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Presentation title

Hydrocarbon-geothermal co-production challenges in Eastern Europe: Geothermal Pilot Projects for Heat and Electricity in Serbia (GOSPEL Project)

Abstract, 1-2 pages:

Hydrocarbon-geothermal co-production from low temperature reservoirs (<100°C) is under evaluation in the Pannonian Basin. Technical, scientific and economic challenges related to the geological and geothermal conditions encountered in this area are investigated in the framework of a Serbian-French program, GOSPEL.

Coordinated by ES Géothermie in partnership with IEL (Initiatives & Energies Locales), the GOSPEL (GeOthermal Serbian Pilot projects for hEat and eLectricity) program aims at the emergence of geothermal projects in Serbia. This program, partly funded by French government and supported by Serbian Autonomous province of Vojvodina, will run for two years.

Launched in May 2017, the project involves a Serbian-French consortium, combining local knowledge and industrial expertise for performing pre-feasibility studies and encouraging the emergence of industrial geothermal energy projects in the country.

The initiative brings together geothermal experts, academic partners, state institutions, local representatives and investors to consider the various dimensions of geothermal energy projects (underground knowledge, user needs, heat and electricity markets and prices, as well as the regulatory framework and funding opportunities).

Starting with a characterization of the potential at country scale, three zones of interest will be identified, followed by a detailed analysis of the underground data and energy valorization opportunities for each prospect.

In the second phase of the GOSPEL project, techno-economic and business models evaluation will be conducted for tangible geothermal energy projects (2 low enthalpy for district heating or agro-industry and 1 high enthalpy for power generation or for energy supply of an industrial process).

In this framework, the hydrocarbon-geothermal co-production conditions and challenges encountered in the Pannonian Basin are investigated through an extensive literature review.

The task started with a state of the art to capture the lessons learned and feedbacks from existing co-production experiences to be applied on the Serbian case study.

An identification of the possible synergies between oil & gas and geothermal energy along the value chain of underground projects allowed defining possible co-production concepts. A preliminary co-production projects mapping has also been performed to highlight the various energy usages, resource features, project types and developed technologies, showing a large panel of co-production opportunities.

In addition, a survey of the initiatives aiming at characterizing co-production potential on a global scale has been initiated and showed that co-production is a growing topic for many countries.

A preliminary SWOT analysis has been drafted to give an overview for decision makers of the main Strengths, Weaknesses, Opportunities and Threats associated with hydrocarbon and geothermal co-production.

A review of the main findings and operational feedbacks from co-production projects will be carried out, addressing the following research questions:

- How to optimize co-production wells scheme to both maintain the oil and/or gas production and secure a sustainable heat and/or power generation from geothermal energy?
- What are the typical corrosion and scaling processes that may be specific to co-production sites?
- What are the co-production associated technologies?
- What are typical thermal and hydraulic conditions encountered in co-production sites?
- What are the issues related to wells conversion and workover?
- How to adapt the oil & gas and water collection and separation process to integrate the geothermal energy production cycle?

Finally, the case study of Serbia will be considered, based on the available geological, geochemical and wells data.

A preliminary matching between the geothermal potential and the oil and gas accumulations confirmed that interesting prospects for geothermal energy production will surely be hydrocarbon-geothermal co-produced fields, notably in the north-eastern part of Vojvodina.

The main elements (geological objects and processes) of the petroleum and geothermal systems will be compared in order to identify common geothermal and hydrocarbon reservoirs and determine the driving factors playing a role on geothermal and hydrocarbon fluids migration and accumulations in the southern margin of the Pannonian Basin. Data on the hydrocarbon content in geothermal fluids will be collected, as well as feedbacks from coproduction experiences in the Pannonian Basin.

Based on this case study, recommendations and guidelines, as well as likely impacts on business models of hydrocarbon-geothermal co-production projects will be provided.

Hydrocarbon-geothermal co-production challenges in Eastern Europe

Geothermal Pilot projects for Heat and Electricity in Serbia (GOSPEL Project)

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THE GOSPEL PROJECT



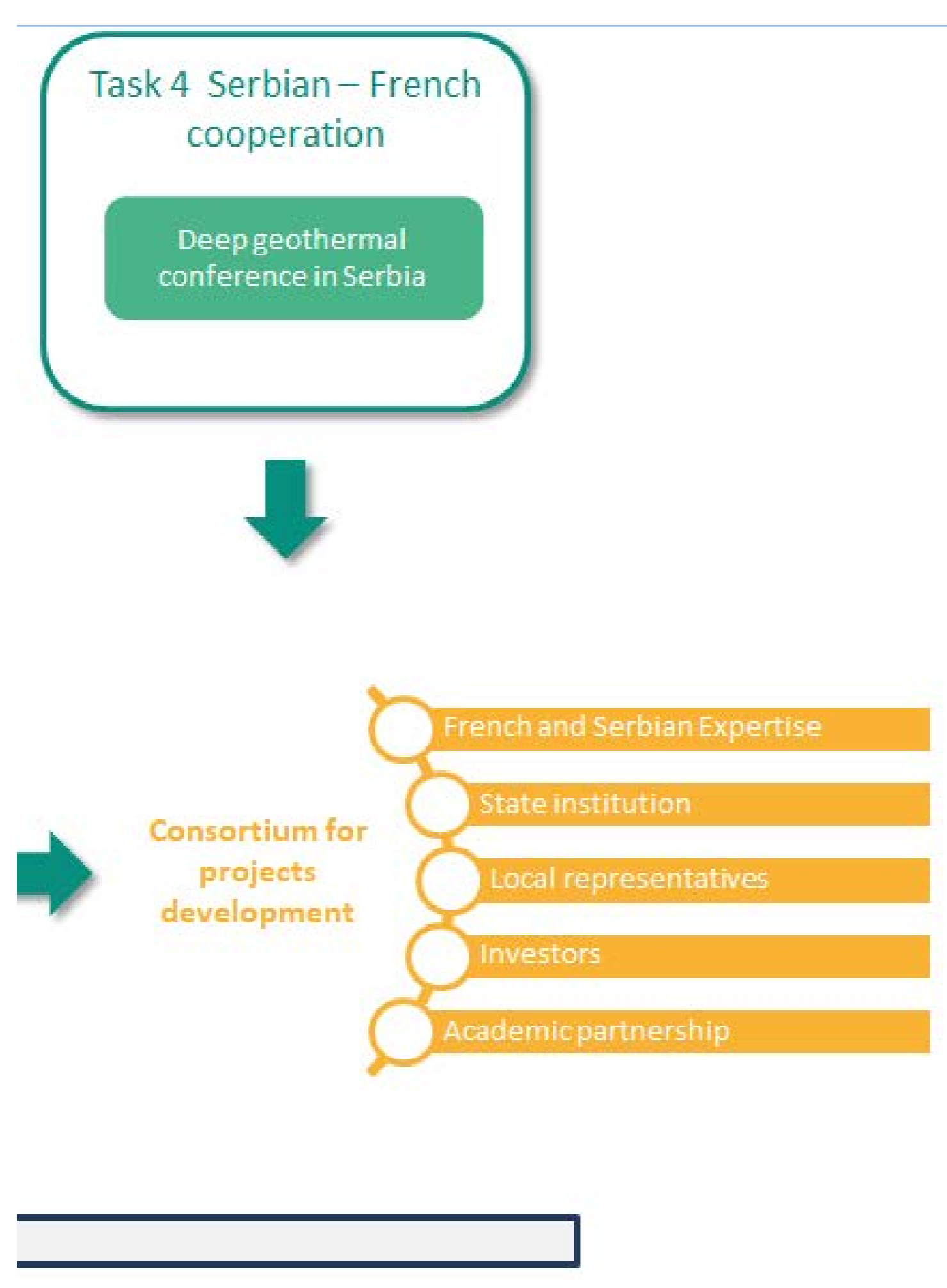
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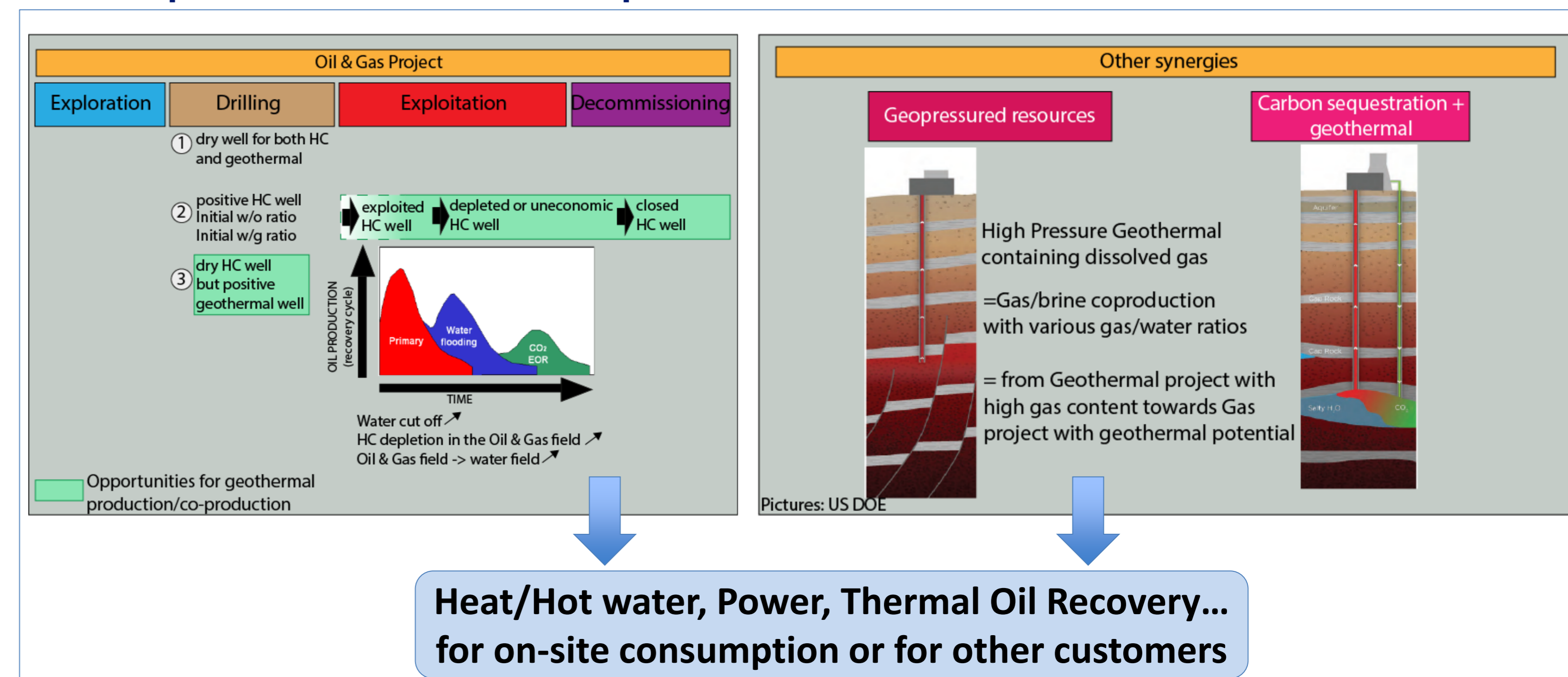


The GOSPEL Project: partners and tasks (ES Géothermie)

HYDROCARBON-GEOTHERMAL CO-PRODUCTION CHALLENGES IN EASTERN EUROPE

Workflow of the task 3: Coproduction HC-GT (EDF R&D / EIFER)

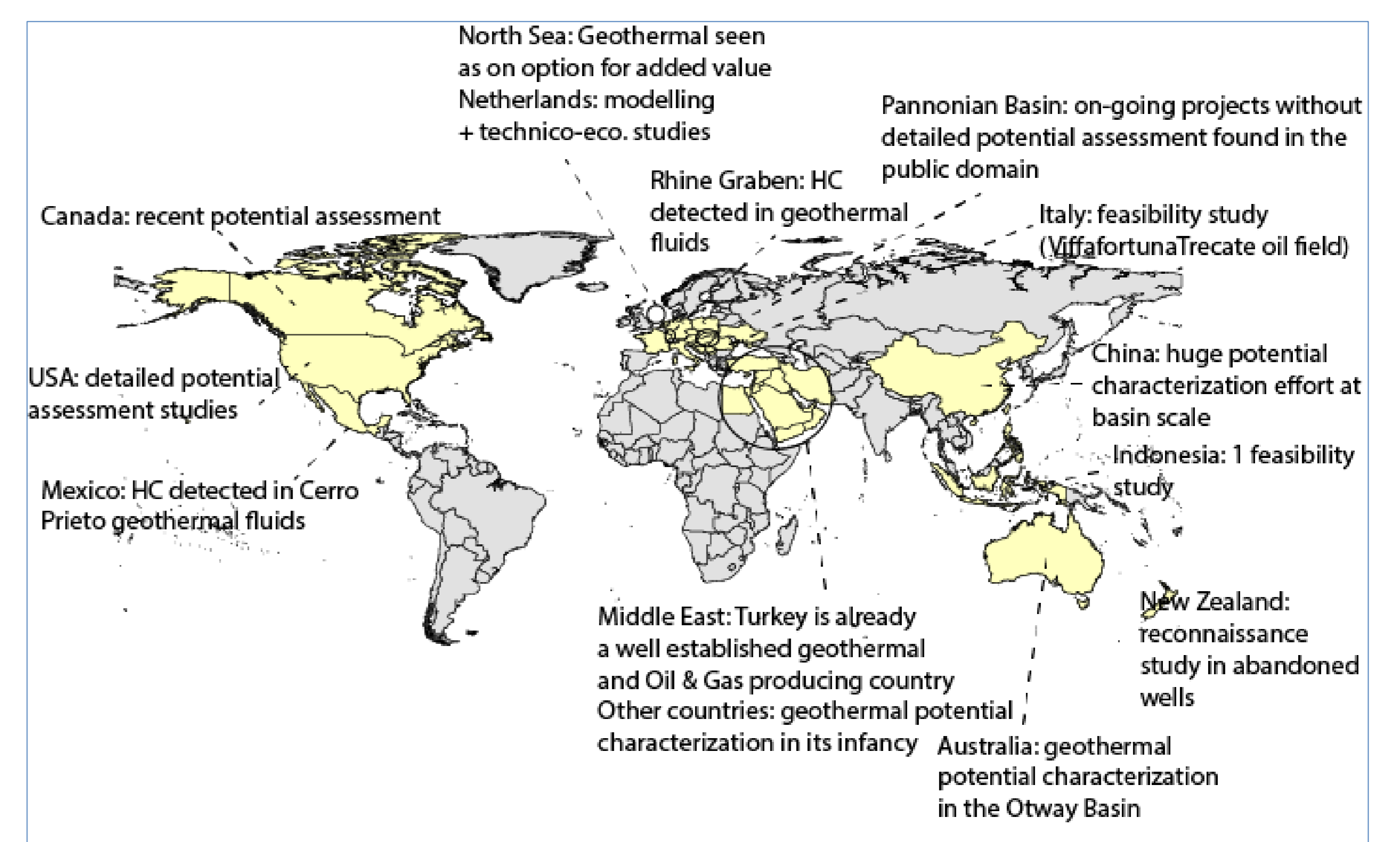
PRELIMINARY RESULTS OF THE STATE OF THE ART (WORLDWIDE SCOPE) Co-production concept



HC-GT Co-production opportunities (EDF R&D / EIFER)

Potential evaluation

- A growing topic in numerous countries
- Various potential calculation methods depending on the data availability and quality (well data: bottom-hole temperature and depth, volume of produced fluids, oil/water, gas/water ratios...)



Which countries have evaluated their HC-GT co-production potential? (Data compilation EDF R&D / EIFER)

Technologies

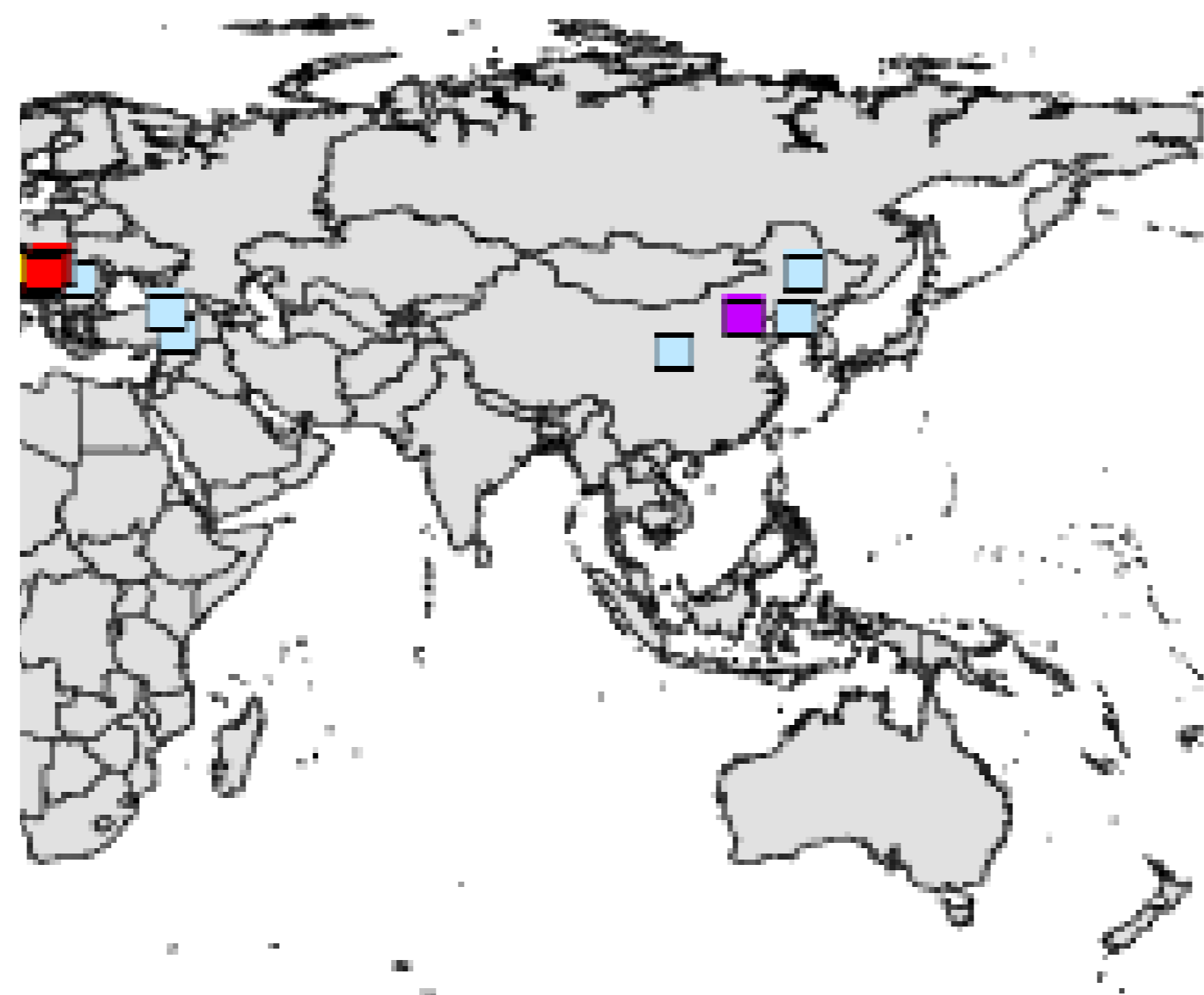
- Closed loop (wellbore heat exchanger)
- ORC and mobile ORC
- Heat exchanger
- HT Heat pumps
- Specific management of corrosion and scaling?

Co-production projects inventory

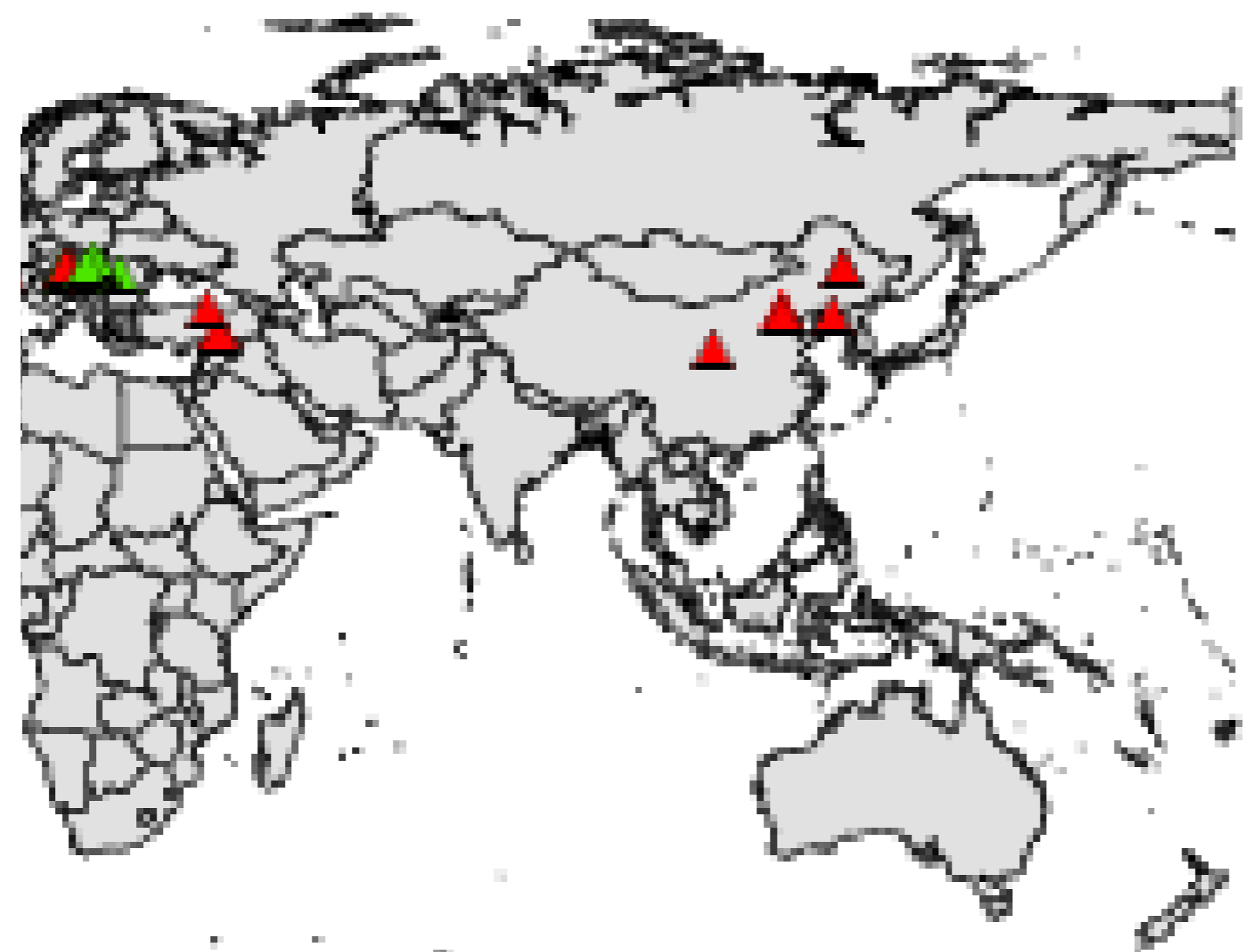
DATA COLLECTION ON CO-PRODUCTION PROJECTS (in Oil & Gas Fields or in Geothermal Fields with high HC content)

PROJECTS MAPPING AND DATA SORTING

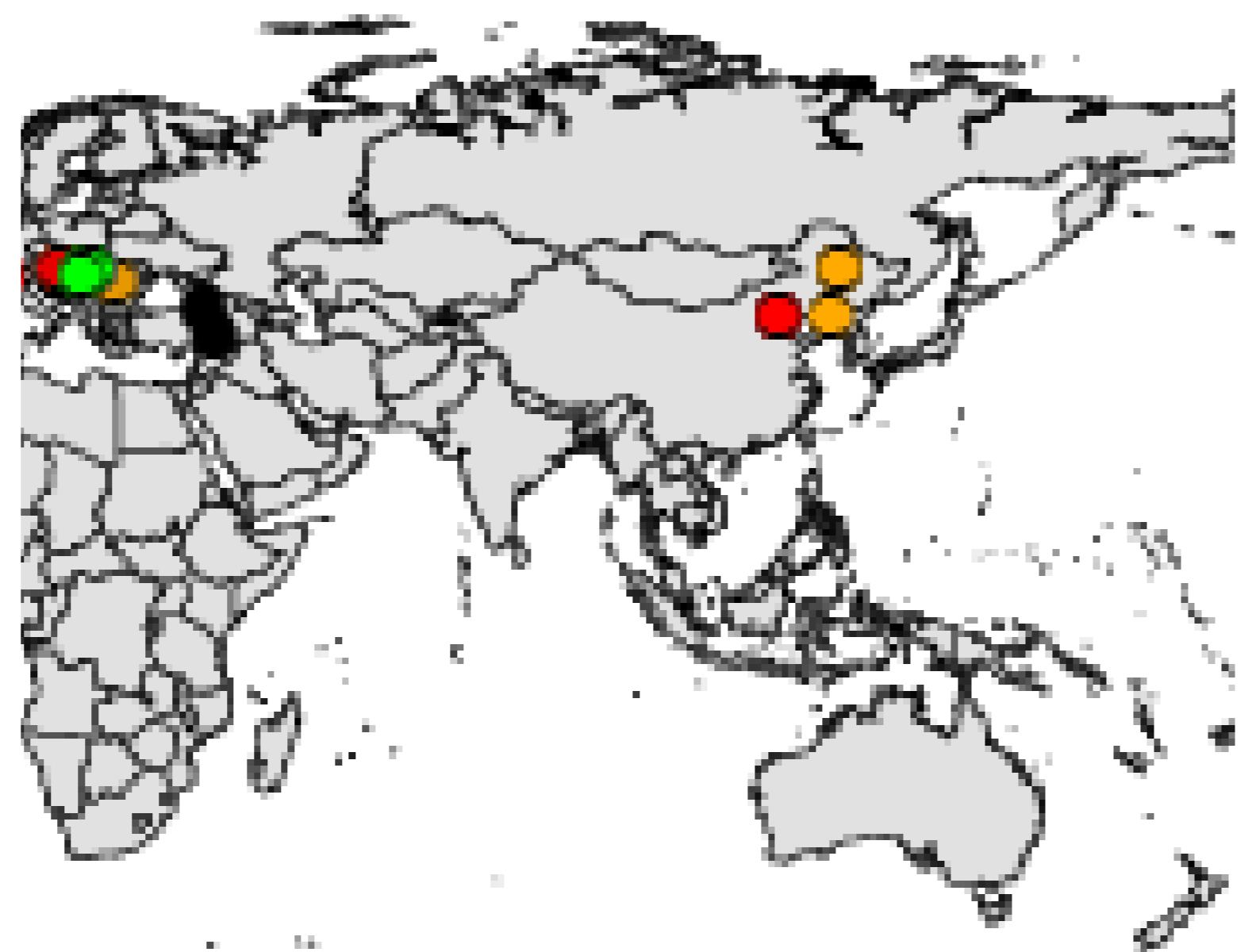
ENERGY USE	<ul style="list-style-type: none"> Heat, power, heat and power, EOR/EGR
CAPACITY	<ul style="list-style-type: none"> From 23 kWe to 16.5 MWe From 450 kWth to 20 MWth
TEMPERATURE AND FLOW RATE	<ul style="list-style-type: none"> From 45 to 172.5° C From 3 to 305 L/s
FIELD TYPE	<ul style="list-style-type: none"> OIL &/or GAS FIELDS (DEPLETED, EOR...) GEOTHERMAL FIELDS
PROJECT and WELL USE TYPE	<ul style="list-style-type: none"> CO-PRODUCING OIL &/or GAS FIELDS CO-PRODUCING GEOTHERMAL FIELDS USE OF ABANDONED OR DRY OIL&GAS WELLS CONVERSION TOWARDS GEOTHERMAL + DRILLING OF NEW WELLS



Co-production projects inventory –Energy use (EDF R&D / EIFER data compilation)



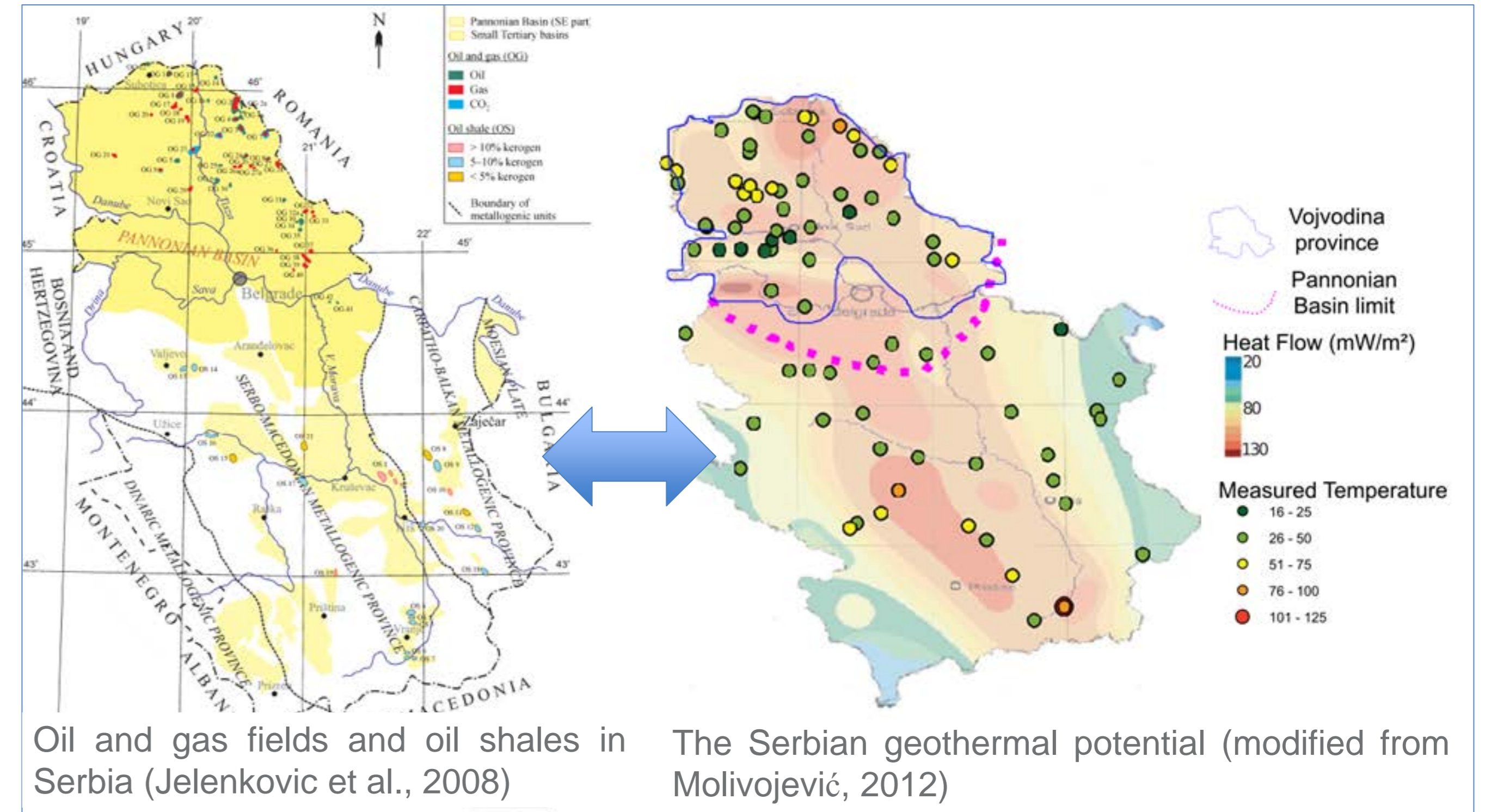
Co-production projects inventory –Field / exploitation type (EDF R&D / EIFER data compilation)



Co-production projects inventory –Project / well use type (EDF R&D / EIFER data compilation)

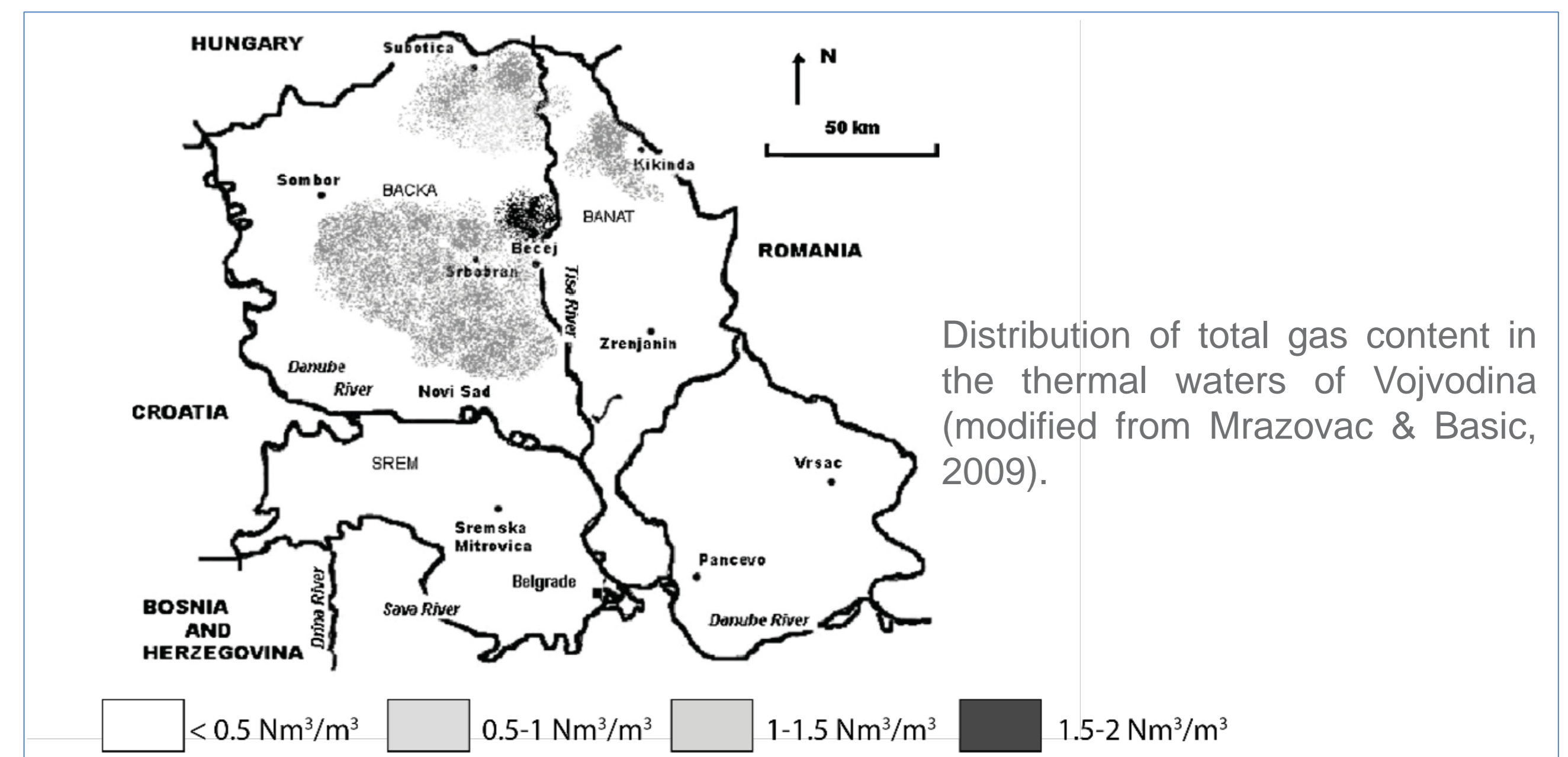
THE SERBIAN CASE STUDY

- Good matching between the geothermal potential and the occurrence of Oil & Gas fields



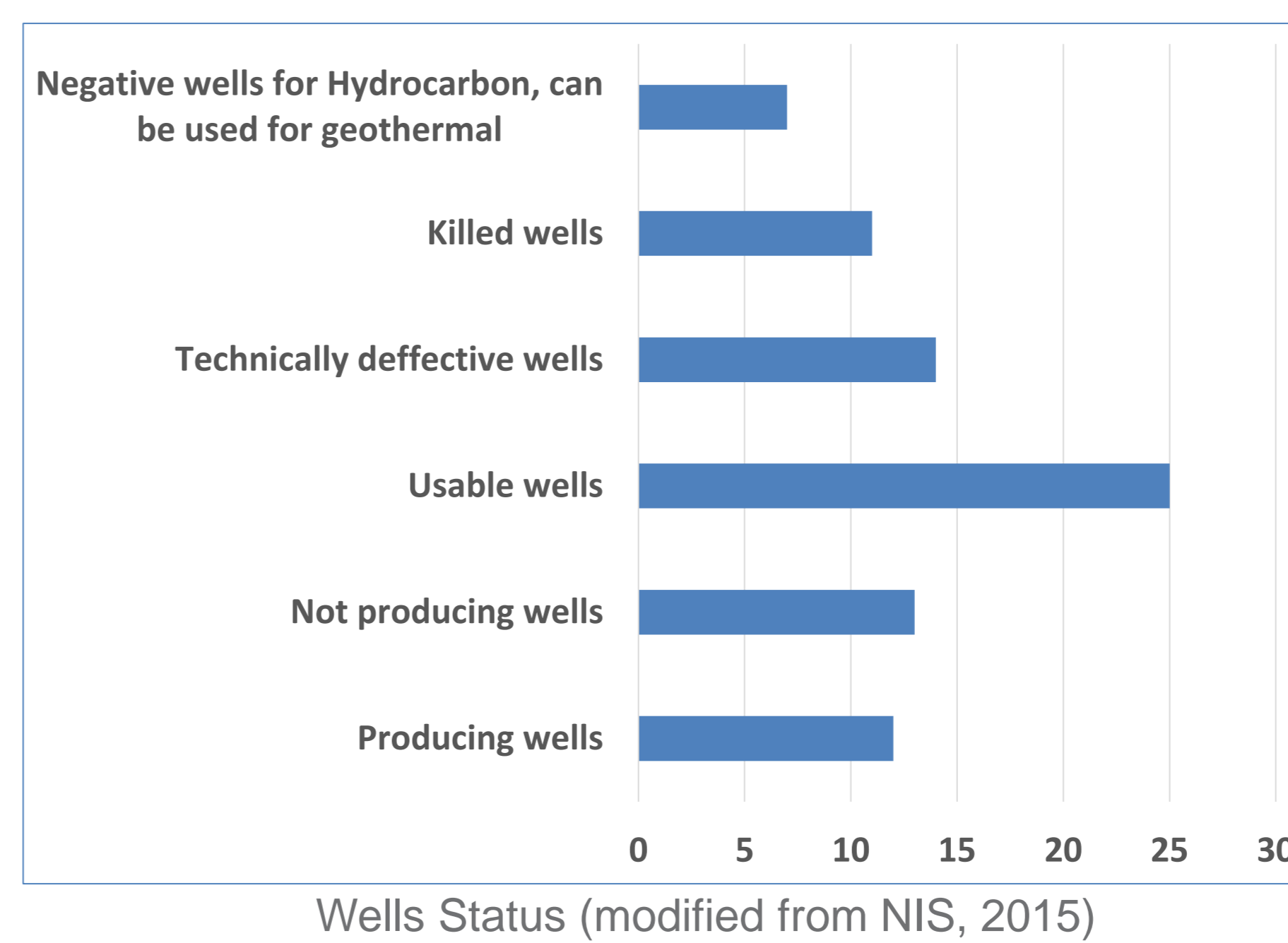
Oil and gas fields and oil shales in Serbia (Jelenkovic et al., 2008) The Serbian geothermal potential (modified from Molivojević, 2012)

- Comparison of the petroleum and geothermal systems in the Vojvodina Province, Pannonian Basin
 - Oil & Gas source rocks at shallow depths ⇔ Geothermal heat flow
 - Oil & Gas reservoirs rocks may also act as geothermal reservoirs (sands of the Lower Pontian, Miocene limestones, triassic fractured limestones and dolomites)
 - Hydrocarbon plays are located in local depression in which the sediments are more than 2500—3000 m thick, there is also a good consistency between the Neogene thickness and the temperature maps
- => the occurrence of Oil and Gas accumulations and geothermal potential may be closely linked
- The gas content in geothermal fluids
 - Mrazovac & Basic (2009) reported that geothermal waters (25–82° C) of the shallowest groundwater system of Vojvodina (surface to lower Pontian) have elevated gas content (> 1 Nm³/m³) with a high methane fraction (on average, about 93.3% of the total gases)
 - CO₂ and N₂ are the remaining gas species dissolved in the fluid
 - This is comparable to the elevated gas content and high methane fraction encountered in other parts of the Pannonian Basin (Romania, Croatia, Hungary)

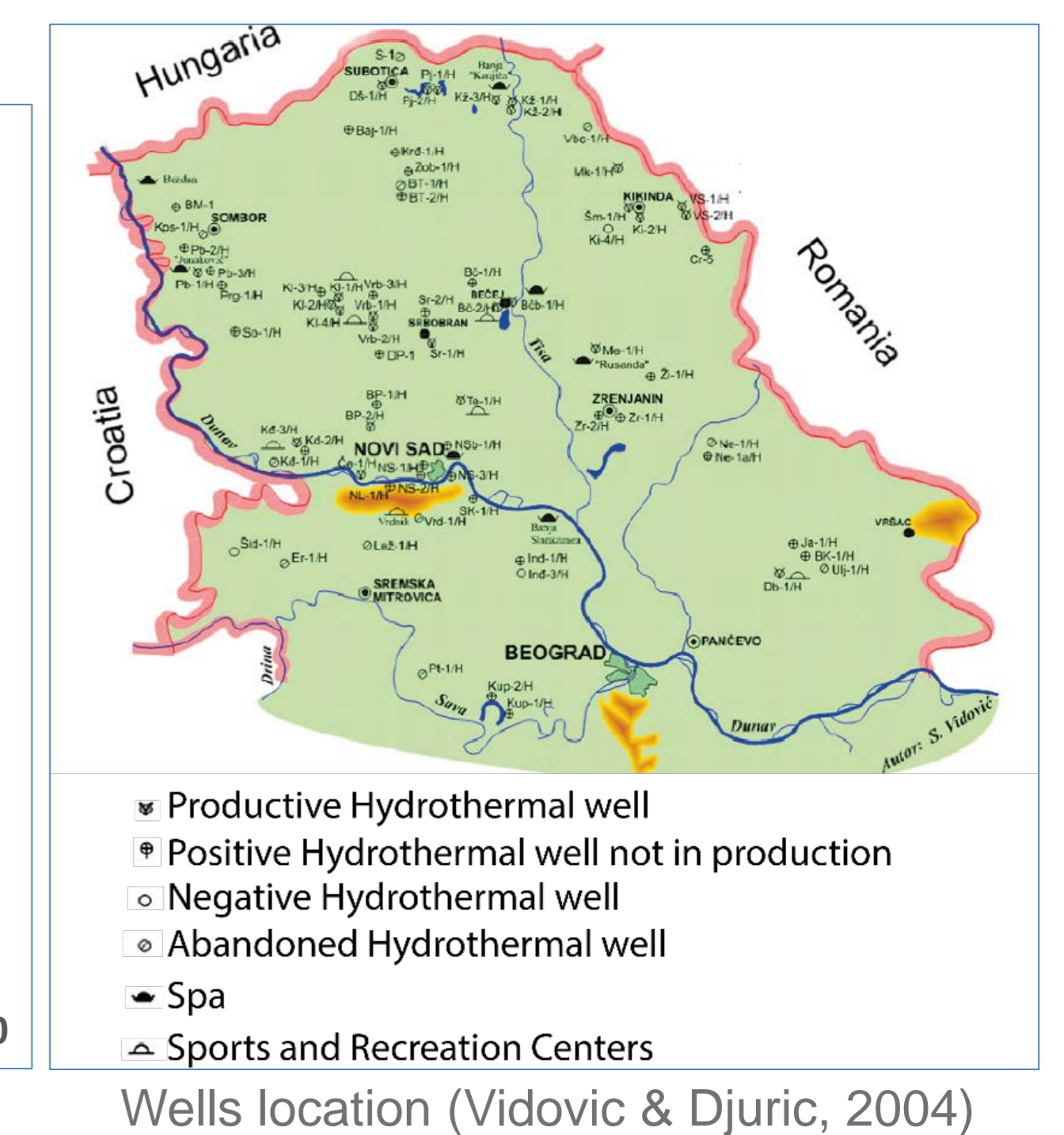


Distribution of total gas content in the thermal waters of Vojvodina (modified from Mrazovac & Basic, 2009).

- Opportunities of Oil and Gas wells conversion towards Geothermal wells may only be possible for a limited number of wells



Wells Status (modified from NIS, 2015)



Wells location (Vidovic & Djuric, 2004)

NEXT STEPS

- Operational feedback from HC-GT Co-production in the Pannonian Basin (sites visit)
- Recommendations for co-production schemes in Vojvodina and inputs for specific co-production business models
- Co-production potential evaluation based on underground data

Acknowledgements: This work was performed in the framework of the GOSPEL project, which has received funding from the DG Trésor under the FASEP agreement n° 1051-SERBIE

References:
 - Jelenković, R., Kostić, A., Životić, D., Ercegovac, M., 2008. Mineral resources of Serbia. GEOLOGICA CARPATHICA, AUGUST 2008, 59, 4, 345—361.
 - Molivojević, M., 2012. Geothermology and Geothermal Energy, (in Serbian), Textbook, University of Belgrade, Fac. Min. & Geol., Belgrade
 - Mrazovac, S., Basic, D., 2009. Methane-rich geothermal waters in the Pannonian Basin of Vojvodina (northern Serbia). Geothermics 38 (2009) 303–312
 - NIS, 2015. Geothermal Resources of Vojvodina and Application of Geothermal Systems. Novi Sad.
 - Vidovic, S., Djuric, S., 2004. Utilisation of geothermal waters and geothermal energy in Vojvodina.