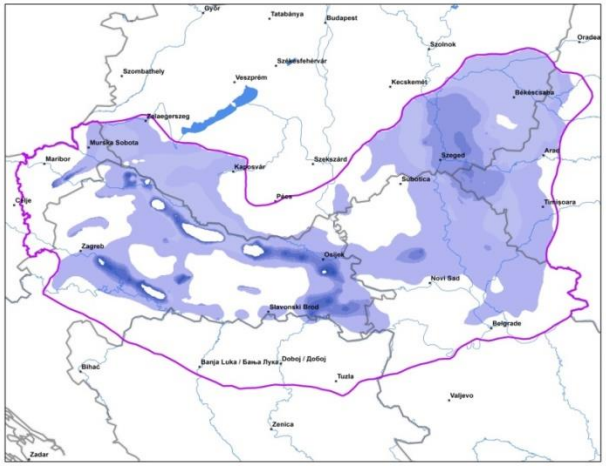


Region	Heating Energy Consumption	Surface	Inhabitants	Consumption per km²	Consumption per capita
Pomurje	1,246,880,285 kWh	1,337 km²	116,078	932,596 kWh/km²	10.741 MWh
Podravje	1,549,821,553 kWh	2,168 km²	322,513	714,862 kWh/km²	4.805 MWh
Posavje (partly)	494,954,758 kWh	644 km²	53,980	768,563 kWh/km²	9.169 MWh
Savinja (partly)	654,710,491 kWh	756 km²	70,736	866,019 kWh/km²	9.255 MWh

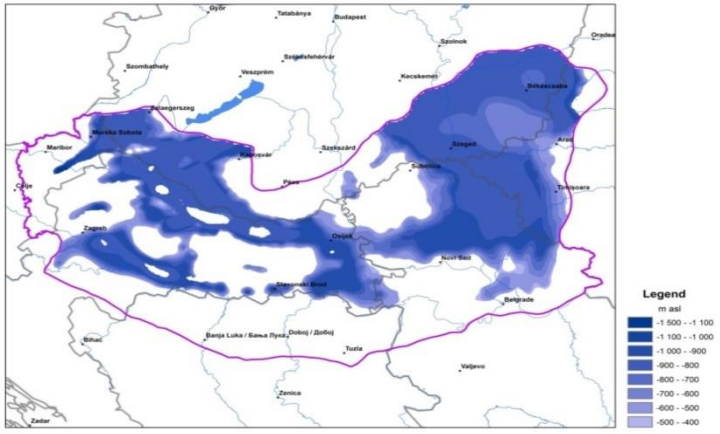
Hypothetical „standard” (notional) projects: national geothermal energy resources







← **Top and bottom of basin fill reservoirs 30-50 ℃** →



Hypothetical „standard” (notional) projects: national geothermal energy resources

Region ID	30-50 °C			50-75 °C			75-100 °C			100-125 °C			125-150 °C		
	P90	P50	P10	P90	P50	P10	P90	P50	P10	P90	P50	P10	P90	P50	P10
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
1. region Mura-Zala Basin	5365	7399	9750	6782	9395	12329	874	1201	1579	103	143	189			
2. region Somogy region	8308	11522	15169	10937	15154	20055	235	325	427						
3. region Drava Basin	9500	13014	17228	22945	32041	42005	10265	14164	18798	1933	2691	3531	90	125	164
4. region Zagrab Basin	3119	4317	5667	892	1227	1628									
5. region Sava Basin	4820	6665	8837	6888	9510	12545	372	513	680						
6. region East-Slavonia	4870	6745	8900	2159	2979	3933									
7. region Vojvodina	7776	10683	14052	1497	2075	2751									
8. region Mako Trough	27219	37607	49658	78234	108496	143502	42474	59153	78067	9575	13278	17482			
9. region Battonya High	5562	7628	10077	6499	8924	11835	1597	2213	2930						
10. region Bekes Basin	10057	13925	18391	26802	37267	49258	17255	23648	31213	3509	4832	6410			
11. region Backa	3637	5032	6633	1629	2267	2976									

All classify as E3, F3.3, G4

Input parameters					**Calculated parameters**			
A	B	C	D	E	F	G	H	**I**
Reservoir area (km^2)	Reservoir thickness (km)	Porosity (V/V)	Reservoir temperature (˚C)	Recovery factor	**Total volume (km^3)**	**Pore volume (km^3)**	**Porosity heat content (PJ)**	**Recove-rable heat (PJ)**
					A*B	C*F	4.187*G*(D-30)	**(H*E)**

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25 April, 2018, Geneva

Thank you!

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