



CO₂ Sources, Transportation and Storage Possibilities in Serbian Oil and Gas Fields

10th "Trondheim Conference on CO₂ Capture, Transport and
Storage"

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NIS.EU

NIS in a nutshell

- One of the largest vertically integrated energy systems in SEE.
- The Company's core activities include:
 - Exploration, production and refining of oil and gas;
 - Sales of a wide range of oil and gas products;
 - Implementation of projects in the field of petrochemistry and energy production.

Briefly in figures

- NIS is engaged in activities performed in 48 oil and gas fields located in Serbia;
- NIS owns a modernized refining compound, with units in Pančevo and Novi Sad and LPG production unit in Elemir;
- 2018 output - 1,332 thousand tons of oil and gas equivalents;
- 14 small cogeneration modules;
- Developed network of over 400 petrol stations in Serbia and the region so far;
- NIS is an international group operating in 9 countries.

Within a broader scope of NIS engagement, participation in research and innovation projects which is EU oriented, at the first place, and then abroad, constitutes an important component of company's activities.

NIS continuously seeks new partnership opportunities for exchanging innovation and knowledge, that could lead to the improvement of overall efficiency and competitiveness of the Company's operations.



NIS affiliates involved in CCS project

Scientific and Technological Center (STC)

provides scientific and technological support to NIS in all stages from exploration and identification of hydrocarbon sites to monitoring of development and exploitation thereof over the entire life cycle



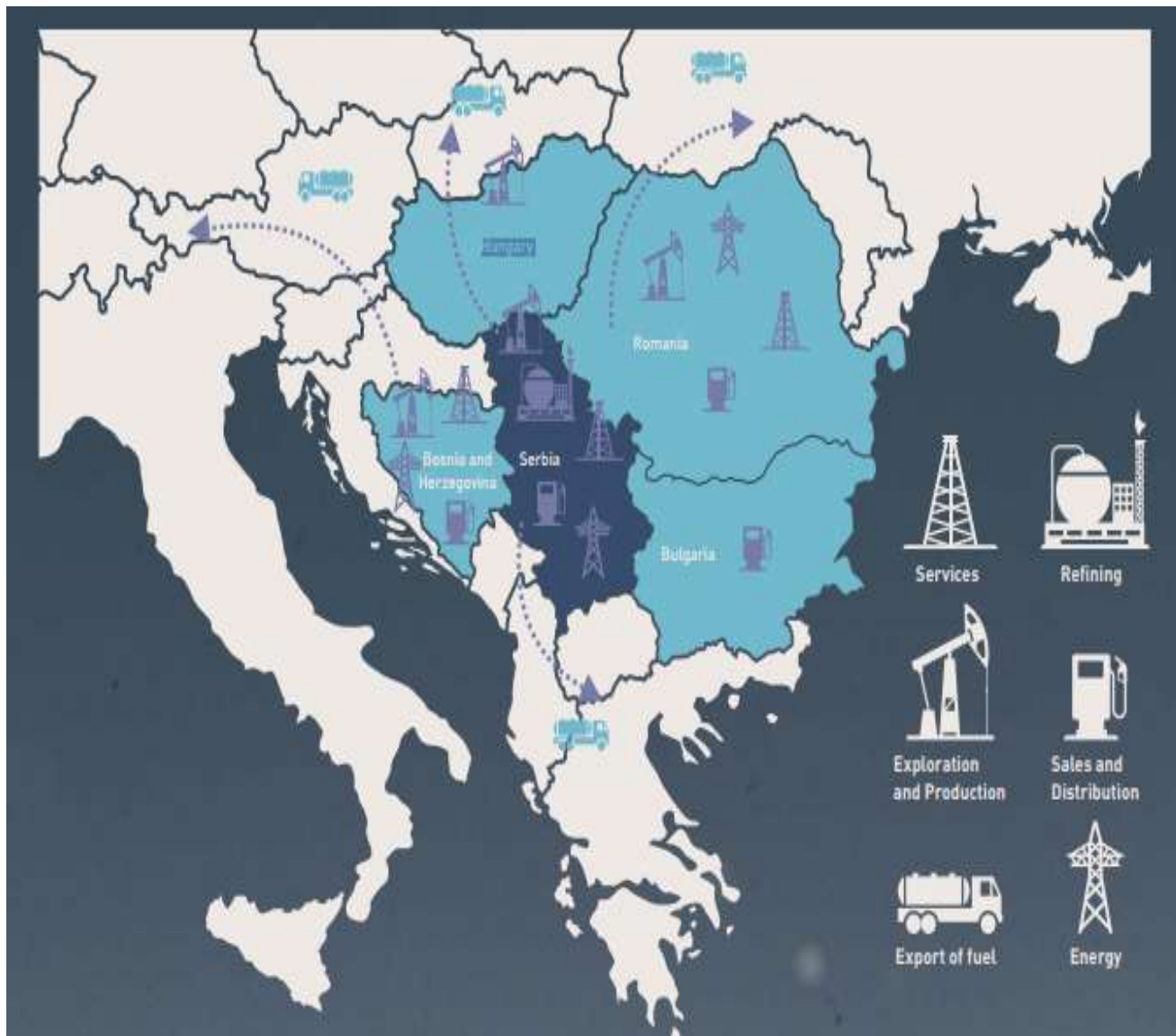
NIS affiliates (related third parties) – 100% NIS ownership

Naftagas Oilfield Services (NOS)

provides services in oil and gas exploration and production through geophysical surveying, well construction, completion and workover, and performance of special and well logging operations



NIS in Europe/on the Balkan Peninsula



NIS is the only company involved in exploration and production in Serbia with the largest part of oil and gas fields being located in the northern part of the country.

Scientific and Technological Center NIS-Naftagas has been assessing the potential for long-term carbon dioxide storage in Serbia.

There are more than 300 reservoirs, including 80 oil and gas fields discovered in the northern part of Vojvodina Province and the rest of Serbia.

Most oil and gas fields in northern Serbia, that is, Vojvodina Province, are located in the Pannonian Basin.

INTRODUCTION

Carbon capture and storage (CCS) was developed as a promising technology for reducing CO₂ emissions from industry into the atmosphere and to reduce global warming problem. CCS technologies are based on capturing the CO₂ from sources, transportation and safe storage of CO₂ in suitable geological formations.

Geological storage of CO₂ can be performed in:

- **Un-mineable coal layers** - *are perspective formations for CO₂ injection to enhance methane production (coal bed methane – CBM) but geological uncertainties and the effects of the coal matrix swelling which are reflected in decreasing of permeability can affect the whole process.*
- **Saline aquifers** - *have a high potential to successfully store large quantities of CO₂. Carbon dioxide in saline aquifers reacts with salt water and due to different mechanisms and chemical processes, remains retained in the formation for long time periods.*
- **Oil and natural gas reservoirs** - *have many advantages compared with other geological formations including very low exploration costs, good traps and seals, well described reservoir properties and the presence of surface facilities and existing oil and gas pipelines that can be reused for CO₂ transportation and injection.*

Injection of CO₂ into the oil reservoirs can be an effective tertiary method (CO₂-EOR) for increasing final recovery factor.

Successful implementations of CCS projects require good evaluation and integrity of storage sites. The main factors that have strong influence on geological storage of CO₂ include the depth of the formation, state of CO₂ in underground conditions, presence of fractures or faults in the formation that can create pathways for migration and wellbore integrity.

The conducted studies recommend storage of CO₂ at depths greater than 800 m or over the 1000 m, reservoir temperatures more than 31 °C, critical pressure around 7.5 MPa.

CO₂ Sources in Serbia

There are two major CO₂ sources in Serbia:

- I - CO₂ from power plants
- II - CO₂ from natural gas mixture

Electricity generation in Serbia is consisted of fossil fuel thermal power plants, gas and liquid fuel fired combined heat and power plants and hydropower plants.

Lignite plays a main role for electricity generation because more than 70% of the electricity is produced from lignite combustion in thermal power plants. The country relies on lignite for 45% of its total primary energy supply. Total capacity of coal – fired power plants is 3936 MW.

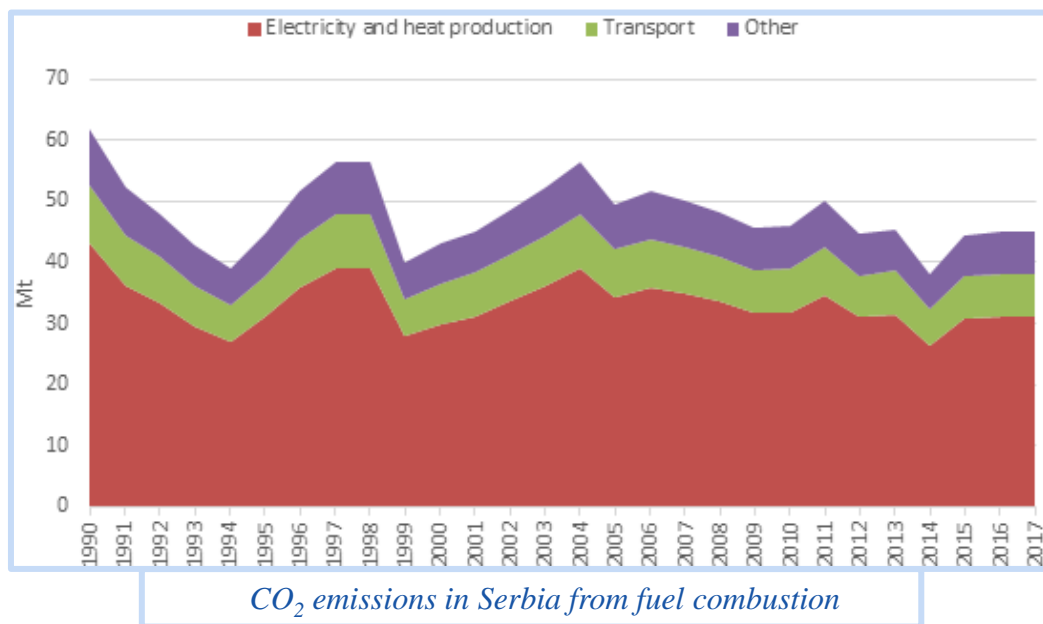


TABLE I: CO₂ Emissions from Thermal Power Plants

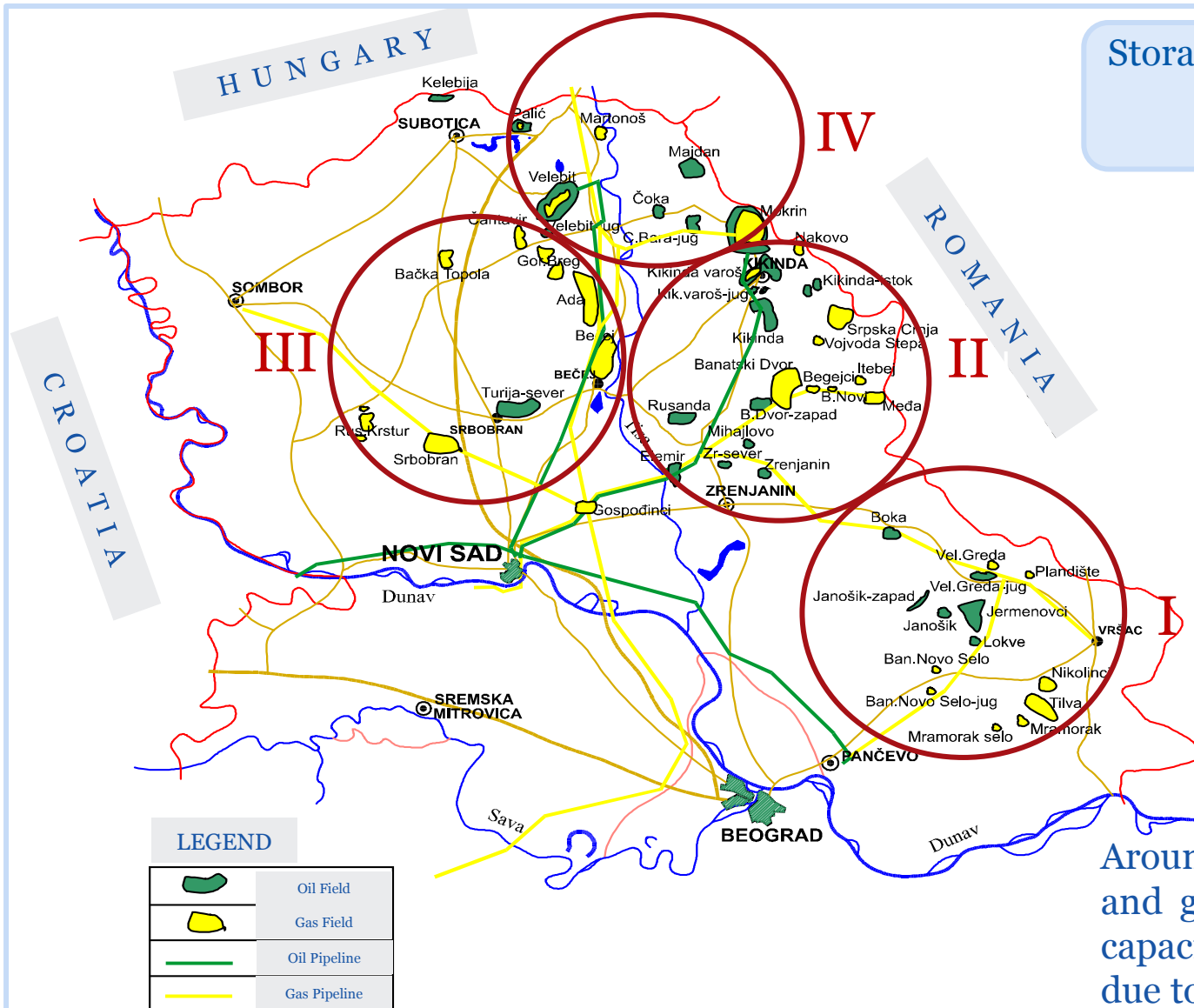
Power plant	CO ₂ emission [Mt CO ₂ /year]
Nikola Tesla	17
Kolubara	0.52
Morava	0.56
Kostolac	4.7
Total	23.14

Serbian coal-fired power plants do not have installed CCS system and require substantial investment

CO₂ from oil and gas fields with high CO₂ content



CO₂ Storage Possibilities in Oil and Natural Gas Reservoirs



Storage capacity is calculated using the following equations:

$$M_{CO_2} = \rho_{CO_2} \cdot R_f \cdot N \cdot B_O - W_i + W_p$$

$$M_{CO_2} = \rho_{CO_2} \cdot R_f \cdot (1 - F_{ig}) \cdot G \cdot B_g$$

TABLE II: Potential volumetric storage capacity

Group	Storage capacity [Mt]
I	14
II	36
III	10
IV	50
Sum	110

Around 80% of storage capacity is in II and IV group of oil and gas fields. Groups I and III have much lower storage capacity and planning and execution of CCS project is risky due to the low storage capacity.

Rusand feild case - Conversion CO₂-EOR Projects to CO₂ Storage Projects

- ✓ Separation of CO₂ from natural gas mixture was started in 2015 on the Rusanda oil field.
- ✓ The first CO₂-EOR project in Serbia and the first High Pressure Acid gas Capture Technology (HiPACT) unit built in the Europe.
- ✓ The main reason for the development of this project was the utilisation of the high content of CO₂ in natural gas mixtures (80%) from 7 gas fields and EOR.
- ✓ NIS invested more than 30 million € in HiPACT (High Pressure Acid-gas Capture Technology) treating unit which is used for CO₂ removal from natural gas.
- ✓ Separated gas consists of 99% CO₂.

Rusanda Field - CO₂-EOR Projects

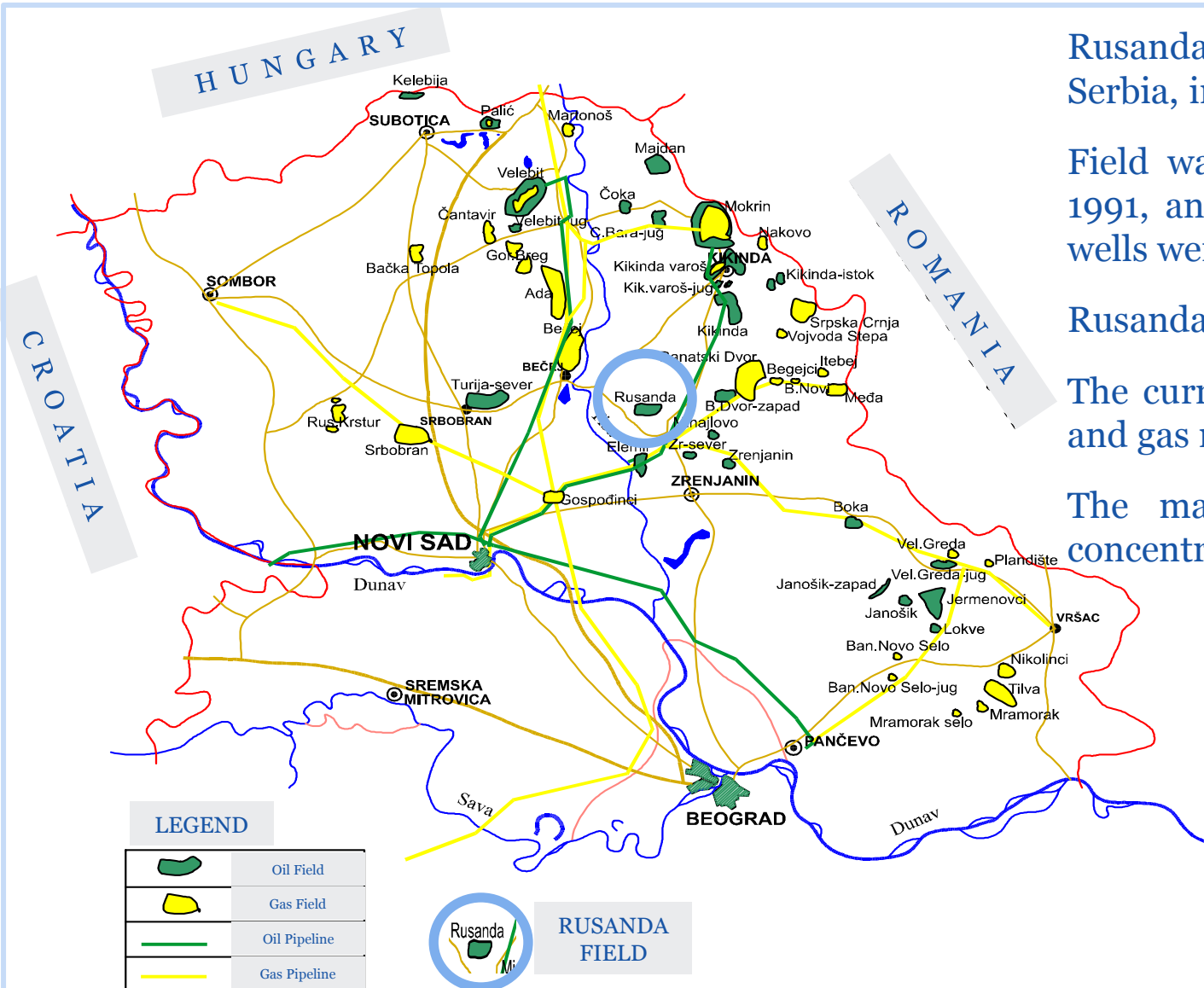
Rusanda field is situated in the northern part of the Republic Serbia, in Vojvodina Province.

Field was discovered in 1986 and has been exploited since 1991, and from discovery to December 1, 2015, a total of 10 wells were drilled: 4 production, 2 injection, 2 observation...

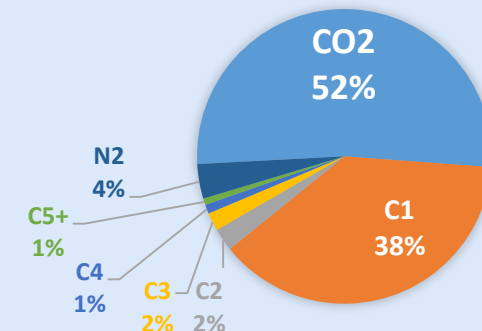
Rusanda field comprises 3 production formations.

The current project is focused on Pg1 formation - mature oil and gas naturally fractured reservoir.

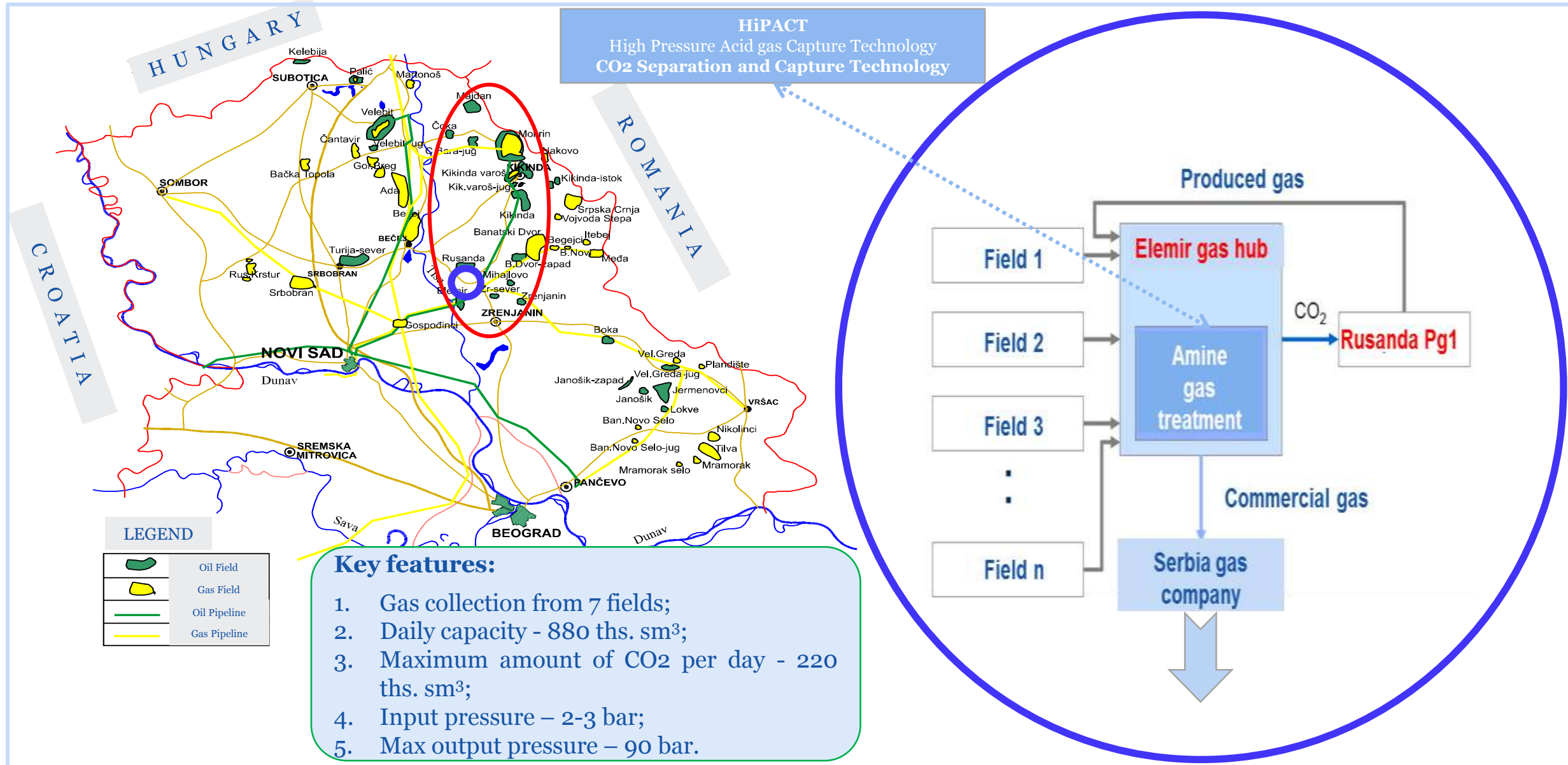
The main feature of this production object is a high concentration of CO₂ (up to 52%).



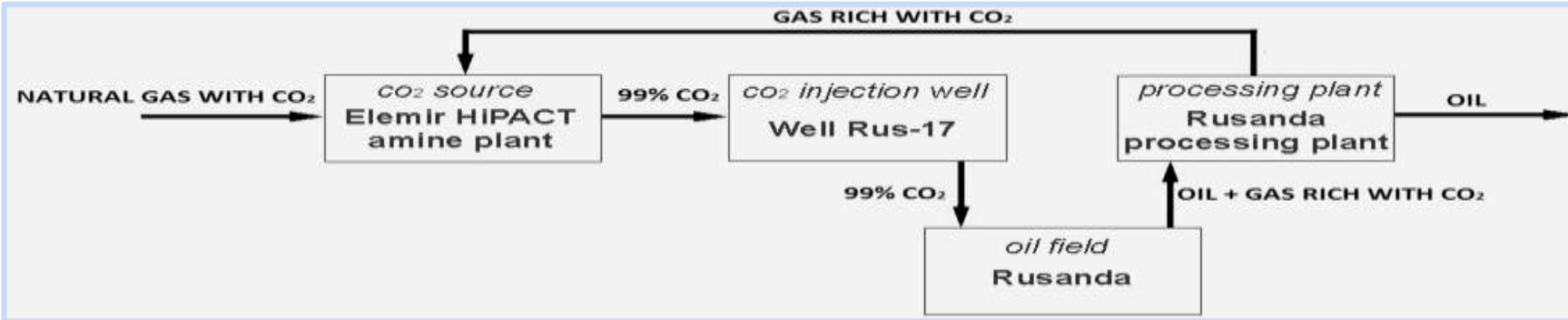
RUSANDA FIELD GAS COMPOSITION



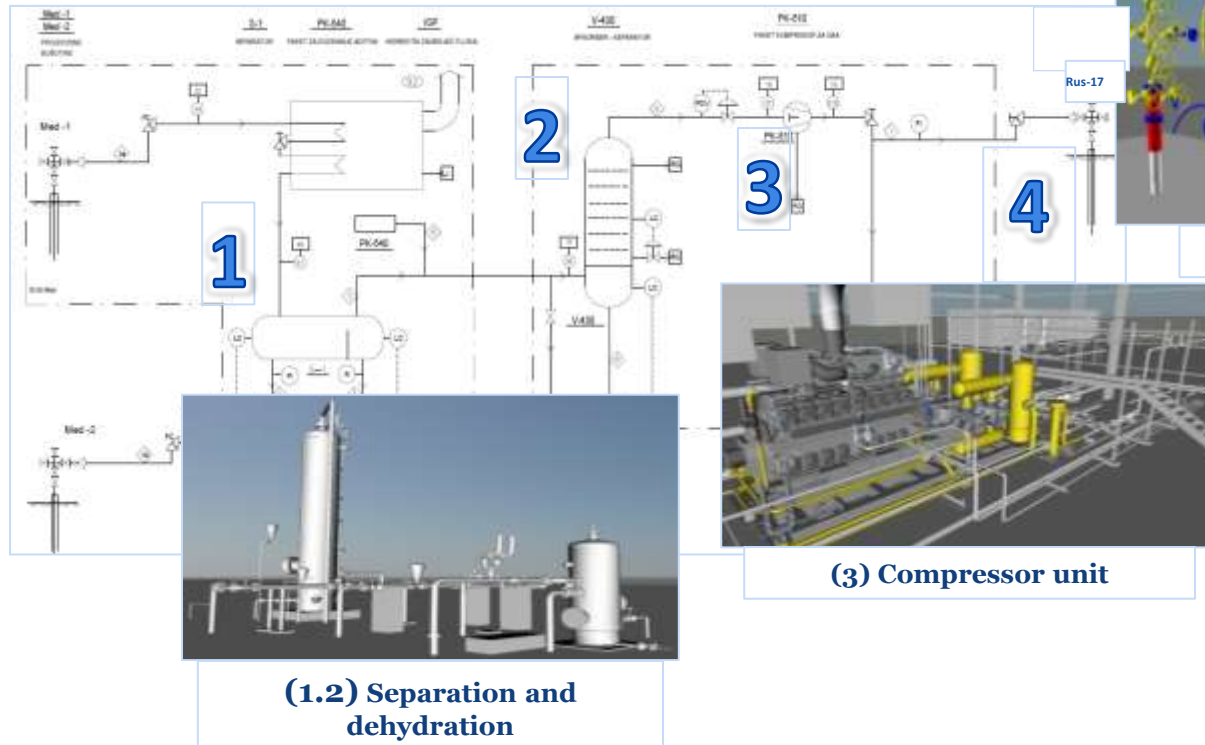
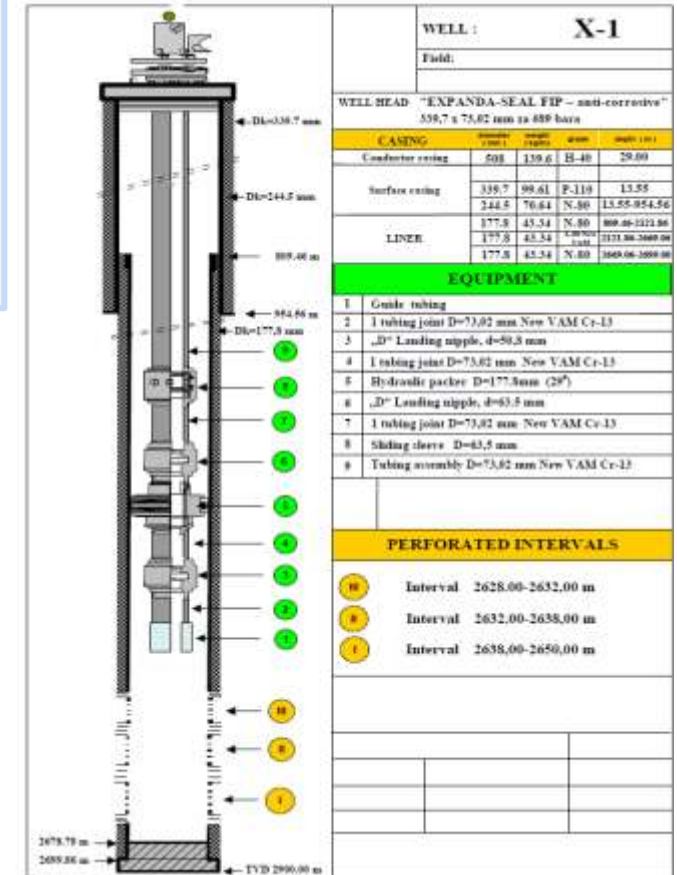
Rusanda Field – Infrastructure overview of CO₂ cycle in CO₂-EOR project



Rusanda Field - CO₂ utilization scheme - CO₂ Extraction and Injection Process



Well equipment



Due to initial high concentration of CO₂, all wells in Rusanda field are equipped with corrosion protection.

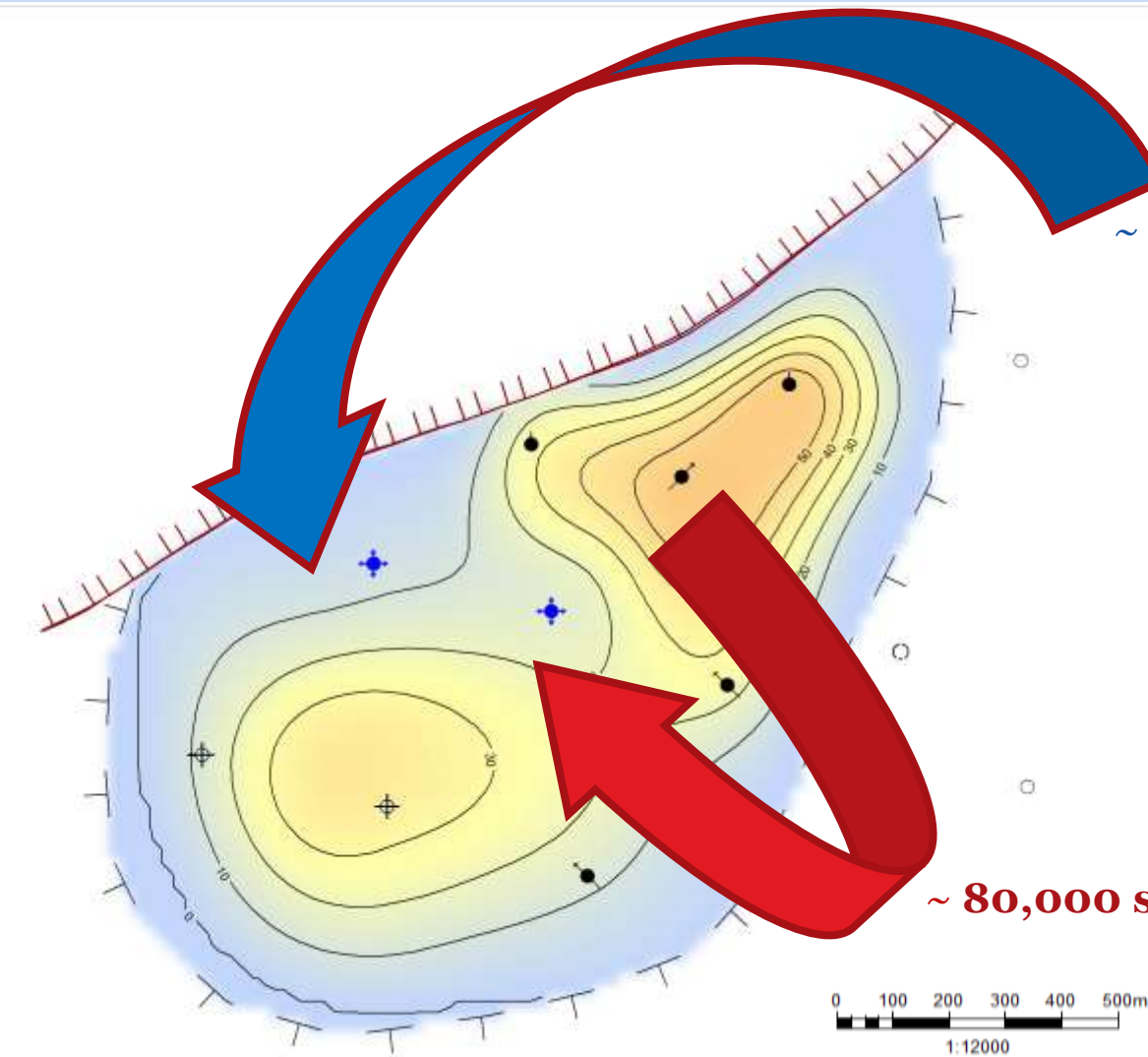
Scheme of CO₂ Injection in Rusanda Field

~ 140,000 sm³/day of pure CO₂ from Elemir amine treatment plant.

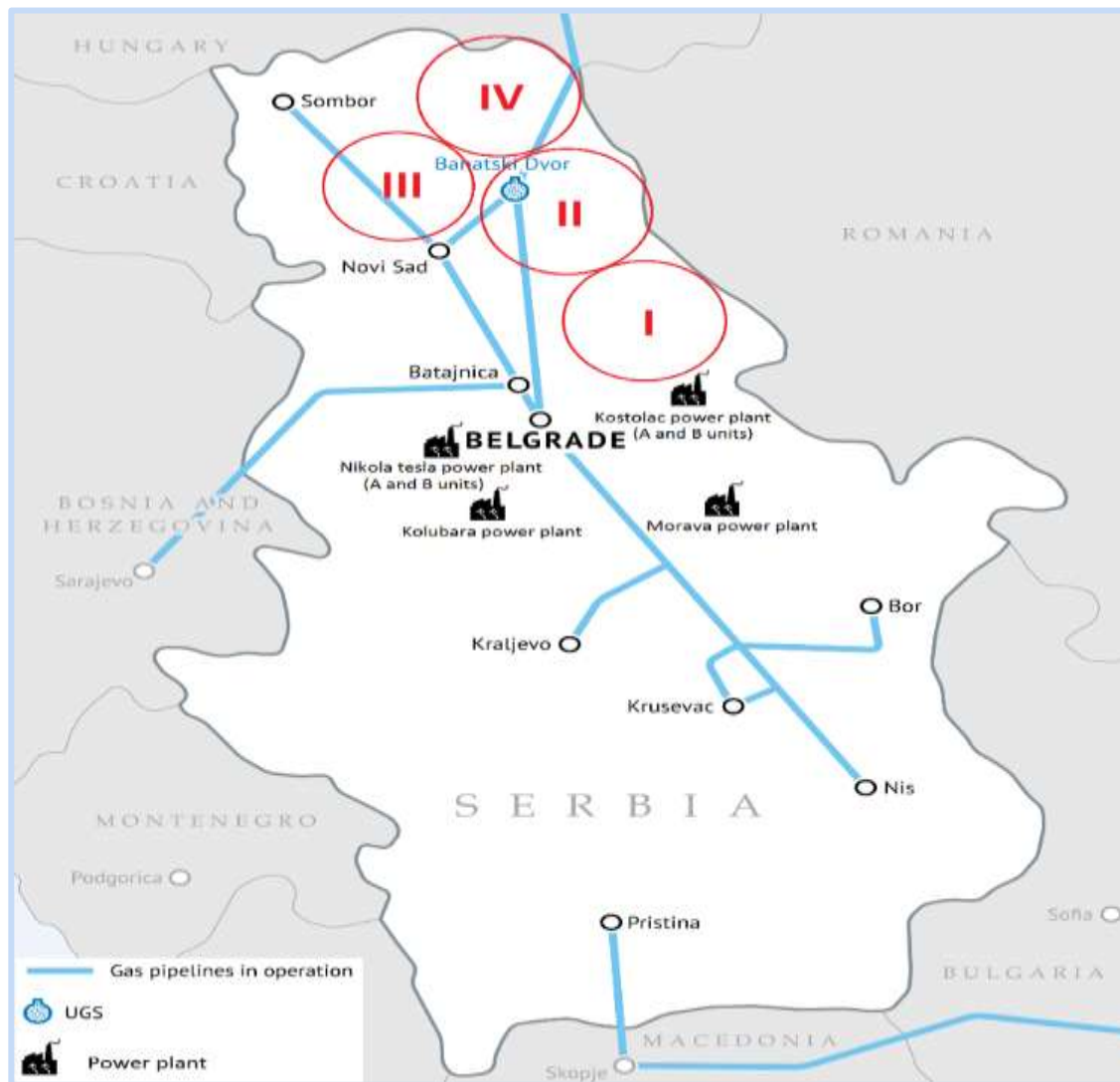
Primary goals:

1. Exploitation of gas assets with high level of CO₂;
2. EOR – CO₂ effects on mobilization of Rusanda Pg1 residual oil;
3. CO₂ Capture and Storage.

~ 80,000 sm³/day of gas recirculation.



Our future plans are related for *Transition/Conversion from CO₂ EOR to CO₂ Storage Project on the Rusanda field*



Distribution of Serbian power plants (coal fired power plants), gas infrastructure and potential zones of CO₂ geological storages

Due to the distance between Serbian power plants and oil and gas fields the significant investment in carbon capture units and pipeline construction for transportation of anthropogenic CO₂ to oil and gas fields are required. Pipeline length could be from 50 – 200 km depending on location of possible geological storage.

HiPACT unit in Elemir is close to the II and IV group of the oil and gas fields near to the most perspective oil and gas structures for CO₂ storage.

CO₂ is transported via pipeline to the Rusanda oil field. Construction of a new pipelines for CO₂ transportation to the other fields is somewhat easier due to the existing magistral gas infrastructure.

CO₂-EOR project in oil field Rusanda has a good result and presents a promising solutions for realization of CCS projects in Serbia.

Additional analyses and pilot test must be conducted to evaluate effects of injected CO₂, not only for increasing of oil recovery factor.

Conclusion

- ❖ The main sources of CO₂ in Serbia are power plants (captured from power plants) and oil and gas fields (CO₂ separated from natural gas).
- ❖ In this article, all oil and gas fields are divided into four groups according to its geographic position.
- ❖ Oil and gas fields in the Serbian part of the Pannonian basin have a significant potential for CO₂ storage.
- ❖ Total estimated storage capacity for oil and gas fields presented in this paper is around 110 Mt.
- ❖ To determine real capacities, every individual site/formation needs to be carefully assessed (petrophysical properties, geochemical analysis, numerical modelling etc.) in order to ensure safe and permanent storage of CO₂.
- ❖ CO₂-EOR projects are primarily implemented to increase oil and gas production (tertiary recovery), however, given the relatively high costs currently associated with CCS, coupling CCS with Enhanced Oil Recovery (EOR) could provide a critical financial incentive to facilitate development of CCS projects in the near term.
- ❖ The first CO₂-EOR project in Serbia was started in 2015 with the injection of CO₂, separated from natural gas mixture, in the oil field Rusanda gas cap to support reservoir pressure and increase oil recovery.
- ❖ Beside CO₂ separated from the natural gas mixture, Serbia has a great potential to implement CCS system in coal – fired power plants and fulfill EU regulative for CO₂ emissions during the EU integration process.
- ❖ It is recommended that due to the high investments in CO₂ capture facilities and transportation - required construction of additional CO₂ pipelines, planning and execution of CCS projects in Serbia should be supported from EU funds or joint venture projects.



THANK YOU

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