



**How is the next generation motivated by oil
industry of 2015 in CEE region**

Conference

Visegrád, 19 November 2015

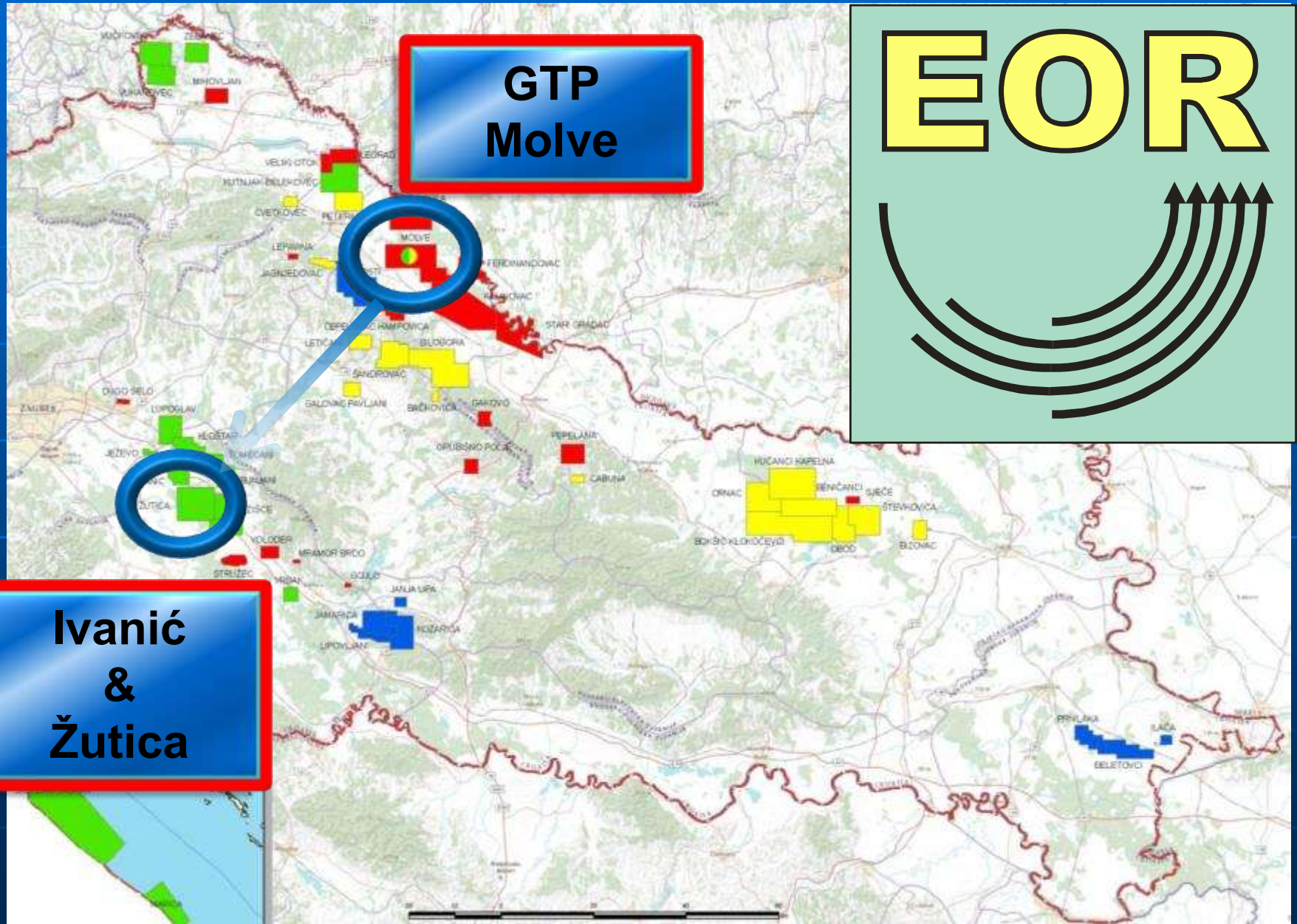
Society of Petroleum Engineers

MONITORING AND THE FIRST RESULTS OF THE CARBON DIOXIDE INJECTION AS PART OF EOR PROJECT ON EXPLOITATION FIELD IVANIĆ

Dalibor Mudrić, Anđelko Vrbošić, Neven Leonard; - INA d.d.



EOR – CO₂ source



EOR – SCOPE OF THE PROJECT

GTP Ethane



Facilities: **CS CO₂, Liquefaction and pumping station**



Facilities: **CO₂ Compressor station**

Ivanić Žutica North

• **INJECTORS:**
22 WAG, 8 DISPOSAL
PRODUCERS: 76

400 000 m³/d

200 000 m³/d

600 000 m³/d

Žutica South

INJECTORS:
23 WAG, 5 DISPOSAL
PRODUCERS: 85

CS Žutica

Facilities: **Membrane separation unit**

Image © 2008 DigitalGlobe

Image © 2008 TerraMetrics

1st PHASE

2nd PHASE

EOR 1st phase – finalization

- Received (3) use permits for CS Molve, CS Ethane and membrane separator unit on CS Žutica;
- June 24th submitted request to Ministry for trial work and start up of CO₂ injection in July 2014;
- July 18th- September 9th functional testing of CO₂ system (CS Molve, CS Ethane and 11 wells on Ivanić);
- **September 30th received approval from Ministry for trial exploitation of the CO₂ system and CO₂ injection into 12 wells in exploitation field Ivanić for one year period;**
- **October 14th 2014 CO₂ injection started into 12 wells in Ivanić;**
- *Injection into 2 more wells in Ivanić and Žutica_{north} started in Oct 2015*

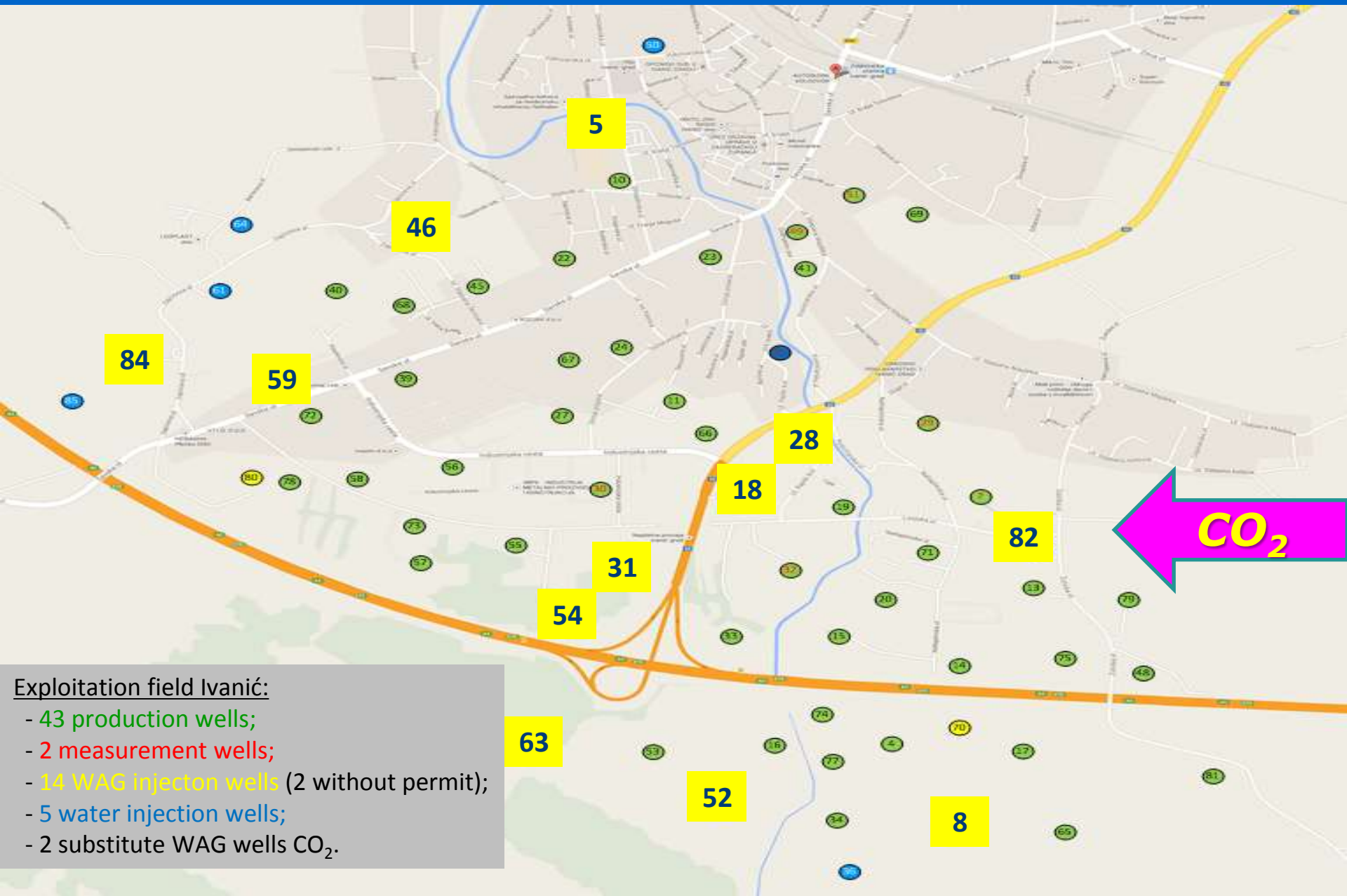
EOR 1st phase – functional testing

- July 18th- September 9th functional testing of CO₂ system (CS Molve, CS Ethane and 11 wells on Ivanić);
- CO₂ injection quantities during functional testing July - September:

TOTAL: 7.6 MM m³



Exploitation field Ivanić – functionally tested



- Exploitation field Ivanić:
- 43 production wells;
 - 2 measurement wells;
 - 14 WAG injection wells (2 without permit);
 - 5 water injection wells;
 - 2 substitute WAG wells CO_2 .

Monitoring on oil field Ivanić

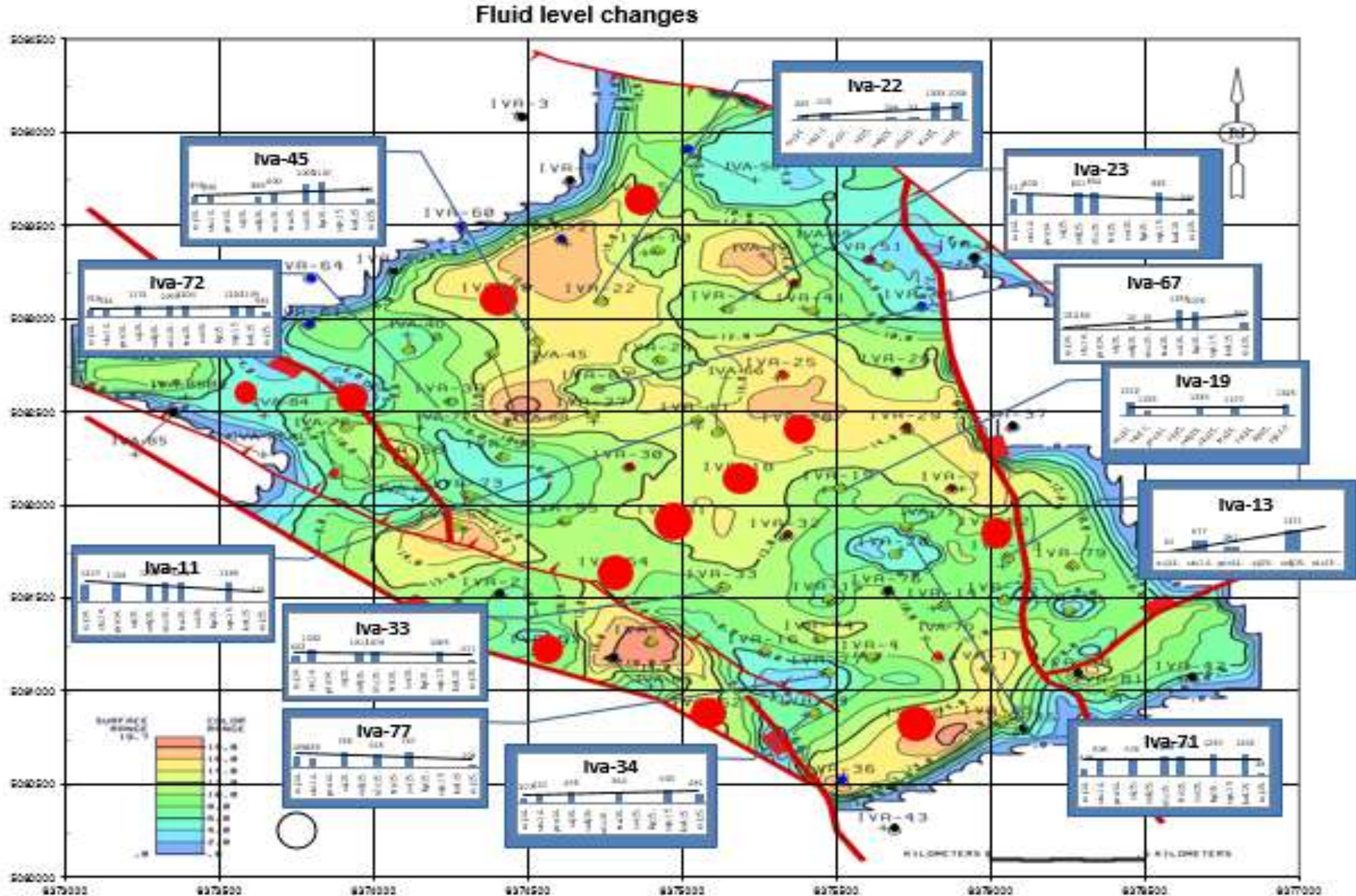
Before the start of CO₂ injection **ZERO STATE** of the exploitation field Ivanić was recorded on all 43 production wells:

- measurement of fluid level in wells;
- pressure measurements in boreholes;
- measuring of produced quantities of oil, gas and water with mobile separator unit;
- laboratory analysis of oil and gas.

Monitoring on oil field Ivanić during trial exploitation

- Continuous measurements of fluid quantities on all exploitation wells with movable separator unit to detect any increase in production (hundred of measurements);
- during all measurements samples of fluid were taken for laboratory analysis;
- On all exploitation wells continuously sampling of gas for chromatographic analysis (hundreds of laboratory analysys)
 - important to detect every possible increased CO₂ concentration;
 - resulted making timely decisions for mining interventions in exploitation wells;
- Continuous fluid level measurement on all exploitation wells (hundreds of measurements)
 - important for timely response in order to possibly increase the capacity rod of pumps, the change of the operating cycle of swings, etc .;
 - changing from atificial lift method to natural flowing.

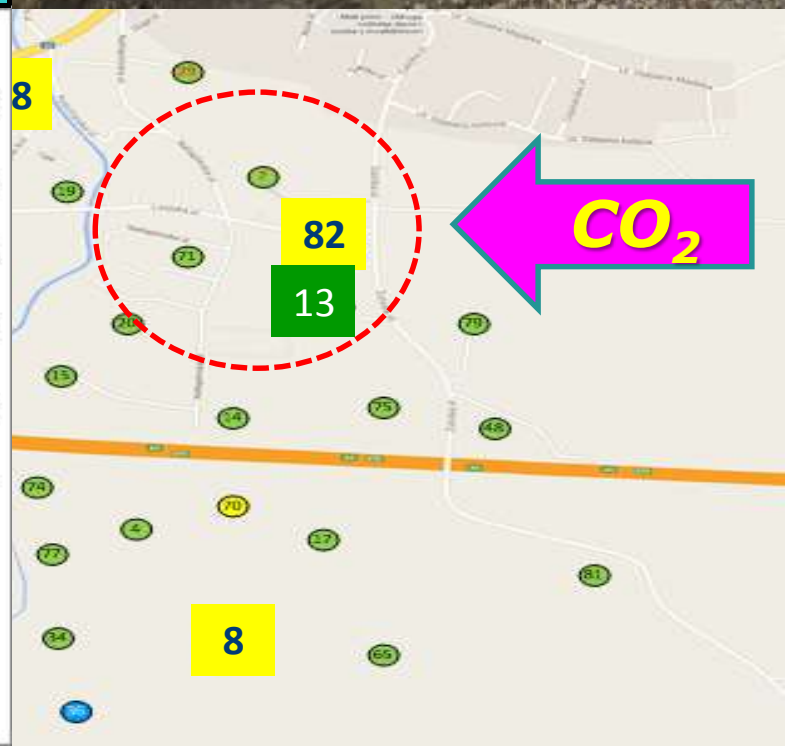
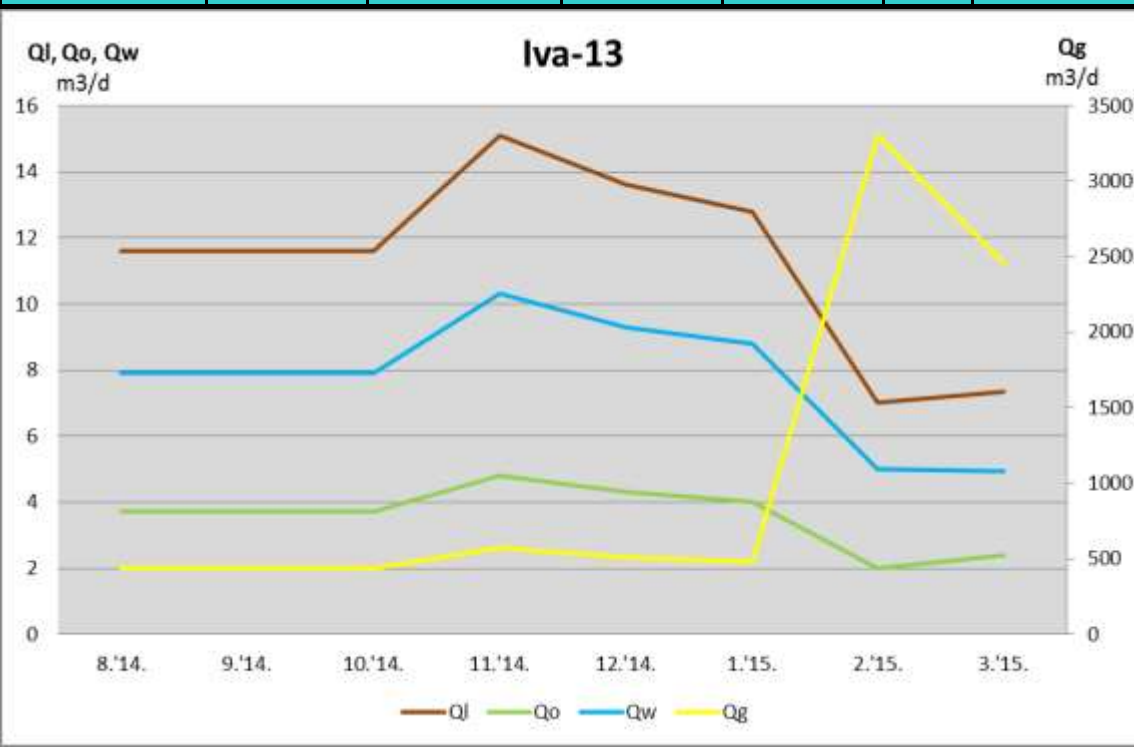
First results of CO₂ injection on fluid level



The figure is a geological map of the Iva area, showing topographic contours and various geological features. The map is overlaid with a grid. Several stations are marked with red dots and labeled: Iva-22, Iva-45, Iva-13, Iva-18, Iva-82, Iva-71, Iva-32, Iva-59, and Iva-46. Four stations are highlighted with blue star symbols: Iva-46, Iva-59, Iva-18, and Iva-82. Surrounding the map are several data plots, each corresponding to a station. These plots show various parameters over time, with labels such as 'Iva-22', 'Iva-45', 'Iva-13', 'Iva-18', 'Iva-82', 'Iva-71', 'Iva-32', 'Iva-59', and 'Iva-46'. The plots include bar charts and line graphs, with axes labeled with months and years (e.g., 'Iva-22', 'Iva-45', 'Iva-13', 'Iva-18', 'Iva-82', 'Iva-71', 'Iva-32', 'Iva-59', 'Iva-46').

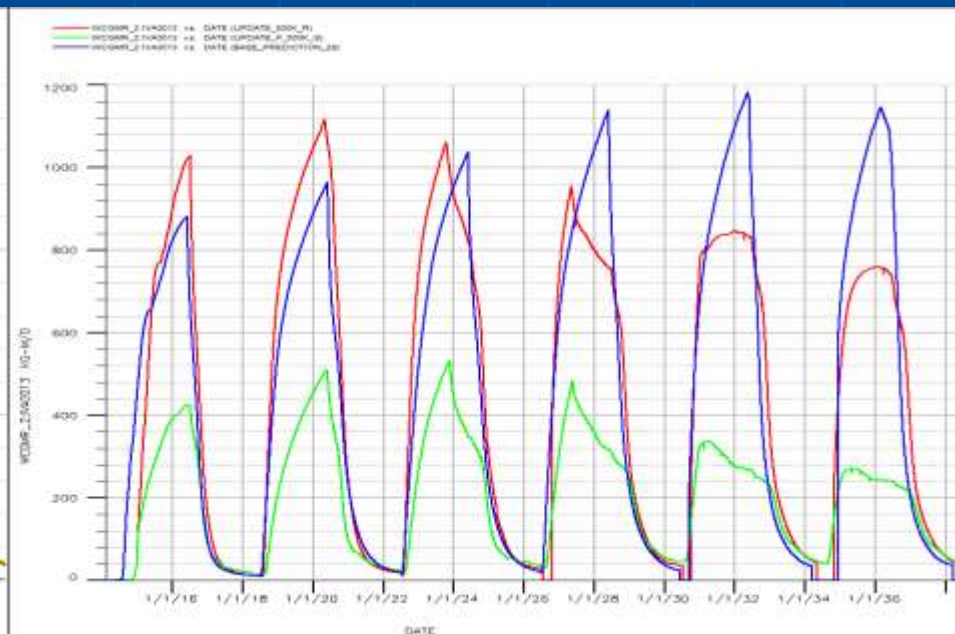
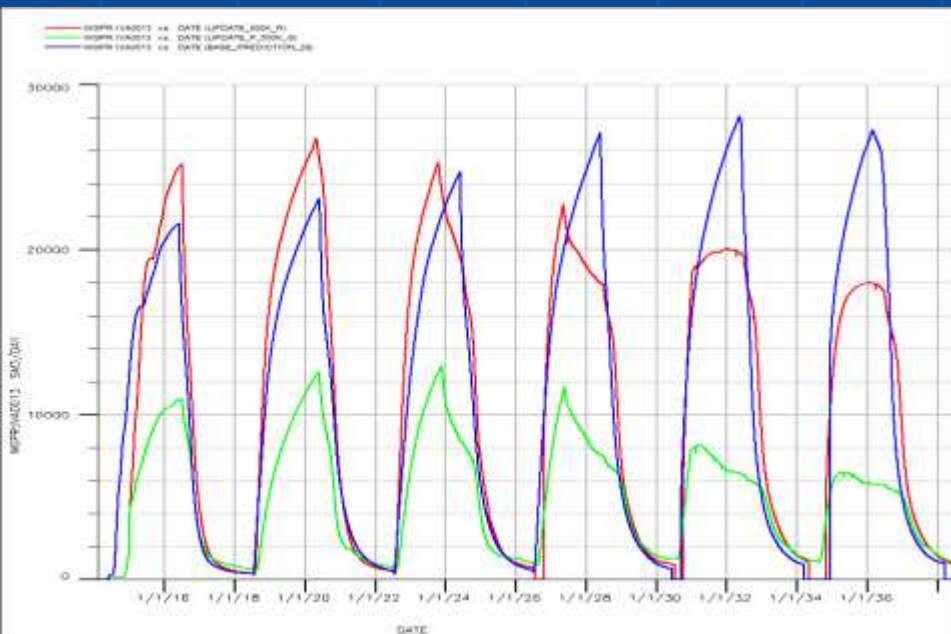
EF Ivanić first results of CO₂ injection

Iva-13	Ql	Qo	Qw	Qg	Cycle	Method
	m3/d	m3/d	m3/d	m3/d	h	
8.'14.	11.6	3.7	7.9	441	4 x 4h	artificial lift
9.'14.	11.6	3.7	7.9	441	4 x 4h	
10.'14.	11.6	3.7	7.9	441	4 x 4h	
11.'14.	15.1	4.8	10.3	574	3 x 6h	
12.'14.	13.6	4.3	9.3	513	24 h	
1.'15.	12.8	4	8.8	482	3 x 7h	natural flow
2.'15.	7	2	5	3300	24 h	
3.'15.	7.35	2.4	4.95	2456	24 h	



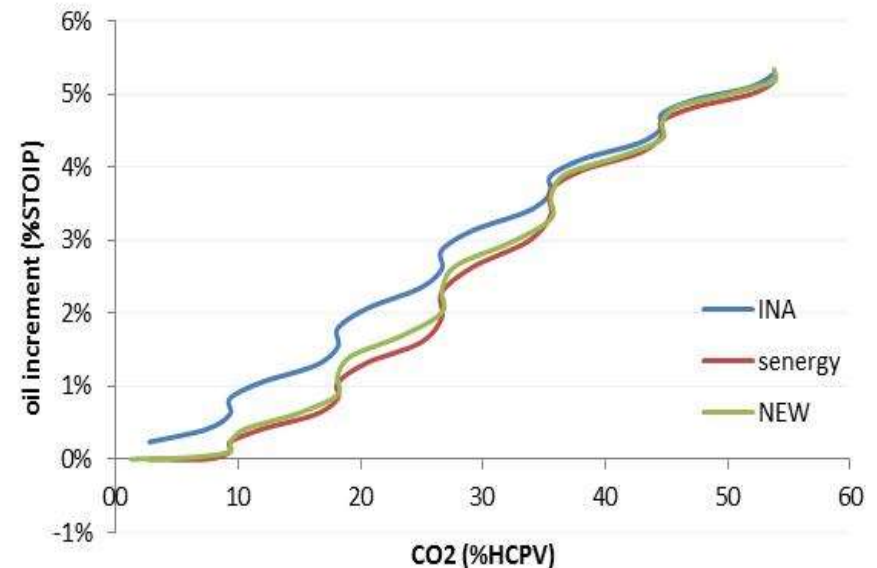
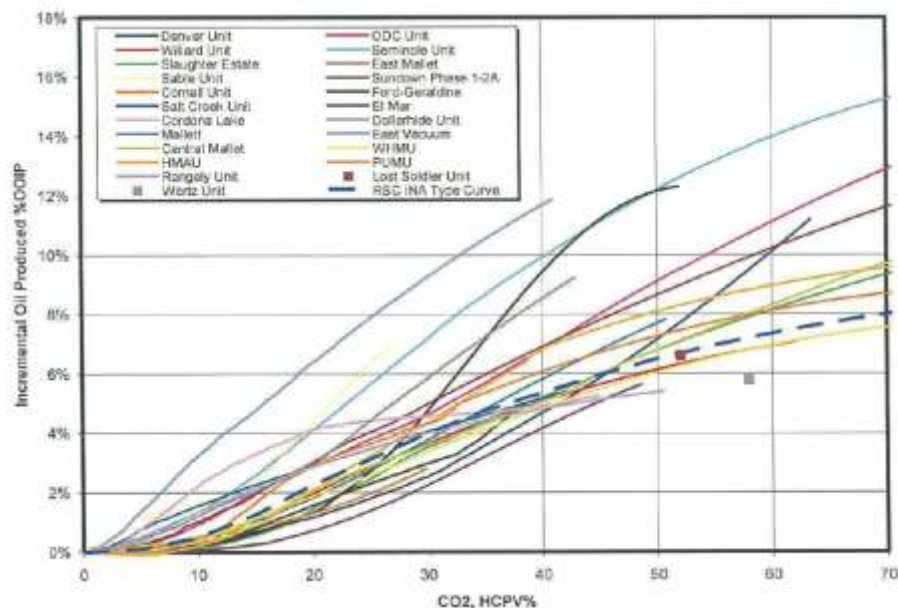
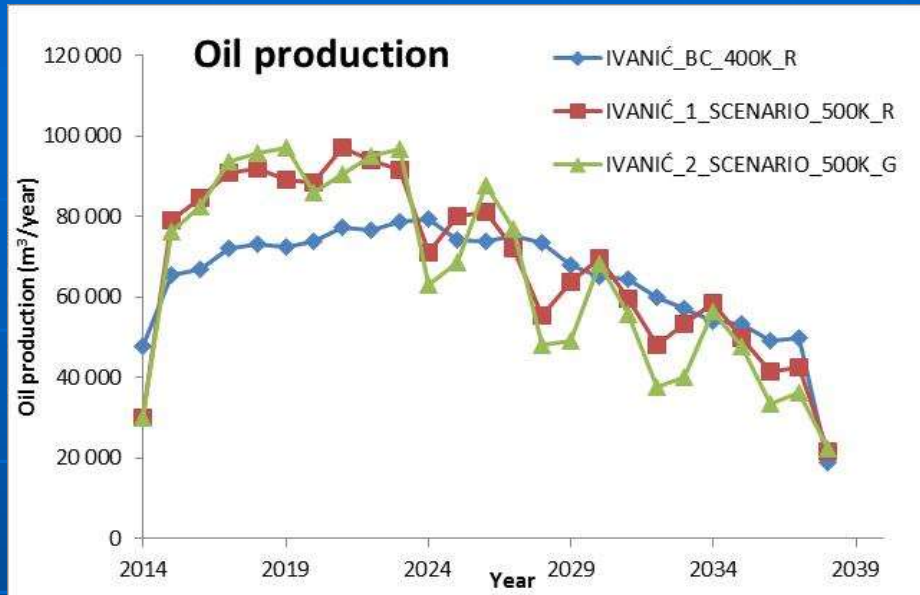
Monitoring data important for Reservoir Simulation

- Current Ivanić E300 model is being continuously updated in order to increase its predictiveness;
- Major obstacle in the quality is field production using SRP's;
- When wells start to erupt, predictiveness is expected to improve;
- However, the model has been able to predict rather quick CO₂ breakthrough to Iva-13;
- Currently ongoing campaign is in progress in order to improve definition of vertical and horizontal sweep efficiency (production/injection profiles, wellcheckers)



Monitoring data important for Reservoir Simulation

- Besides, updating the model with production data. Sensitivities are being run in order to estimate expected EOR increment;
- Expected impact is being manually shifted by using cum CO₂ injected (as %HCPV) vs. expected increment;
- By doing so, better fit to actual pilot is being achieved while expected recovery is being kept.



Distribution of CO₂ through the reservoir

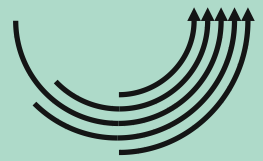
- A need for measurements in injection and exploitation wells in order to monitor the distribution of CO₂ in the reservoir through a process of injection into oil reservoirs Ivanic;
- Gathered data is necessary for making numerical geological model which will be used for better understanding of CO₂ injection process in exploitation field of hydrocarbons Ivanic;
- Electrical well logging has been done in some injection wells;
- Have not laid down all the necessary parameters for understanding the distribution of CO₂ and making the model → the main reason for extension of trial exploitation in EF Ivanić for another year.

EOR 1st phase – trial exploitation

- Trial exploitation of the CO₂ system and CO₂ injection into 12 wells in exploitation field Ivanić for one year period (30.09.2014.- 30.09.2015);
- October 14th CO₂ injection started into 12 wells in Ivanić:
Iva-5, Iva-8, Iva-18, Iva-28, Iva-31, Iva-46, Iva-52, Iva-54,
Iva-59, Iva-63, Iva-82, Iva-84;
- **Total CO₂ injection quantities from 14th October: 113 MM m³**
- All activities are conducted in accordance with the program for trial exploitation in Ivanić;
- Have not laid down all the necessary parameters for understanding the distribution of CO₂ → the main reason for extension of trial exploitation in EF Ivanić for another year.

THANK YOU FOR YOUR ATTENTION !!!

EOR



SRETNO !!!