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DIRECT HYDRO-GEOTHERMAL ENERGY USE IN DISTRICT HEATING & COOLING SYSTEMS THE POTENTIAL OF CROATIAN PANNONIAN BASINS

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Geothermal resources of Croatian Pannonian basins natural thermal springs / geothermal fields, existing deep wells and further development can contribute to the significant amount of energy & data to be used for constructing better models, resulting in lower operating costs of district heating / cooling systems.

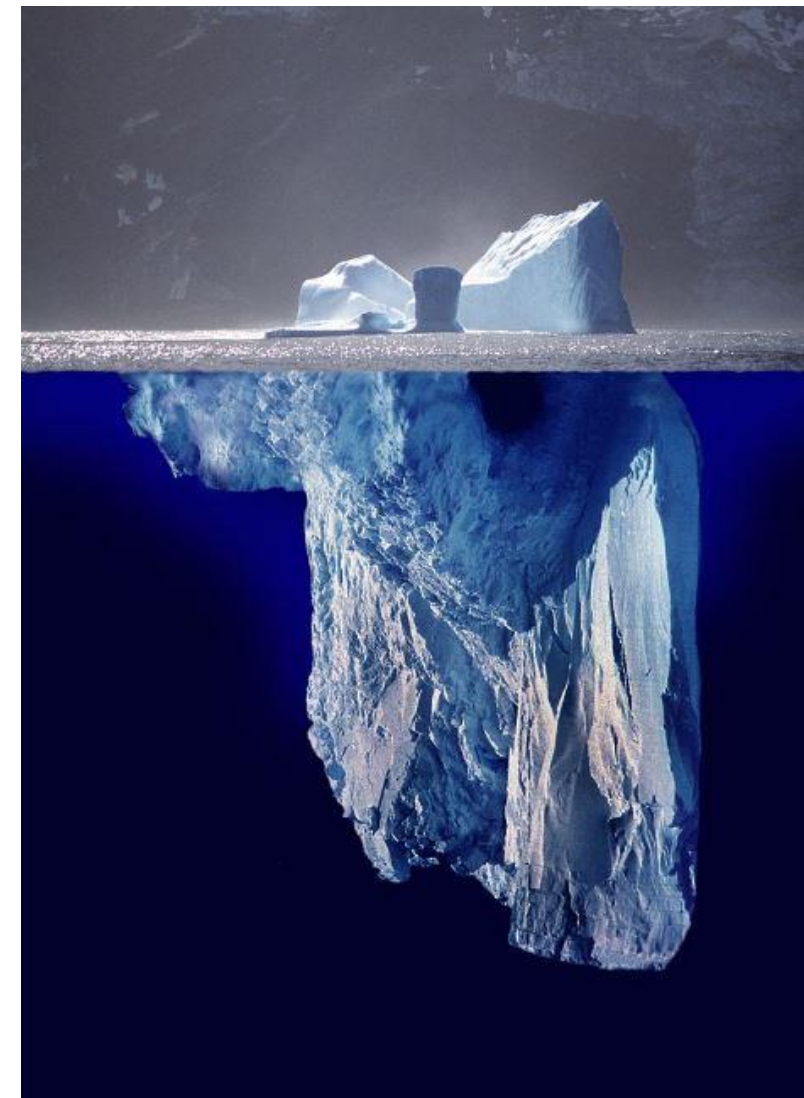
There are initial geothermal district heating / power plants in Croatia

Quantified part of the proven geothermal resources for power plants is estimated at the 2.5% of existing installed capacity in Croatia, or 29% of nuclear.

That is just 10% of expected power & cogeneration heat resources to be found & developed here.

We will see that geothermal direct heating can substitute nearly $\frac{1}{2}$ yearly consumption of natural gas.

Are intelligent data operation of district heating / cooling systems a challenge for these numbers?



Direct heating possibilities are estimated at 12-26% substitute of natural gas annual consumption, adding 3-6% the non-conventional gas - dissolved in the part of recovered geothermal water

This, after all conservative assessments, is suggesting that geothermal energy could play an important role in $\frac{1}{4}$ of the energy balance of the country.

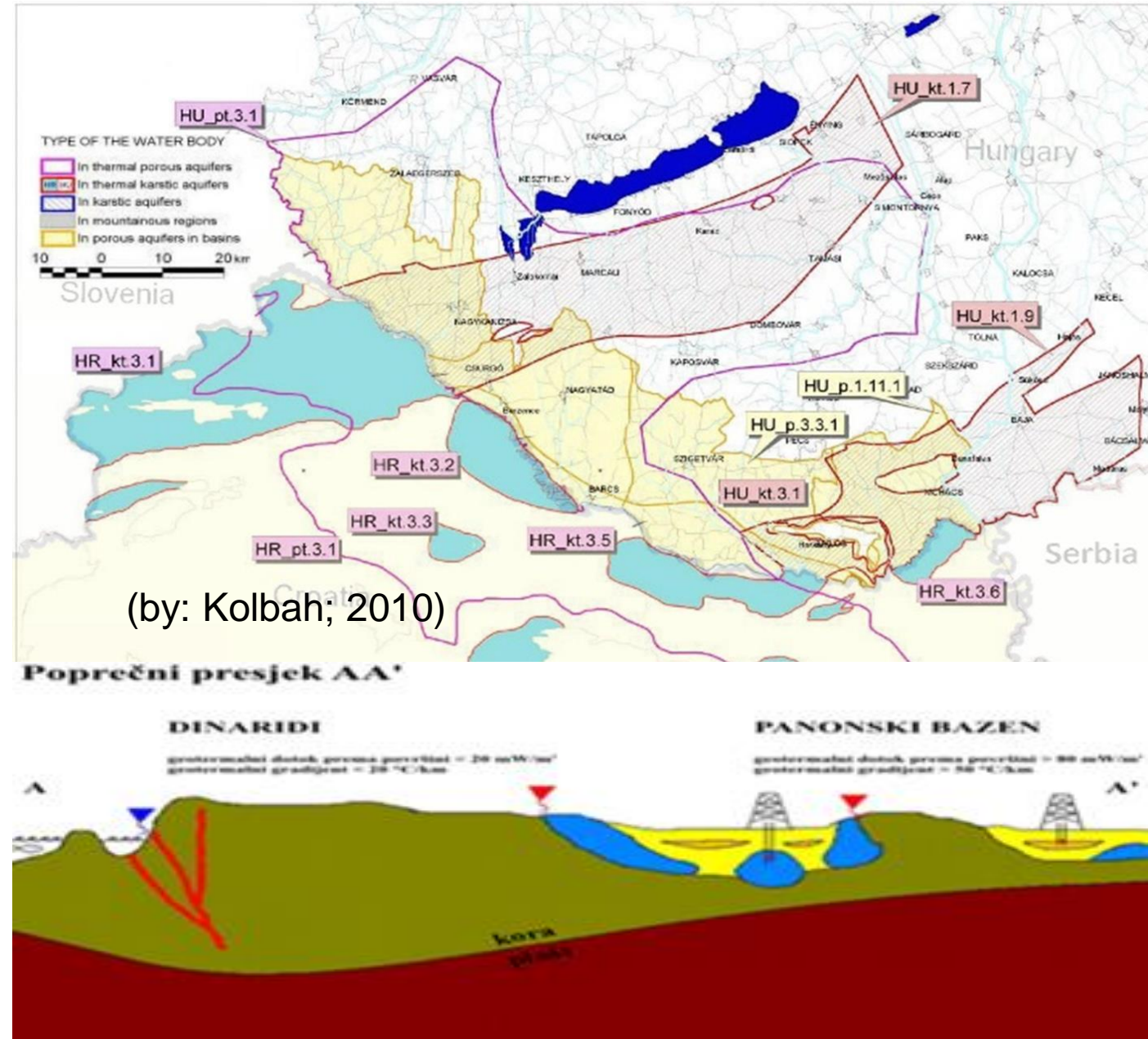
We have to add them to the other cogeneration units, large heat pumps and electric boilers in district energy systems



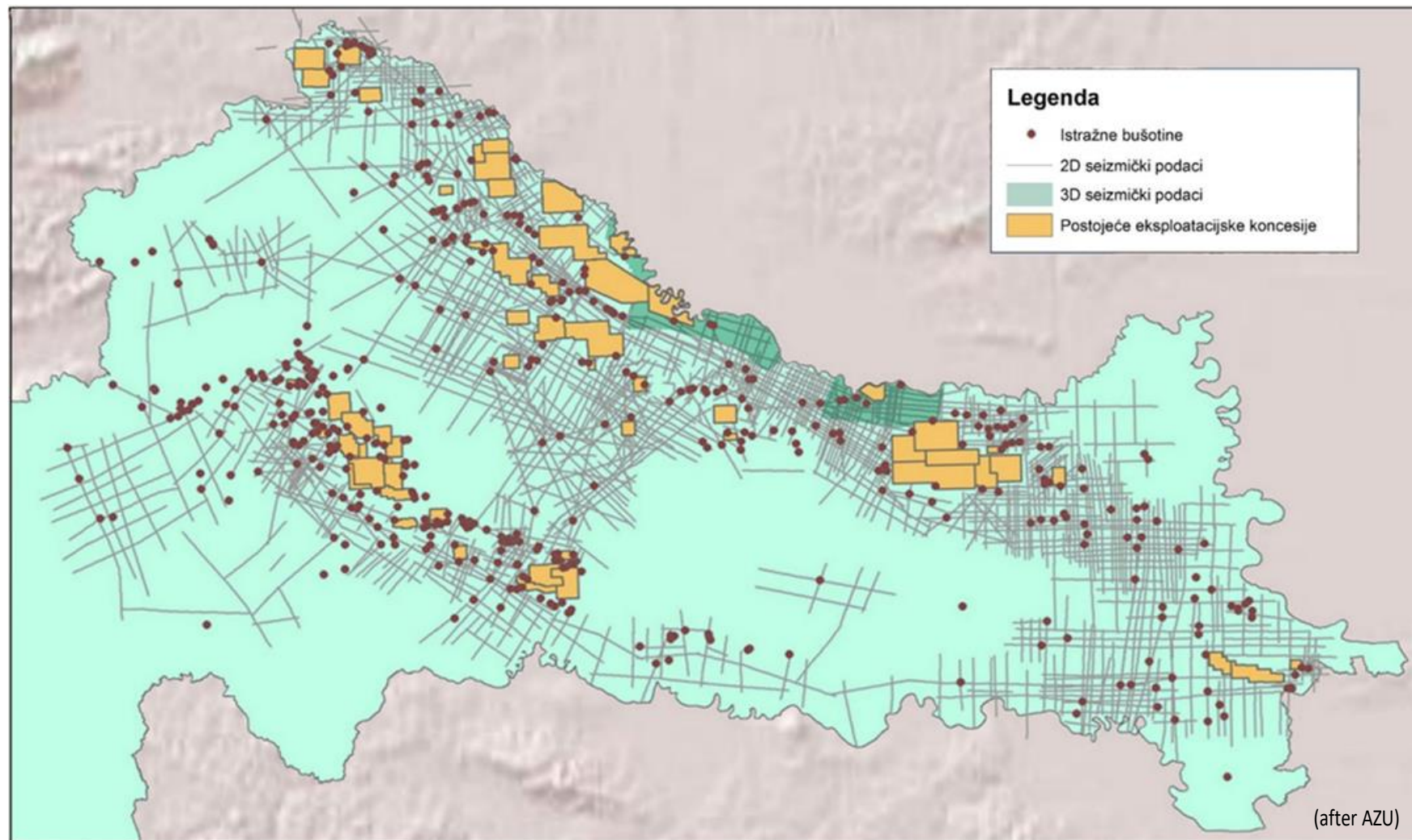
Geothermal water energy resources in Pannonian basins are related to deep water bodies (DWB) and to the increased geothermal flow by favorite CONDUCTION through the thin crust and possible CONVECTION in the massive reservoirs in the young basins. Including hydro-geothermal resources increased complexity of operating the systems but also an opportunity for economic, CO₂ emissions and energy savings in the system

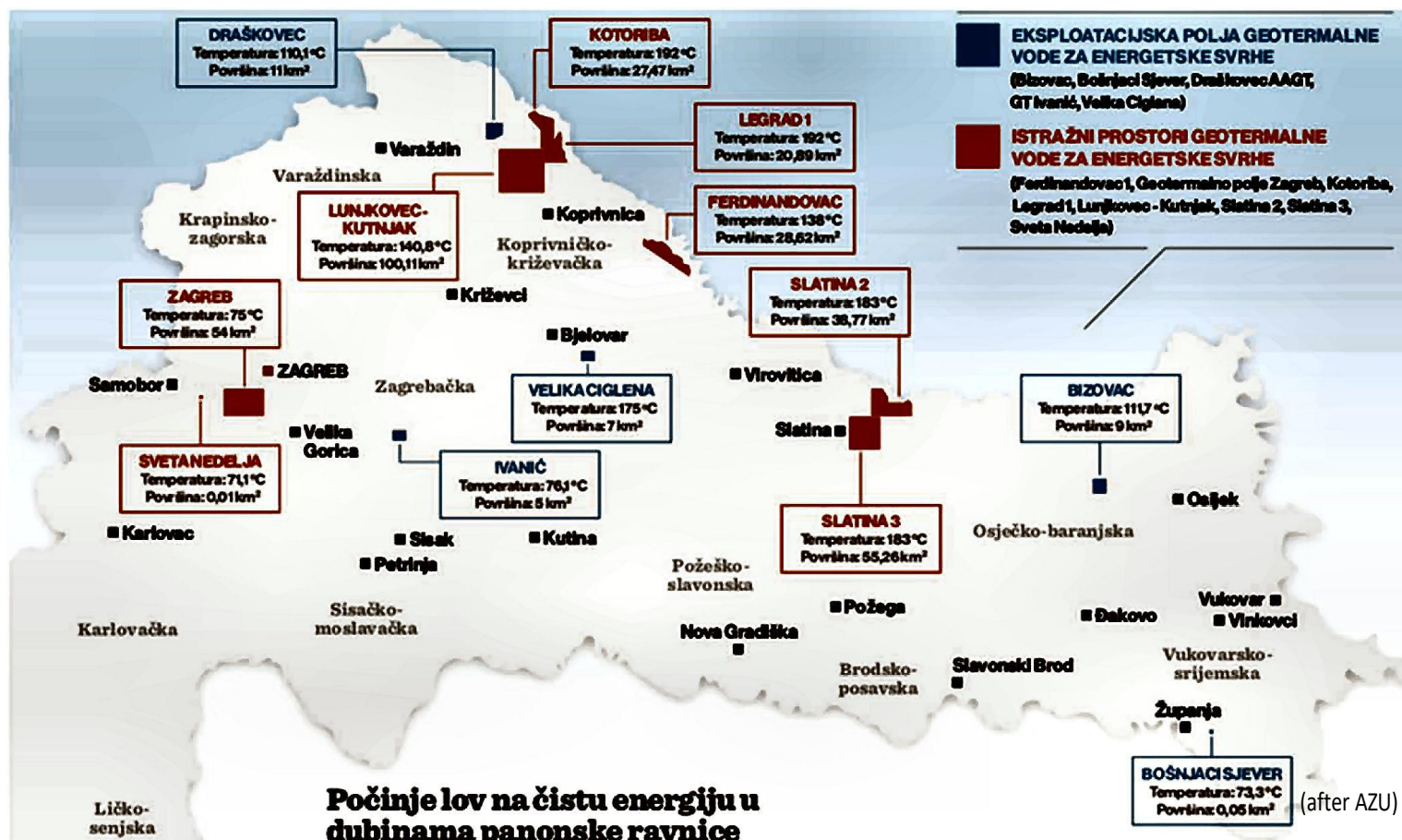
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Acquisition of 2D and 3D seismic illustrates the total intensity of geological-geophysical engagement and possible knowledge of deep Croatian Pannonian basins geology. Over 1,000 wildcat exploration wells and additional 3,000 development wells over 50 producing oil, gas and geothermal fields, with over 100 years of Exploration & Production experience.

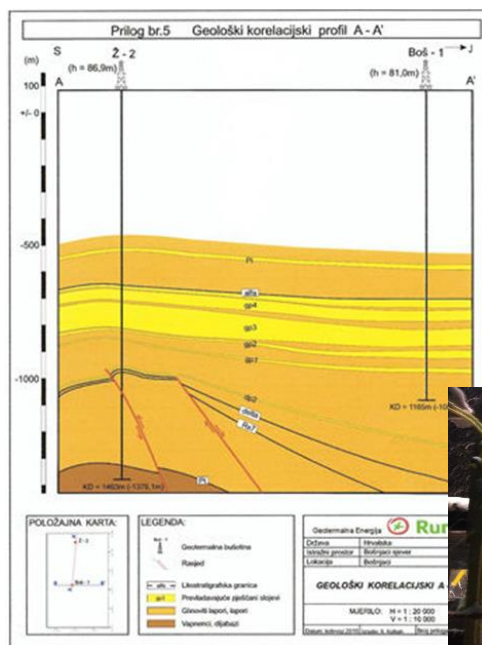




The possible electricity production is conservatively quantified at the Geothermal fields: Lunjkovec-Kutnjak and exploration blocks: M. Bukovec, Legrad-1, Kotoriba and Ferdinandovac-1, further 100 MW_e of installed capacity is expected, what is nearly 2.5 % of the existing power plants capacity in Croatia, or 29% of our part at nuclear power plant Krško. With the production of electricity from geothermal water with an average flow of 100 l / sec and a temperature of > 140 °C, and the outlet of the plant 80 °C, the remaining co-generation heating capacity of 500 MW_t is expected



With the production of electricity at the geothermal field Velika Ciglena 2018 should be „breaking the ice" in Croatian energy scene and with direct heat consumption it need to be efficiently and successfully integrated into the large-scale variable energy sources like wind and solar energy calls for a rethinking of the design and operation of energy systems and their interaction



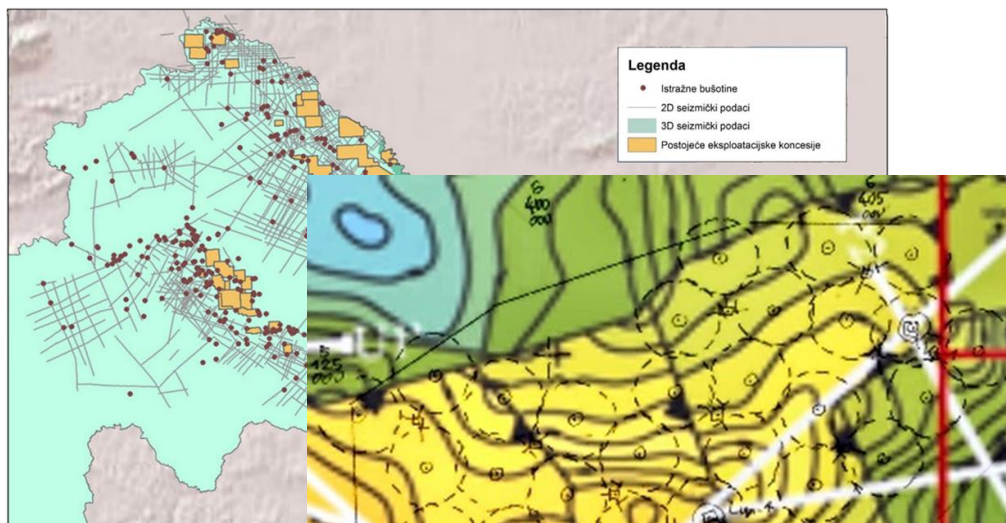
Less deep (up to 1500 m) we find interesting geothermal water bodies, so at 500 sites (of > 1000 existing ones) we could get 750-1300 MW_t for directly used heat or 12-26% per annum use of natural gas in a country



Direct geothermal heat use in HT hydroponic tomato greenhouse at the GT field Bosnians-N



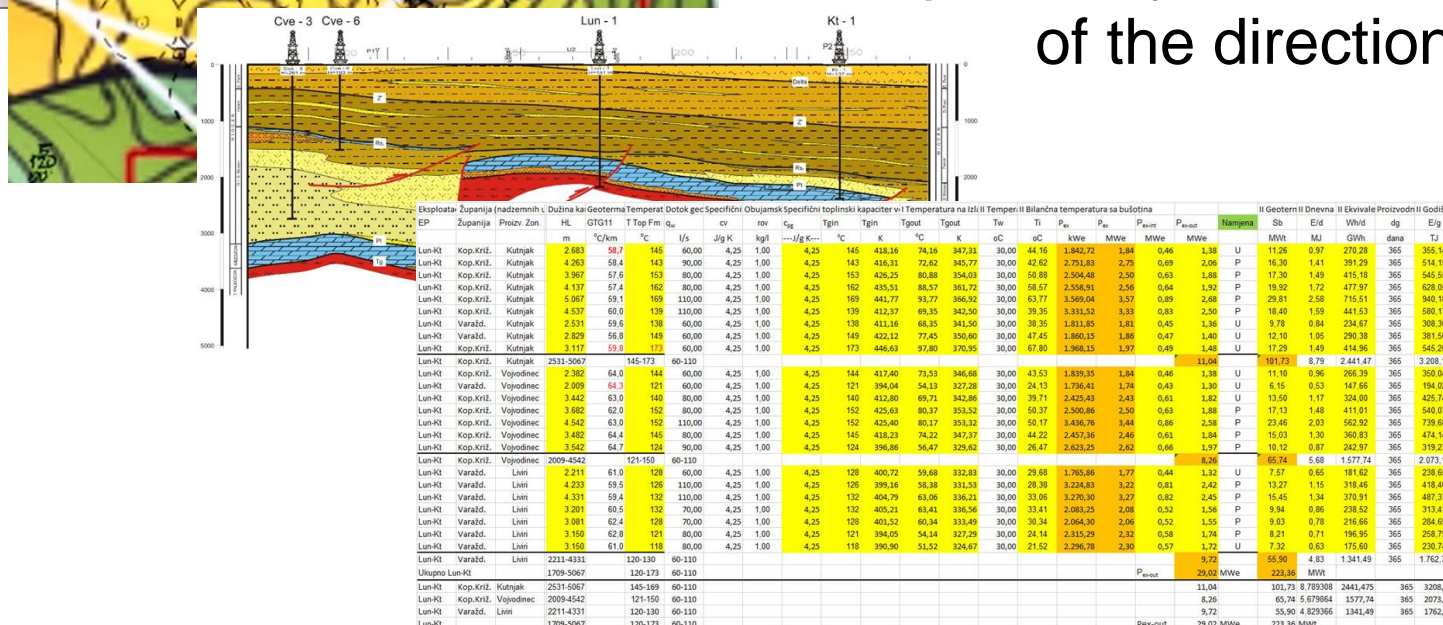
Intelligent operation of district heating / cooling systems will provide new technologies essential for providing the needed solutions; e.g. solutions for short term and seasonal storage

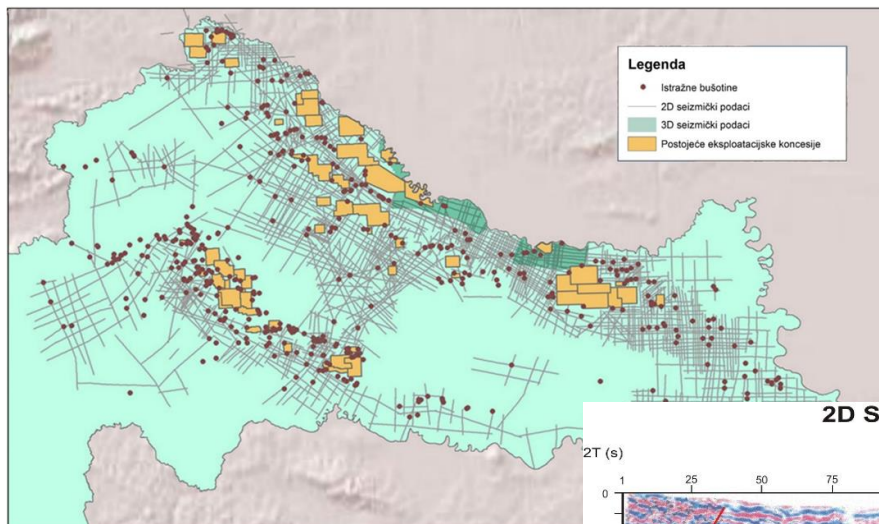


Scheme of development of geothermal production by deep wells in example of Lunjkovec – Kulnjak geothermal field

Legend:

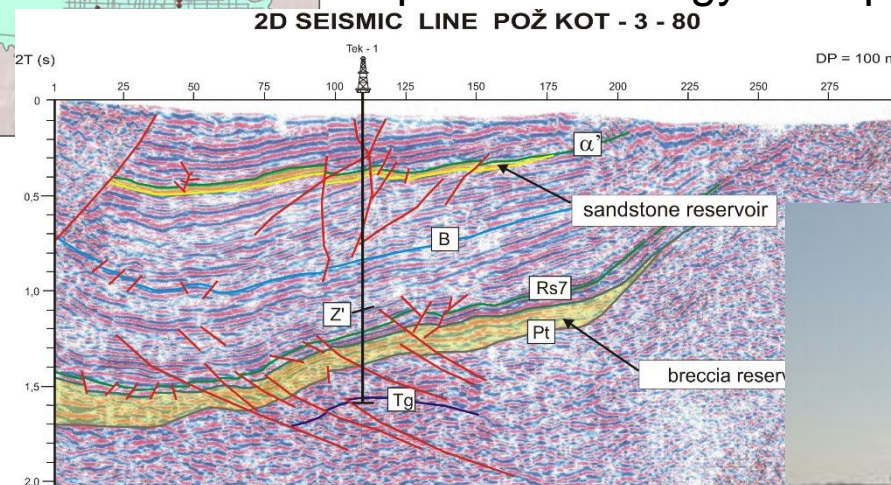
Dashed circles - drainage radius in the geothermal reservoir,
Squares - joint surface position of the mouth of the directional wells (bushes)





The direct heat use requires lower investment, thanks to the relatively shallow drilling (<1500m) and lower geological risk in the better explored area, by massive geological-geophysical acquisition and > 4,000 deep wells with a number of tests and production. With relatively small sample at 500 locations, we expect possibility of direct heat yearly consumption from 750 to 1,300 MW_t, equivalent to 300-650x10⁶m³ natural-gas per year, or 12-26% of annual consumption of natural gas in Croatia, plus provided energy from power plant cogeneration and non-conventional gas reach 1/2 of it

Nearly most of N Croatia with high geothermal surface flow have opportunity to use some of DWB according to local basin developments



data-intelligent operation of integrated power and thermal systems for accelerating the green transition using thermal storage solutions on the proper scales is a challenge to Croatian geothermal direct heat resources



Worldwide gas reserves and (assumed) resources by type, at the end of 2008:

(in Billion m ³)	Reserves	Resources	TOTAL
Conventional Gas	188	239	427
Unconventional Gas	5	2720	2725
- shale gas		456	456
- other tight gas	3	210	213
- Coalbed methane	2	254	256
- aquifer gas		800	800
- gashydrat		1000	

Non-conventional resources of natural gas dissolved in geothermal water (Aquifer-gas / Water-Dissolved-gas) and produced within this. It is the case at Bošnjaci, Draškovec, Bizovac and many other locations in Croatia. According to the world wide analysis, aquifer-gas resources are considered to be nearly double that of the total amounts of natural gas in conventional traps. In the 400 of 500 allocated objects, by conservative estimates, we expect $> 160 \times 10^6 \text{m}^3$ natural-gas or $> 5\%$ of annual consumption of natural gas in the country

GTW m3/dan	Delta T oC	Pt MWt	G/W m3/m3	Gas m3/dan
500	30	0,71	3,5	1.750
1.000	30	1,41	3,5	3.500
1.500	30	2,12	3,5	5.250
2.000	30	2,83	3,5	7.000
500	40	0,94	4,5	2.250
1.000	40	1,89	4,5	4.500
1.500	40	2,83	4,5	6.750
2.000	40	3,77	4,5	9.000

Source: DIW Berlin 2010

Electric power, direct heat with unconventional gas with thermal storage solutions should be integrated into the energy systems powered by digitalization and data intelligence, which is the main subject of the Center for IT-Intelligent Energy Systems (CITIES) project

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Hydro-dynamically testing at the site of a geothermal power plant under construction Draškovec



Conclusion

The intelligent data operation of district heating / cooling systems opens next, crucial market for the development of geothermal-water potential especially direct heating, non-conventional gas production but also the possibilities of underground heat storage technologies - development and management DWB. To that point, serious development of direct heating facilities was limited to a very limited number of HT greenhouse producers, enough strong to invest in development and substitute huge amounts of energy nearly all seasons of the year.

Even with the production of electricity our very conservative quantification, of the several already proven fields have not been accepted by official institutions. That happens due to heavily subsidized „clean” energy prices, the declining demand because of energy saving and still high and not regulated „dirty” energy production in the EU. In countries like Croatia with such low energy prices it makes any investment in power plants economically not acceptable. So even such stable, renewable and clean resources like geothermal very hardly can be developed and even recognized.

Now even the international developers here claim that 100 MW_e installed capacity is possible in the first round at already known fields what we see just the 10 % of expected.

Here an open debate between different industry, academia and governmental partners, will hopefully result in an improved collaboration between different partners and a better understanding of problems' solutions and possibilities in the domain of district heating / cooling systems where intelligent data operation can lead to rational development and consumption of all country resources as well as geothermal.



Thank you for attention! "Green Oilers"

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