

Authors

Elodie JEANDEL and Eléonore Dalmais

Companies

EDF/EIFER and ES Géothermie

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)**

Élodie JEANDEL (EDF R&D/EIFER)

Eléonore DALMAIS (ES Géothermie)

SMU Conference, Dallas, 2018





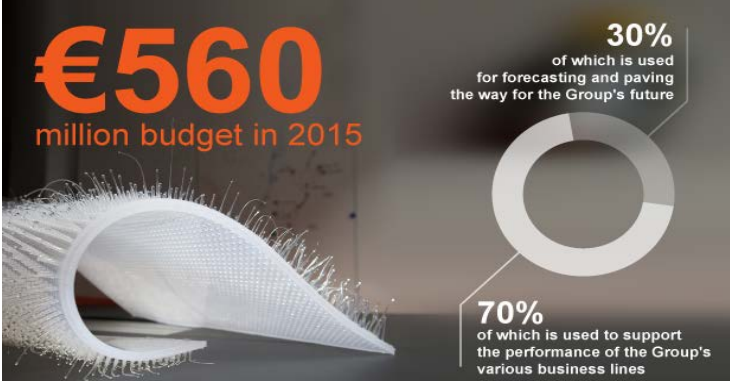
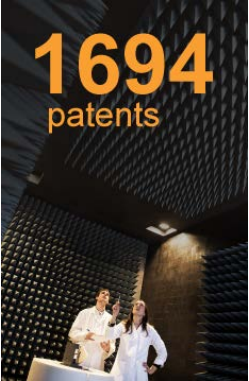
SUMMARY

The GOSPEL Project “*Geothermal Pilot projects for Heat and Electricity in Serbia*”

Hydrocarbon-geothermal co-production challenges: Worldwide scope

The Pannonian Basin and Serbian case study

EDF R&D Key Figures



Hydrocarbon-geothermal co-production challenges in Eastern Europe

The GOSPEL Project

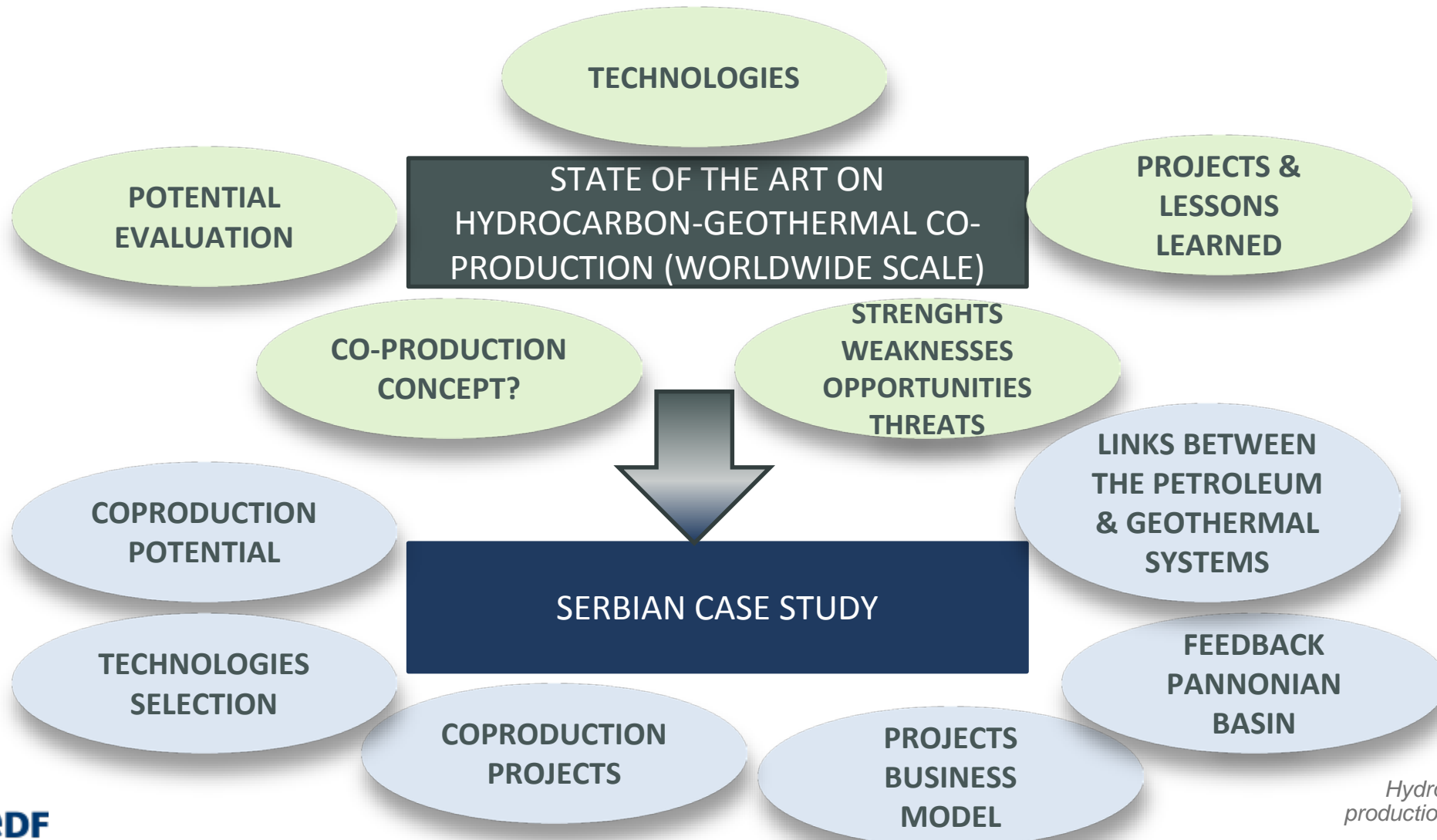
"Geothermal Pilot projects for Heat and Electricity in Serbia"

- 2 years project (May 2017-2019) partly funded by the French government and supported by the Serbian Autonomous province of Vojvodina
- Coordination: ES Géothermie in partnership with IEL (*"Initiatives & Energies Locales"*)
- A french-serbian consortium combining local knowledge and industrial expertise
- Objectives:
 - Performing pre-feasibility studies and encouraging the emergence of industrial geothermal energy projects in the country
 - The various dimensions of geothermal energy projects will be considered (underground knowledge, user needs, heat and electricity markets and prices, as well as the regulatory framework and funding opportunities)
 - Regional evaluation will be followed by the selection of 3 areas of interest for identifying and characterising 3 projects

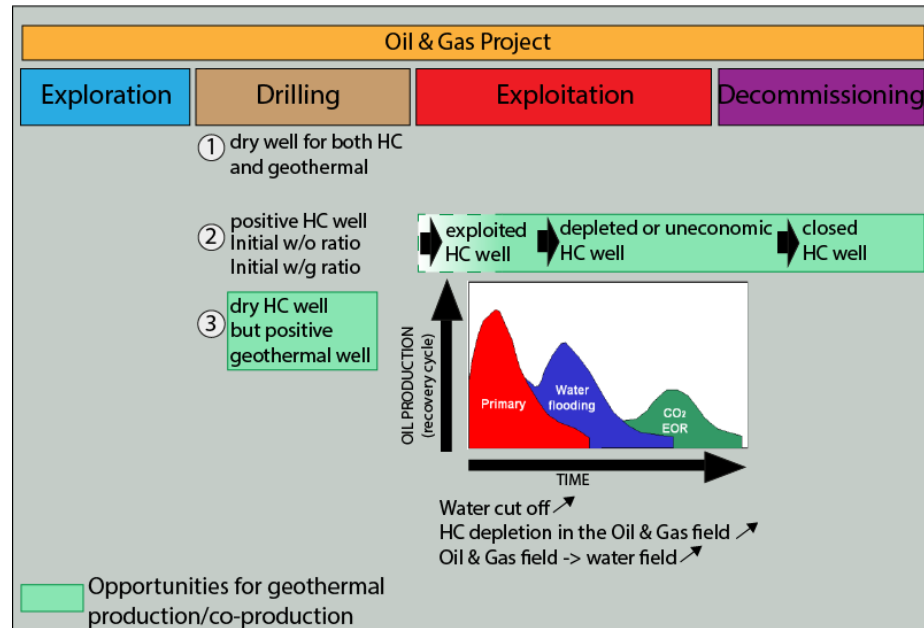


The GOSPEL Project

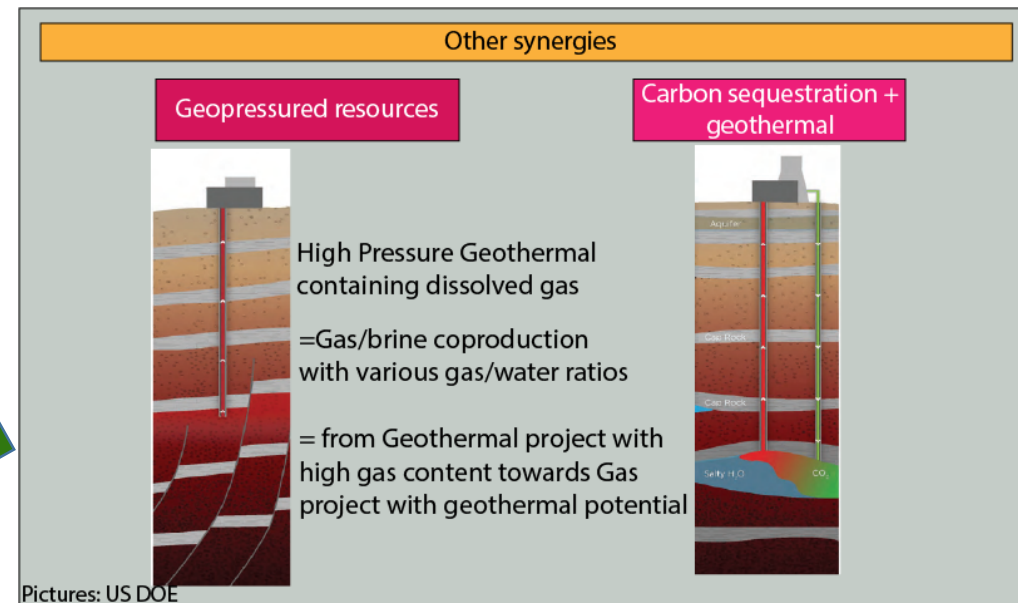
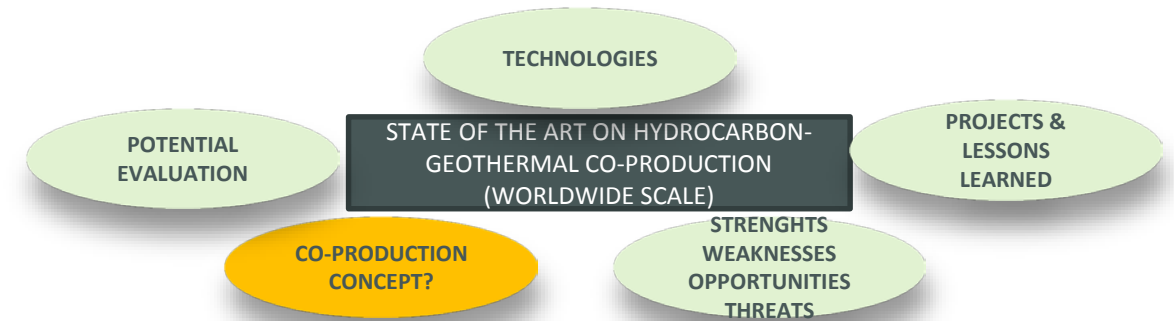
Task 3: Geotechnologies: Hydrocarbon-geothermal co-production challenges in Eastern Europe



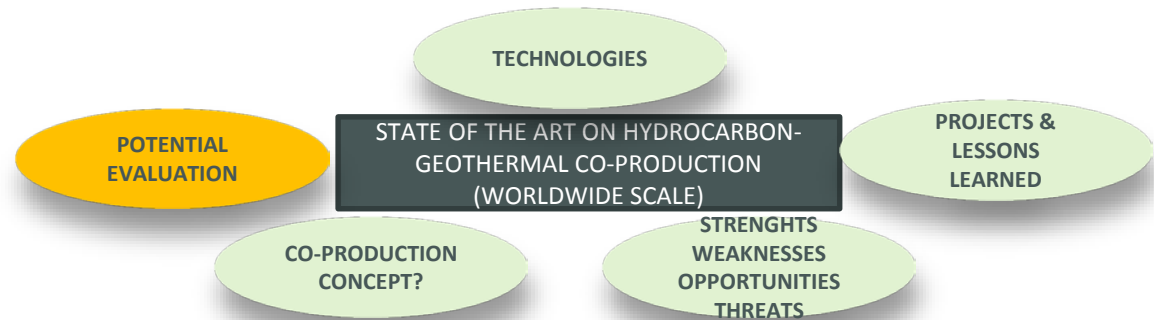
Co-production concept: a wide range of opportunities



Heat/Hot Water, Power,
Thermal Oil Recovery...
For on-site consumption or
for other customers



Co-production potential evaluation: A growing topic...



North Sea: Geothermal seen as an option for added value
Netherlands: modelling + technico-eco. studies

Pannonian Basin: on-going projects without detailed potential assessment found in the public domain

Canada: recent potential assessment

Rhine Graben: HC detected in geothermal fluids

Italy: feasibility study (ViffafortunaTrecate oil field)

USA: detailed potential assessment studies

Mexico: HC detected in Cerro Prieto geothermal fluids

China: huge potential - characterization effort at basin scale

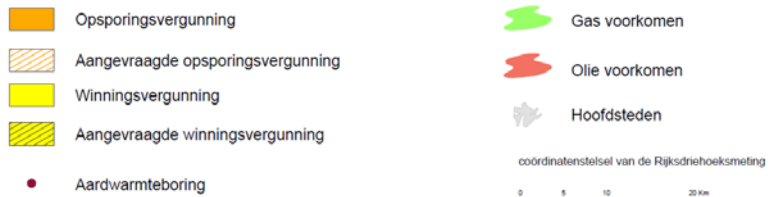
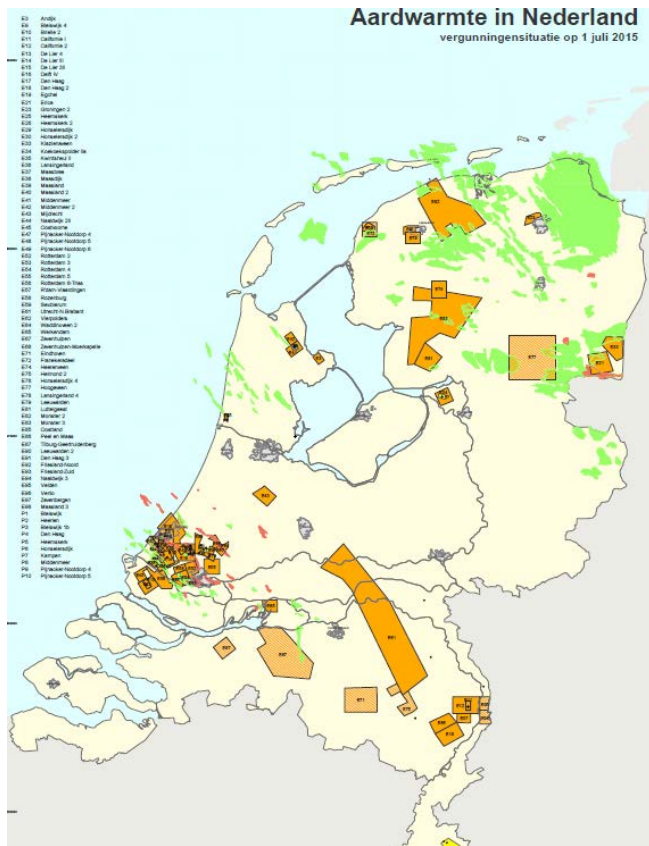
Indonesia: 1 feasibility study

Middle East: Turkey is already a well established geothermal and Oil & Gas producing country
Other countries: geothermal potential characterization in its infancy

New Zealand: reconnaissance study in abandoned wells

Australia: geothermal potential characterization in the Otway Basin

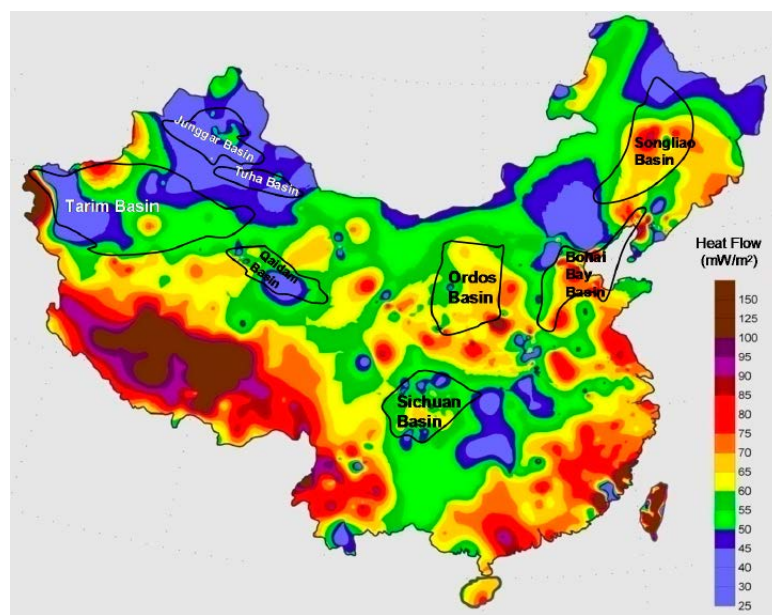
CANGEA; AAPG; Navarro et al., 2014; WEC, 2017; Peters et al., 2014; Van Wees et al., 2015; Sanjuan et al., 2014; Soldo & Alimonti, 2014; Wang et al., 2016; Kuyumcu, 2000; Reyes, 2007; Syarifudin et al., 2016; Barnett & Burns, 2008



Geothermal licenses versus Oil & Gas fields

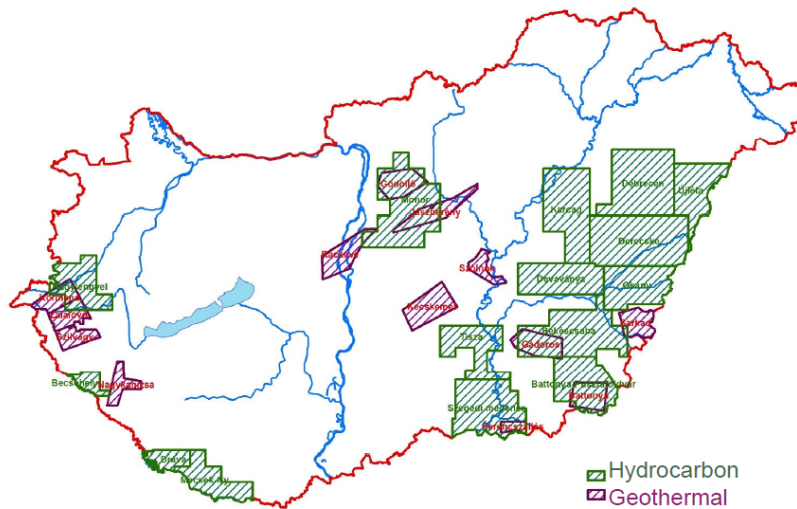
In the Netherlands

Example: Geothermal and Oil & Gas synergies (TNO)



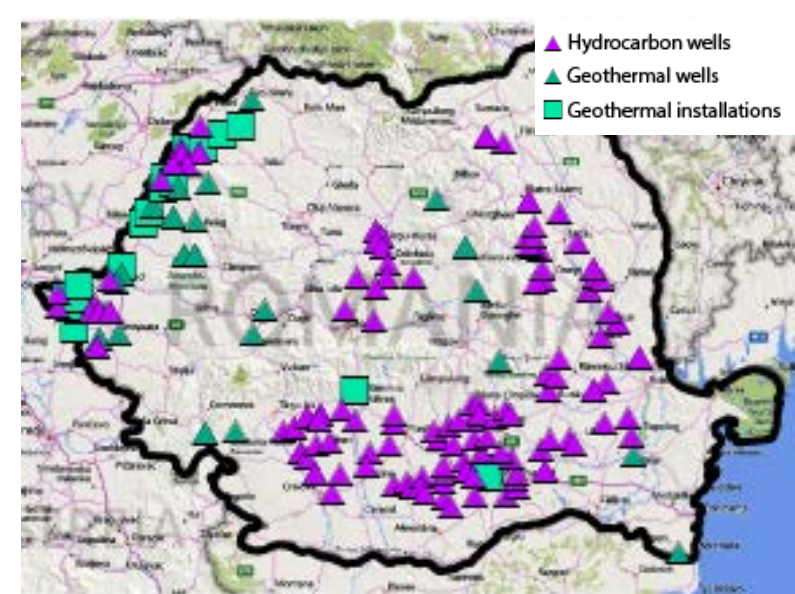
In China

Example: Matching between heat flow and sedimentary basins (Wang et al., 2016)



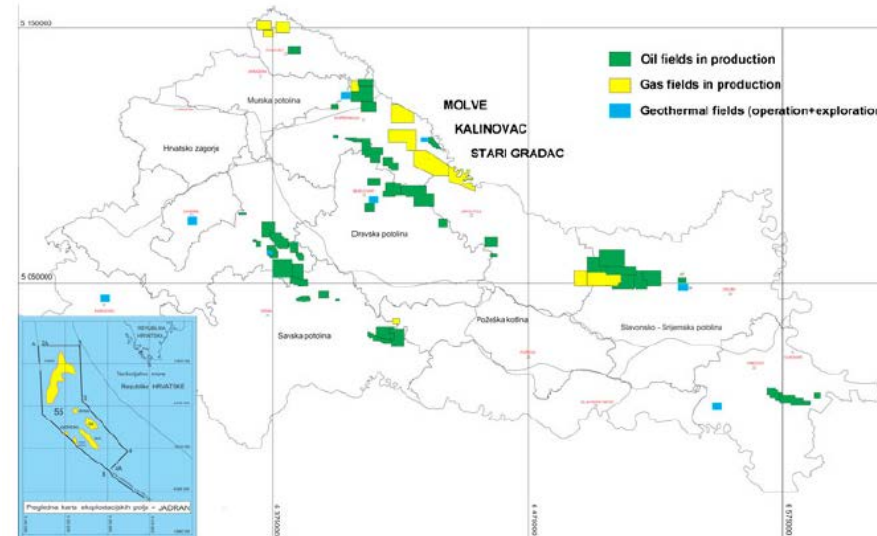
HC and Geothermal concessions in Hungary

(Hungarian Office for Mining and Geology, 2014)



In Romania

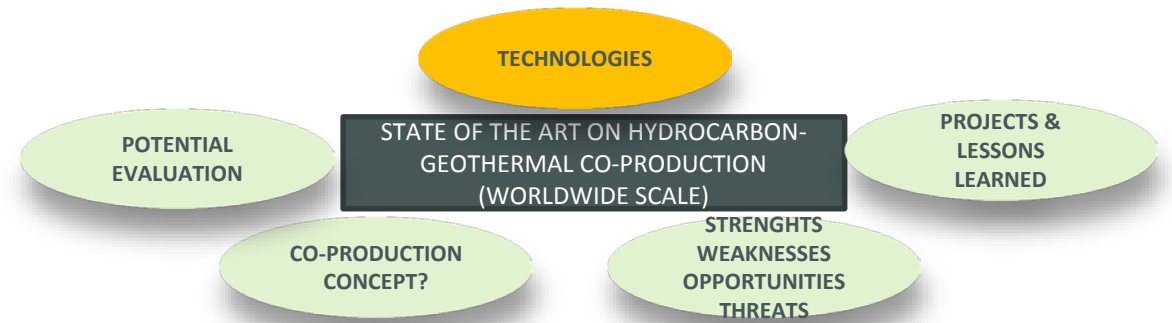
Hydrocarbon and Geothermal wells & installations location, modified from <http://harti.igr.ro/geofizica-v1/>



HC and Geothermal concessions in Croatia (Kurevija & Vulin, 2011)

Co-production technologies

- Closed loops: A few publications presented numerical models considering WellBore Heat Exchanger in existing oil and gas wells (Nalla et al., 2005, Kujawa et al. 2006, Zhang et al. 2008, Davis and Michaelides, 2009, Bu et al. 2012, Cheng et al. 2013),
- Mobile ORC and ORC
- Heat Pumps
- Water-Oil-Gas multiphase mixture management technologies in co-produced fields
- Corrosion and scaling issues



Ormat Organic Rankine Cycle (ORC) 250 kW, Rocky Mountain Oilfield Testing

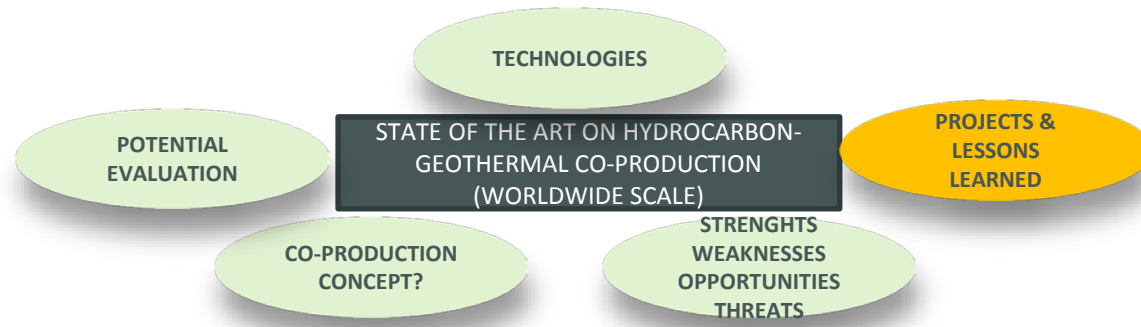


Degasification unit at Kunszentmárton, Hungary (Geothermal Era-Net)



Heat exchanger and geothermal power generation plant (Huabei oilfield, China)

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
- CAPACITY
- TEMPERATURE AND FLOW RATE
- FIELD TYPE
- PROJECT and WELL USE TYPE

Heat, power, heat and power, EOR/EGR

From 23 kWe to 16.5 MWe
From 450 kWth to 20 MWth

From 45 to 172.5°C
From 3 to 305 L/s

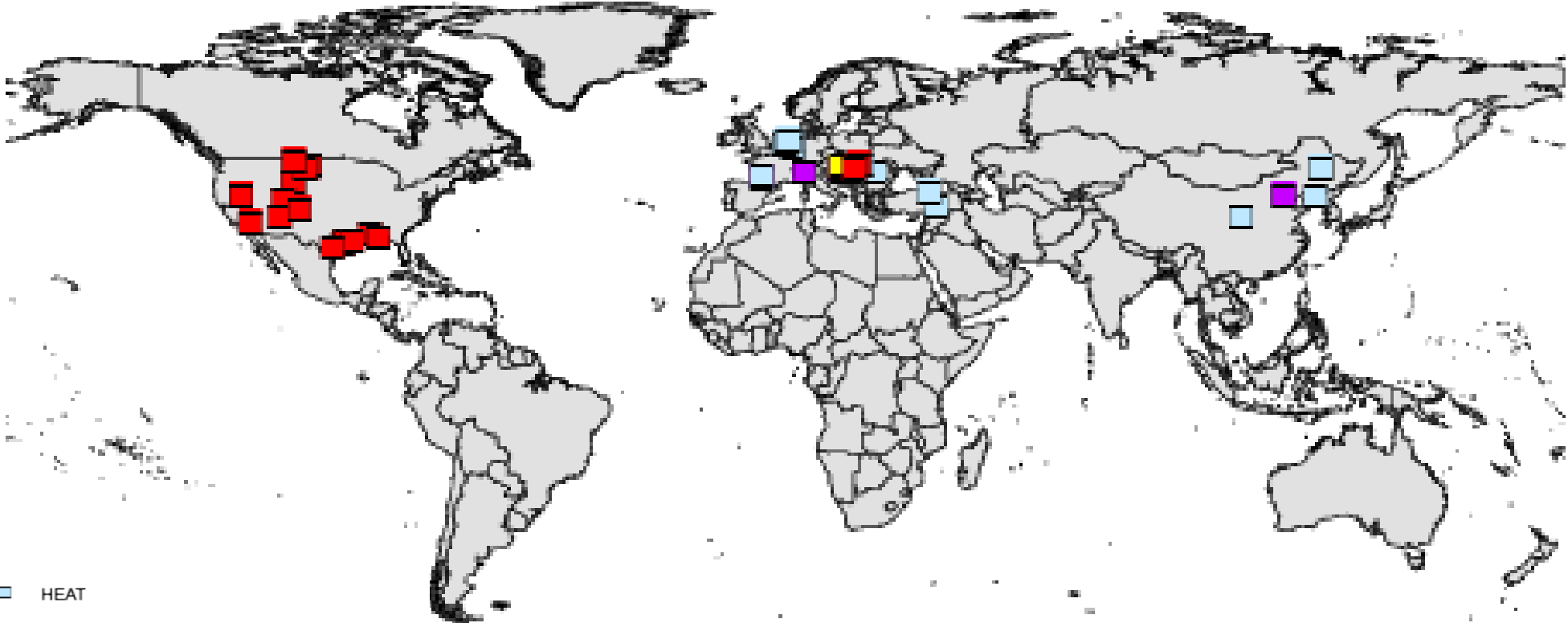
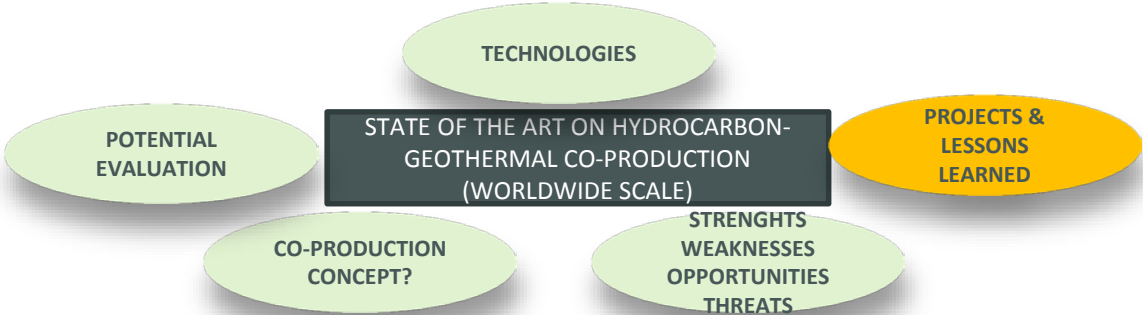
OIL &/or GAS FIELDS (DEPLETED, EOR...)
GEOTHERMAL FIELDS

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

- The projects inventory Includes feasibility studies
- It is particularly difficult to « classify » co-production projects and differentiate the power and heat capacity associated to geothermal energy production and/or methane combustion
- The list is not exhaustive!

Co-production projects inventory

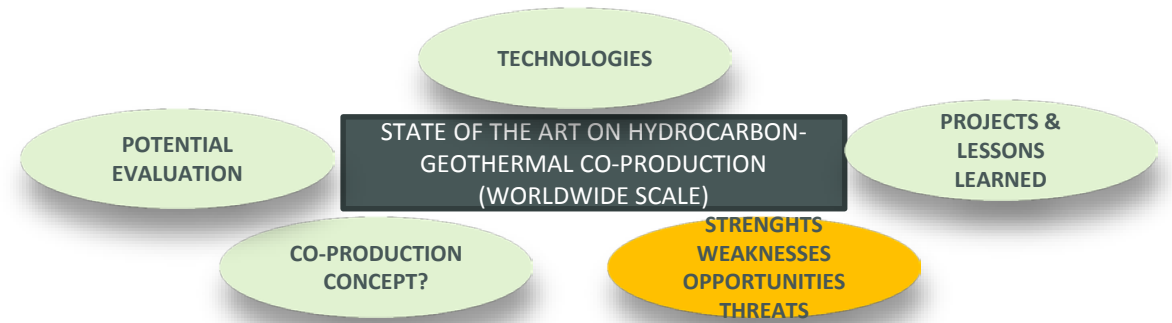
ENERGY USE



- HEAT
- POWER
- POWER AND HEAT
- THERMAL EOR/GAS LIFTING
- UNKNOWN



Co-production SWOT



Strengths/Opportunities

- **Abundance of Geological Data and Abandoned Wells** in Oil & Gas fields
- **A major untapped resource** (theoretical potential)
- **Lower CAPEX** for geothermal energy projects
- **Wider expansion and deployment of geothermal energy and Enhanced Geothermal System technologies**
- **Extension of the economic life** of Oil & Gas fields? May geothermal scheme act as an EOR/EGR method?
- **Valorisation of uneconomic Oil & Gas wells and improved water and abandoned wells management in Oil & Gas Fields**
- **Technologies: mobile ORC, heat pump...**
- **A large panel of possible energy customers**
- **Renewable energy incentives**

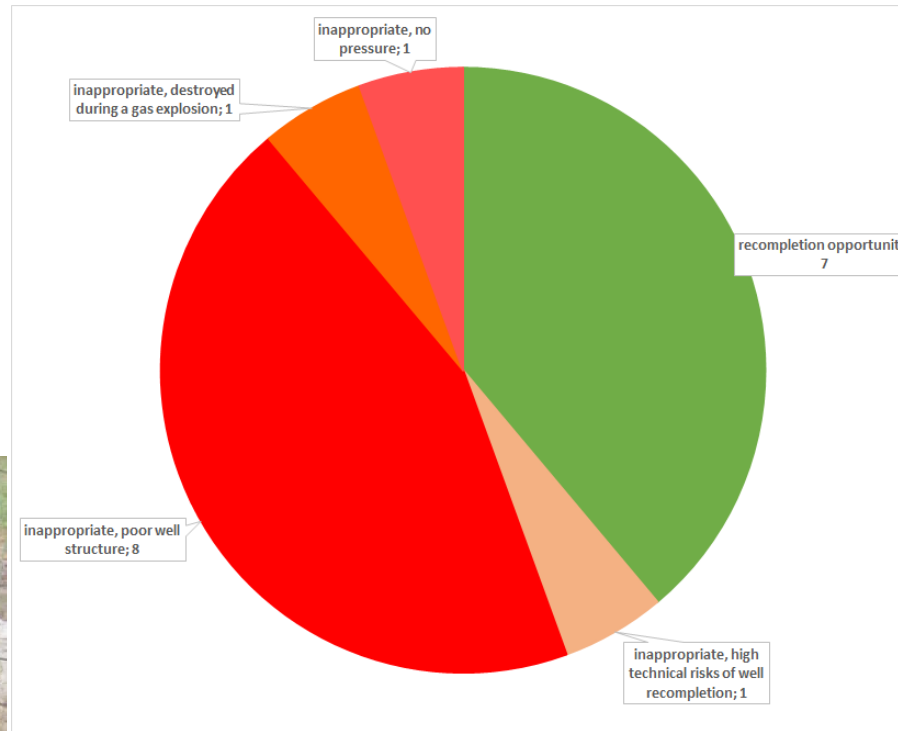
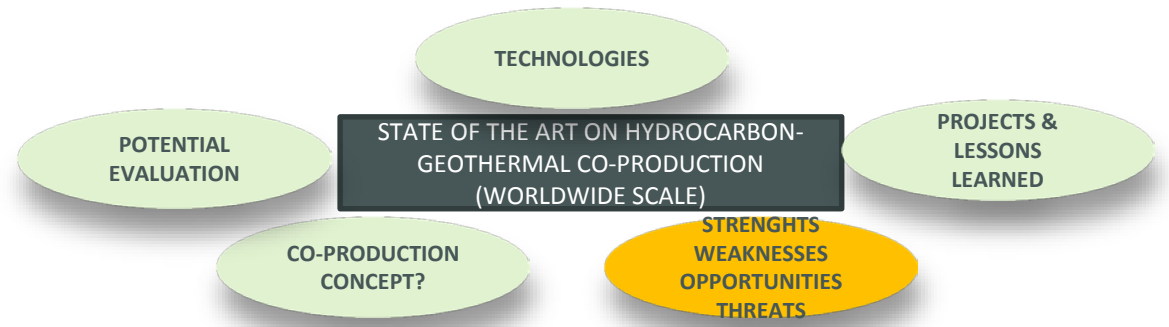
Weaknesses/Threats

- **Thermal conditions, lower production rates and wellbore diameters in Oil & Gas fields**
- Risk of significant **heat losses**
- Management of hydrocarbon-water-**multi-phase fluids**
- **Saline fluids** of sedimentary basins and corrosion/scaling processes
- **A recent topic**
- **Integrity and location of abandoned wells, workover feasibility and costs**
- **Regulation**
- **Economic profitability** and competition with fossil fuels
- **Social acceptance?**

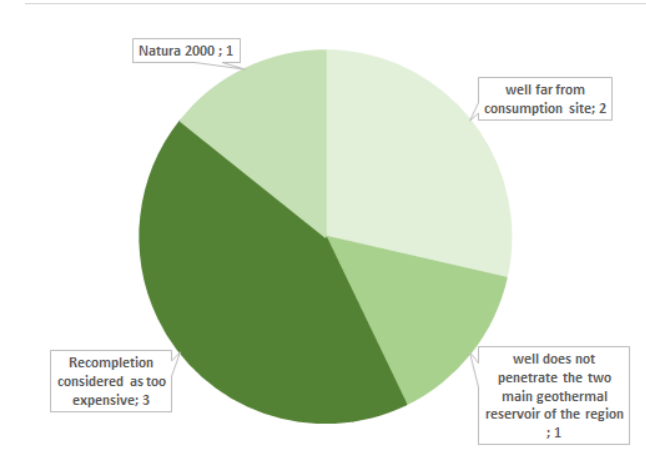


Co-production SWOT

Evaluation of abandoned hydrocarbon wells in the Pannonian Basin (Case study of Hungary, Kujbus & Kujbus, 2015)

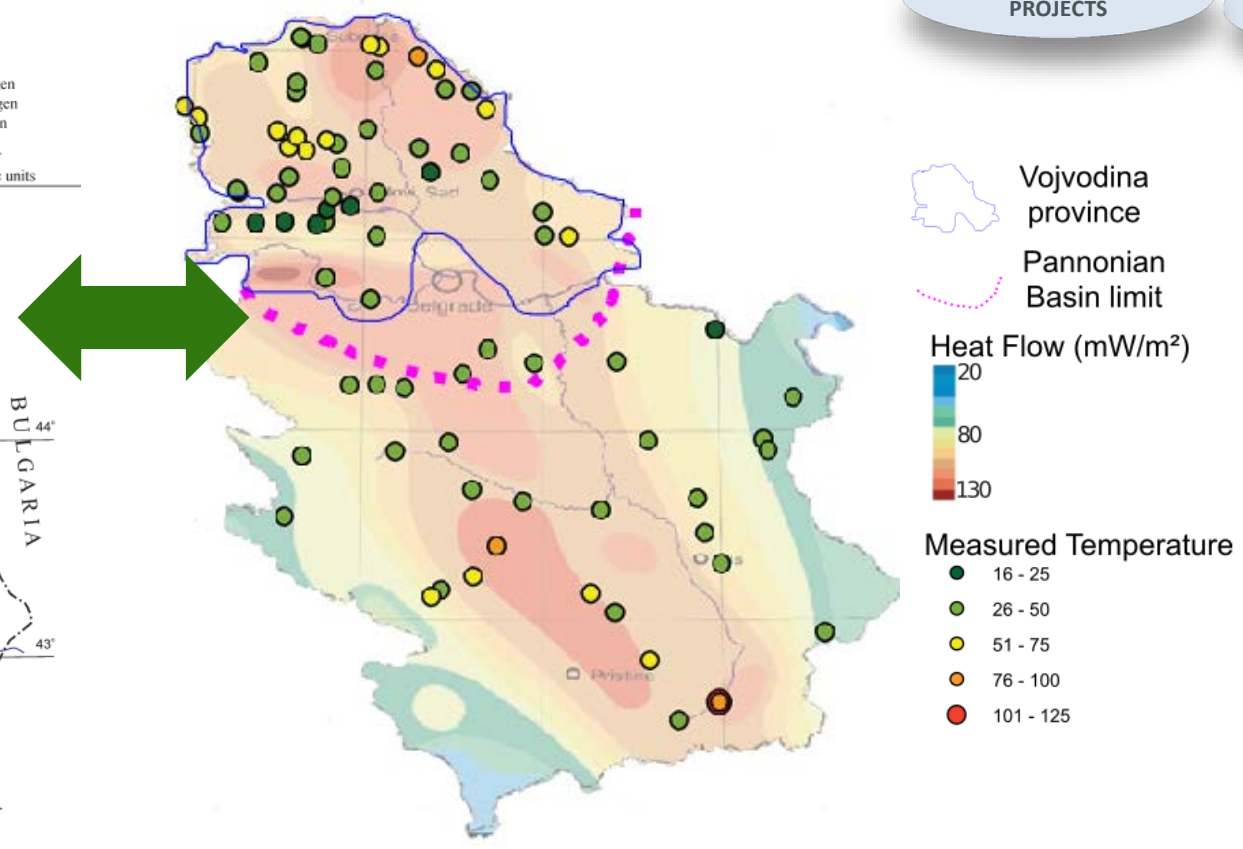
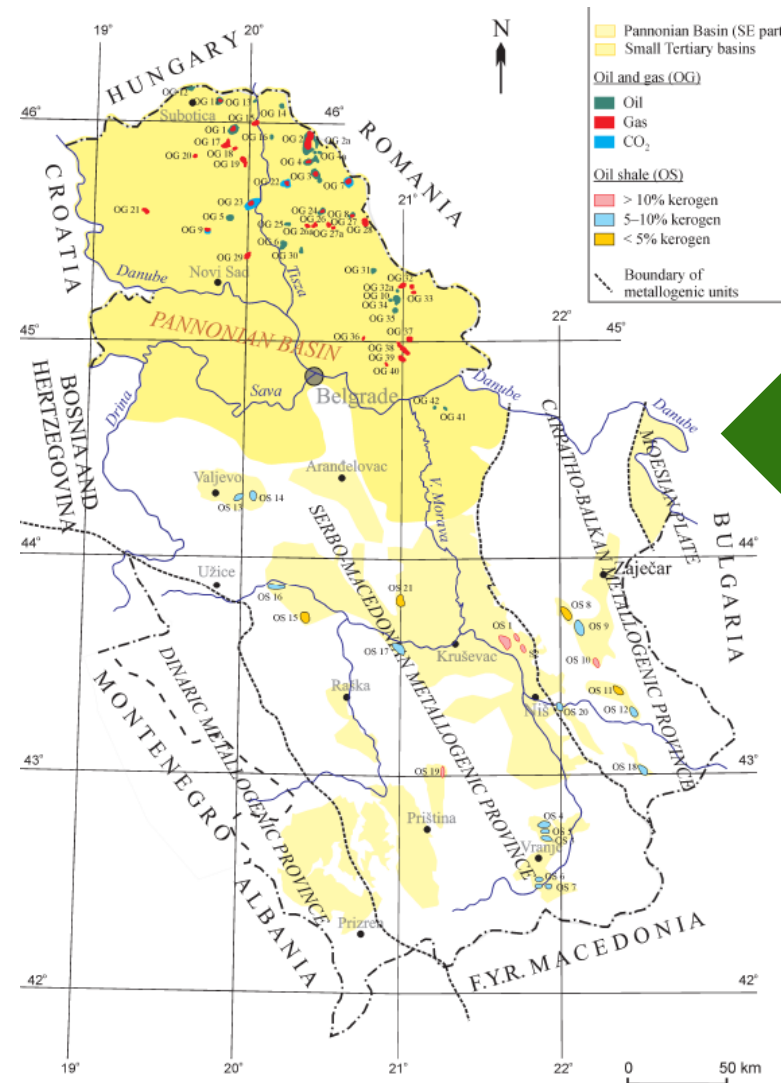


Main observations done for the 18 wells investigated by Geothermal Express Ltd. (Kujbus & Kujbus, 2015)



Evaluation of the wells presenting recompletion opportunity (Kujbus & Kujbus, 2015)

The Serbian case study



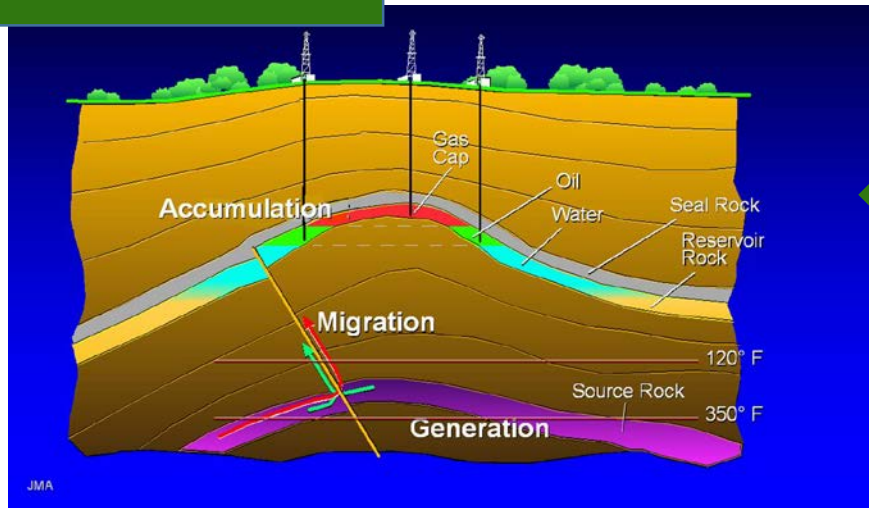
Interesting prospects for geothermal energy production will surely be HC co-produced fields

The Serbian geothermal potential. Modified from Eptisa, Mannvit, Energy Saving Group, 2011

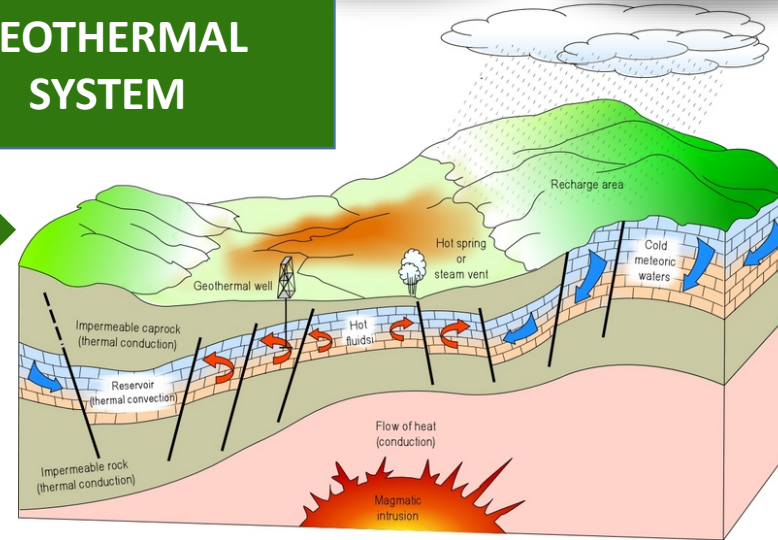
Oil and gas fields and oil shales in Serbia. Jelenkovic et al., 2008

The Serbian case study

PETROLEUM SYSTEM



GEOHERMAL SYSTEM



- Oil & Gas source rocks at shallow depths ⇔ Geothermal heat flow
- Oil & Gas reservoirs rocks may also act as geothermal reservoirs, especially the sands of the Lower Pontian, the Miocene limestones and the 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 temperature maps

= the occurrence of Oil and Gas accumulations and geothermal potential may be closely linked





**Thank you
Merci
Хвала**

elodie.jeandel@eifer.org

