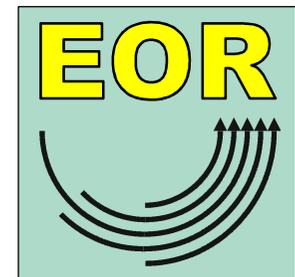


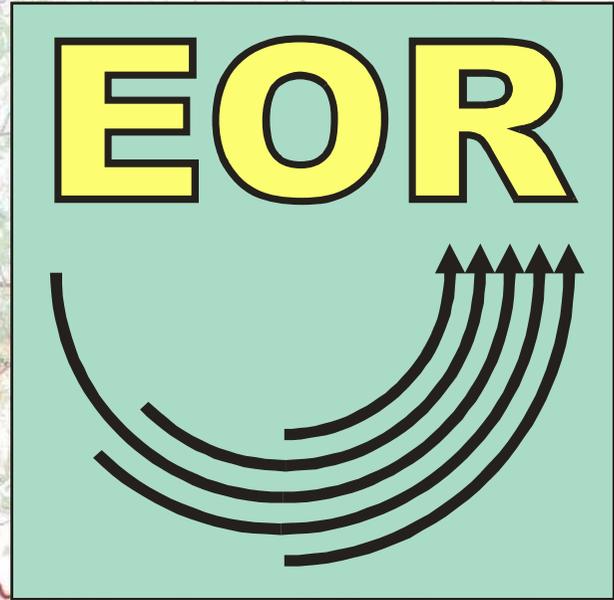
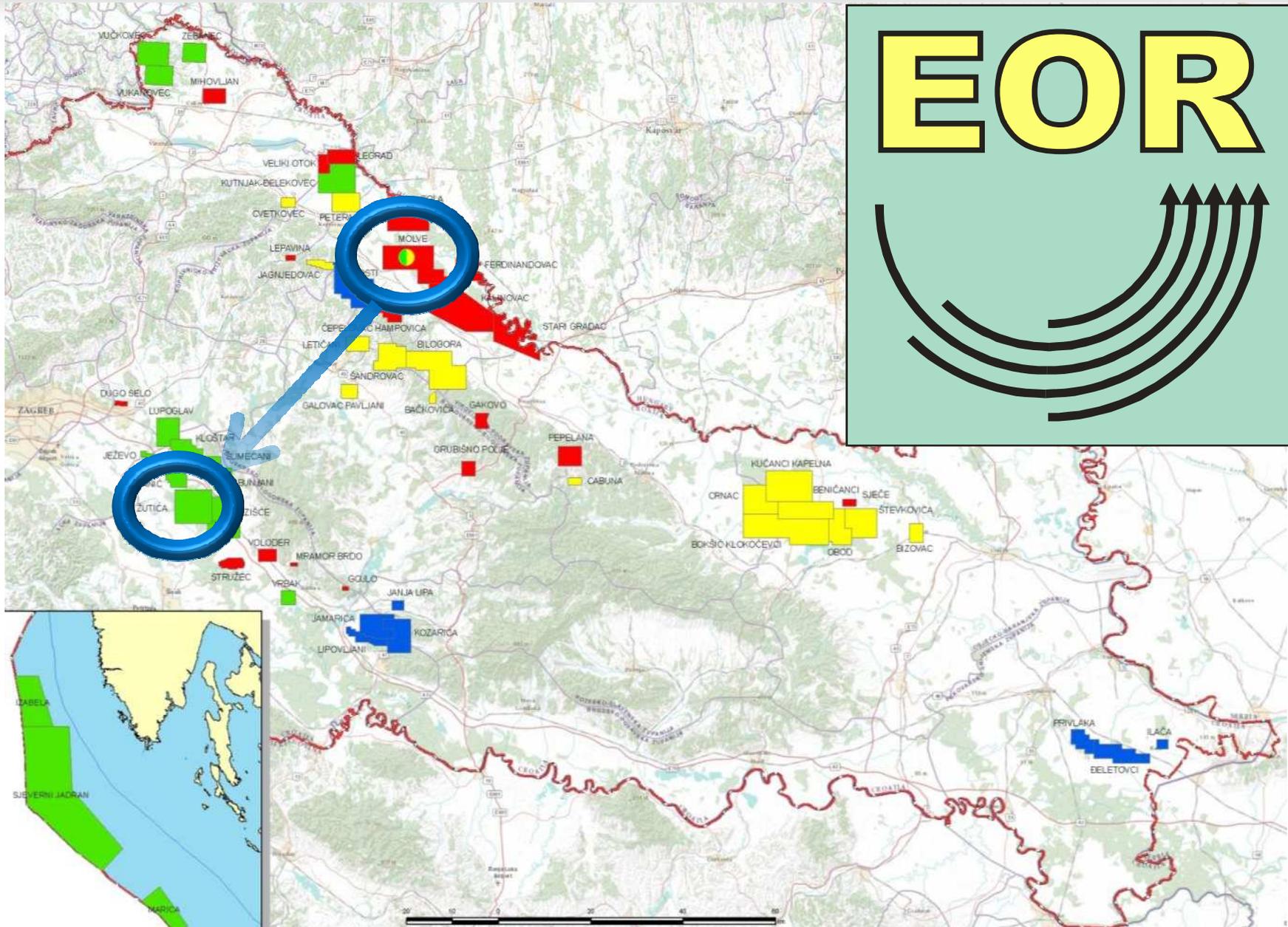


# PREPARATION AND EVALUATION OF THE WAG CO<sub>2</sub> INJECTION ON THE OILFIELD IVANIĆ AND ŽUTICA

DUBRAVKO NOVOSEL  
IGOR KRULJAC  
NEVEN LEONARD



- 1. INTRODUCTION,
- 2. NUMERICAL STIMULATION OF THE EOR PROJECT,
- 3. EOR PROJECT REALIZATION,
- 4. CONCLUSION.

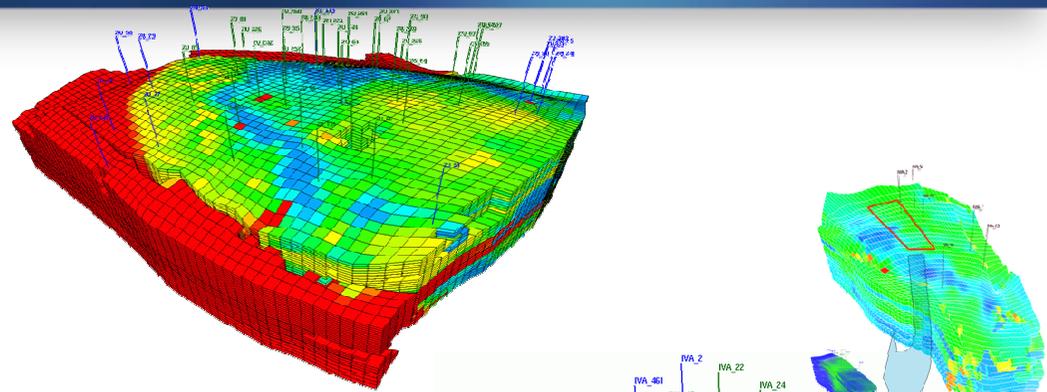
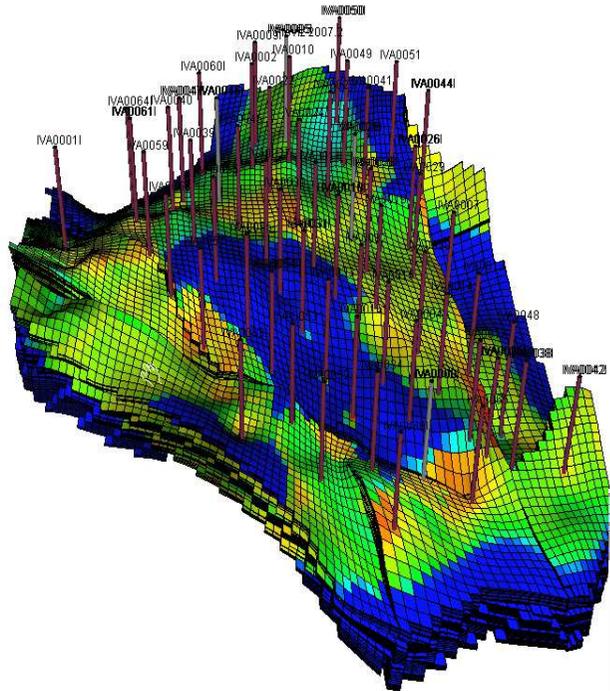


# EOR: Modelling CO<sub>2</sub> injection on Ivanić field - History



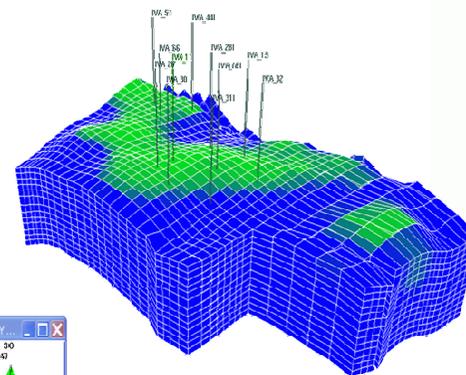
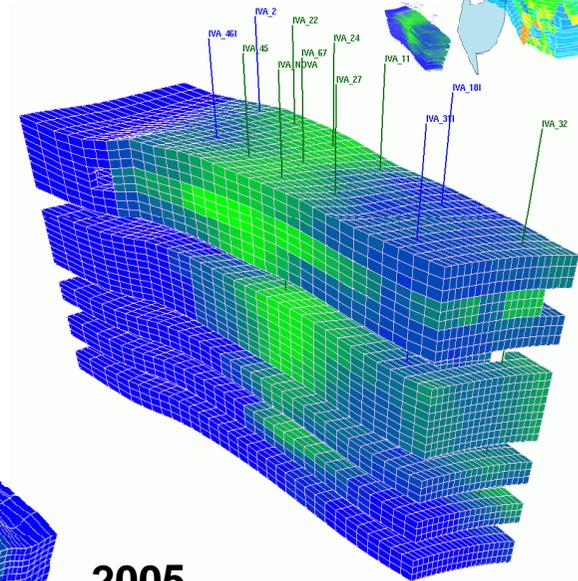
**2010.**

New geological model and new full-field numerical simulation of Ivanić field



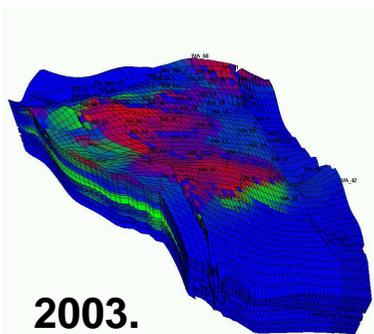
**2005/06.**

Pattern simulation of Žutica.



**2005.**

Pattern simulation of Ivanić:  
- finer grid,  
- applied info from the pilot



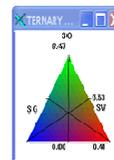
**2003.**

Full-field numerical simulation of Ivanić field.



**2004.**

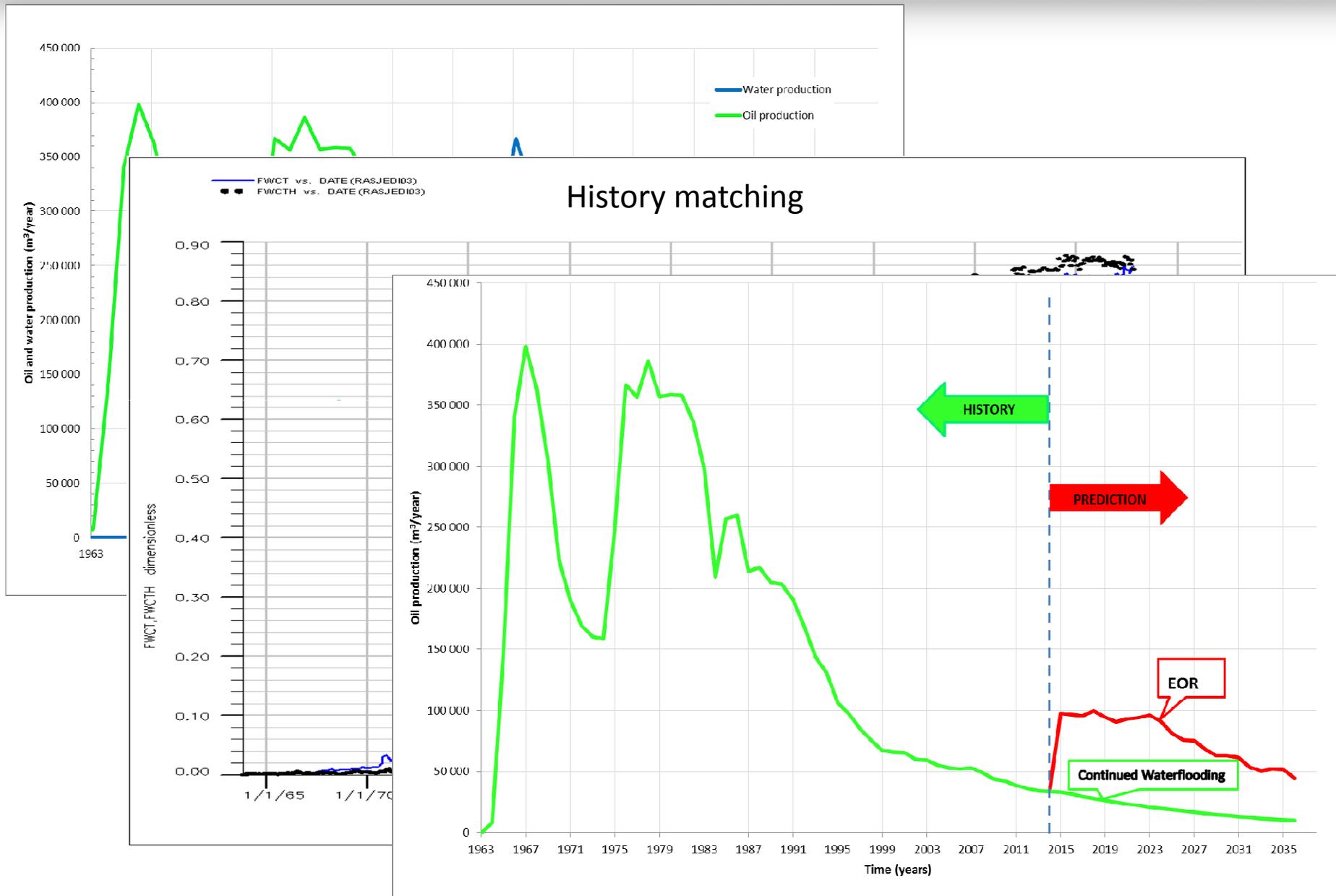
First results of pilot injection.



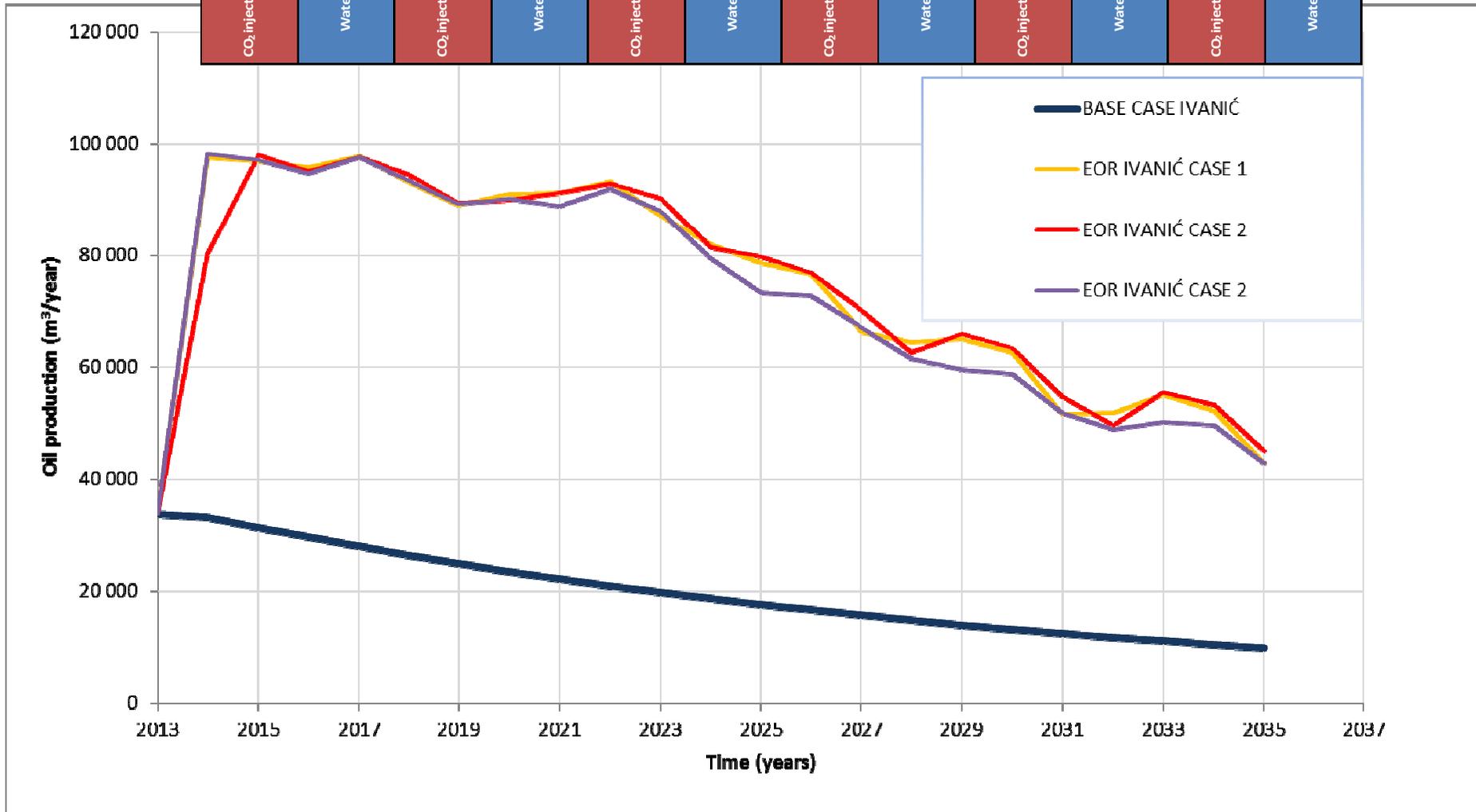
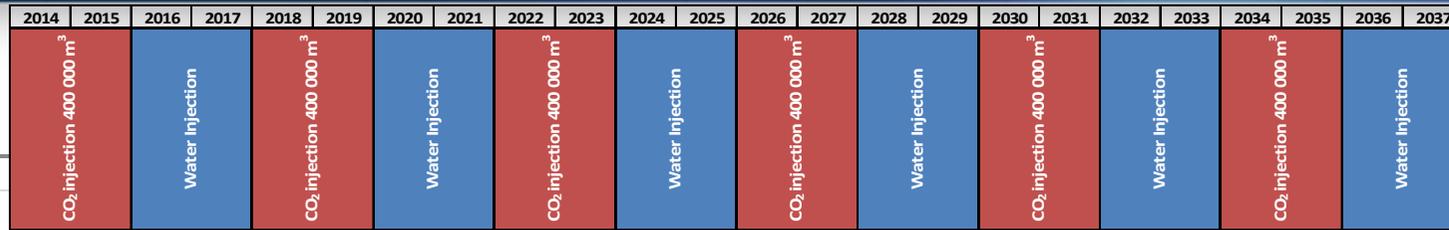
**2004/05.**

Simulation of the pilot.

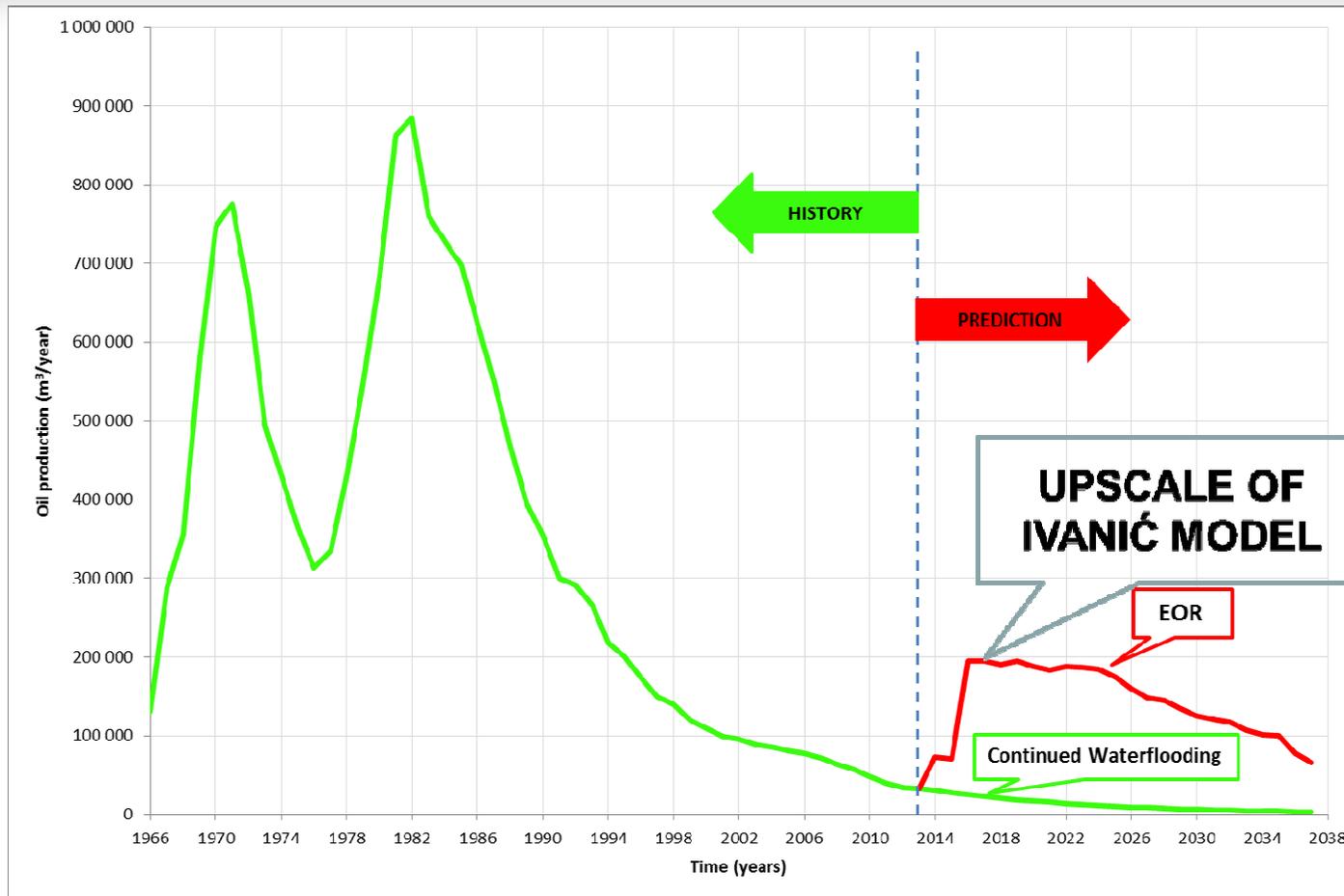
# IVANIĆ PRODUCTION HISTORY, HISTORY MATCHING AND PREDICTION



# IVANIĆ INJECTION SCENARIO AND SENSITIVITIES



# ŽUTICA PRODUCTION HISTORY AND EOR PREDICTION



- Geological models for Žutica North and South are in phase of preparation
- Based on similarities of fluid type and rock type EOR effect on Žutica field is obtained by up-scaling/down-scaling of results of Ivanić predictions.

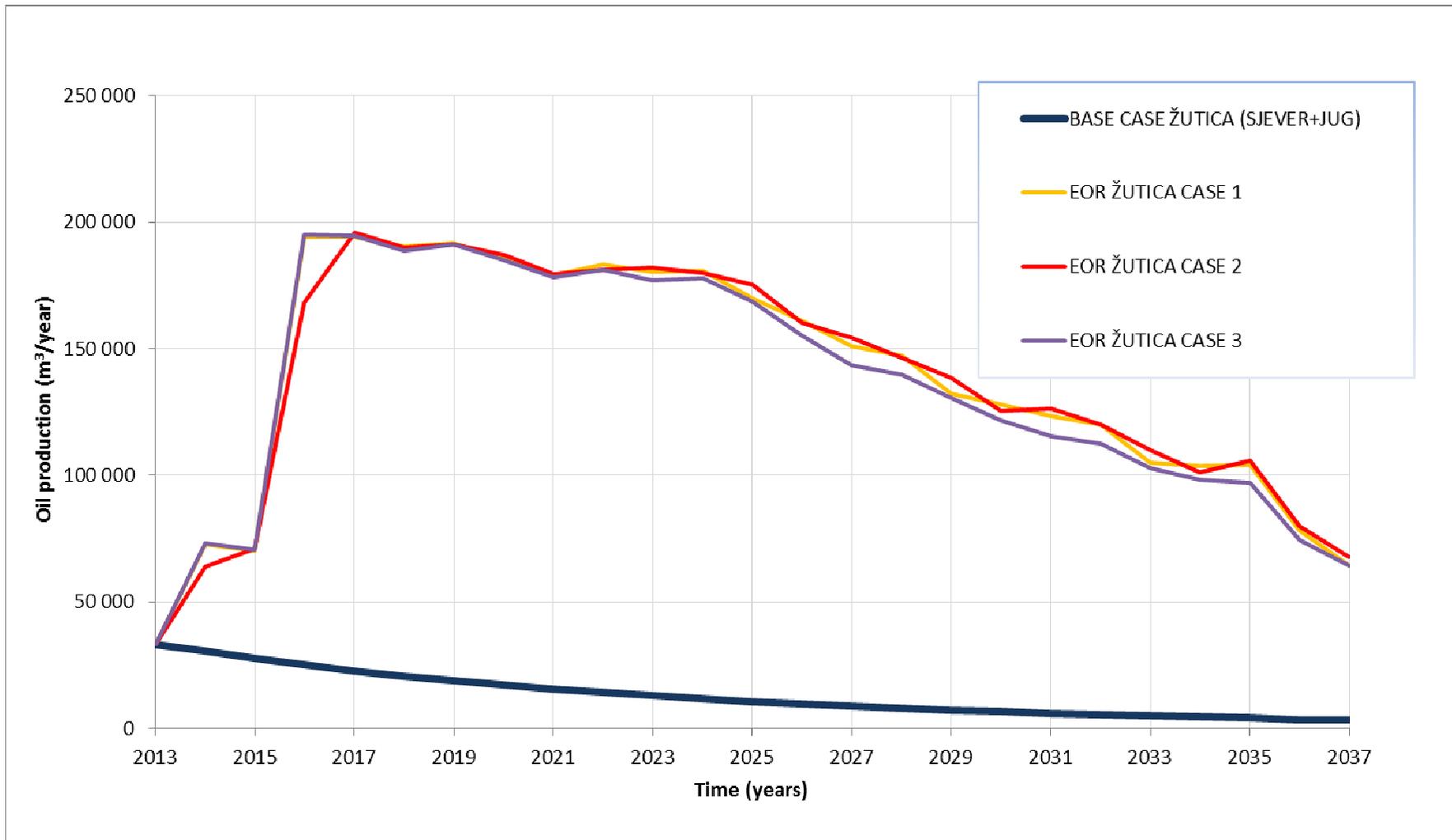
# RESULTS AND SENSITIVITIES, ŽUTICA NORTH + SOUTH



CO<sub>2</sub> injection:

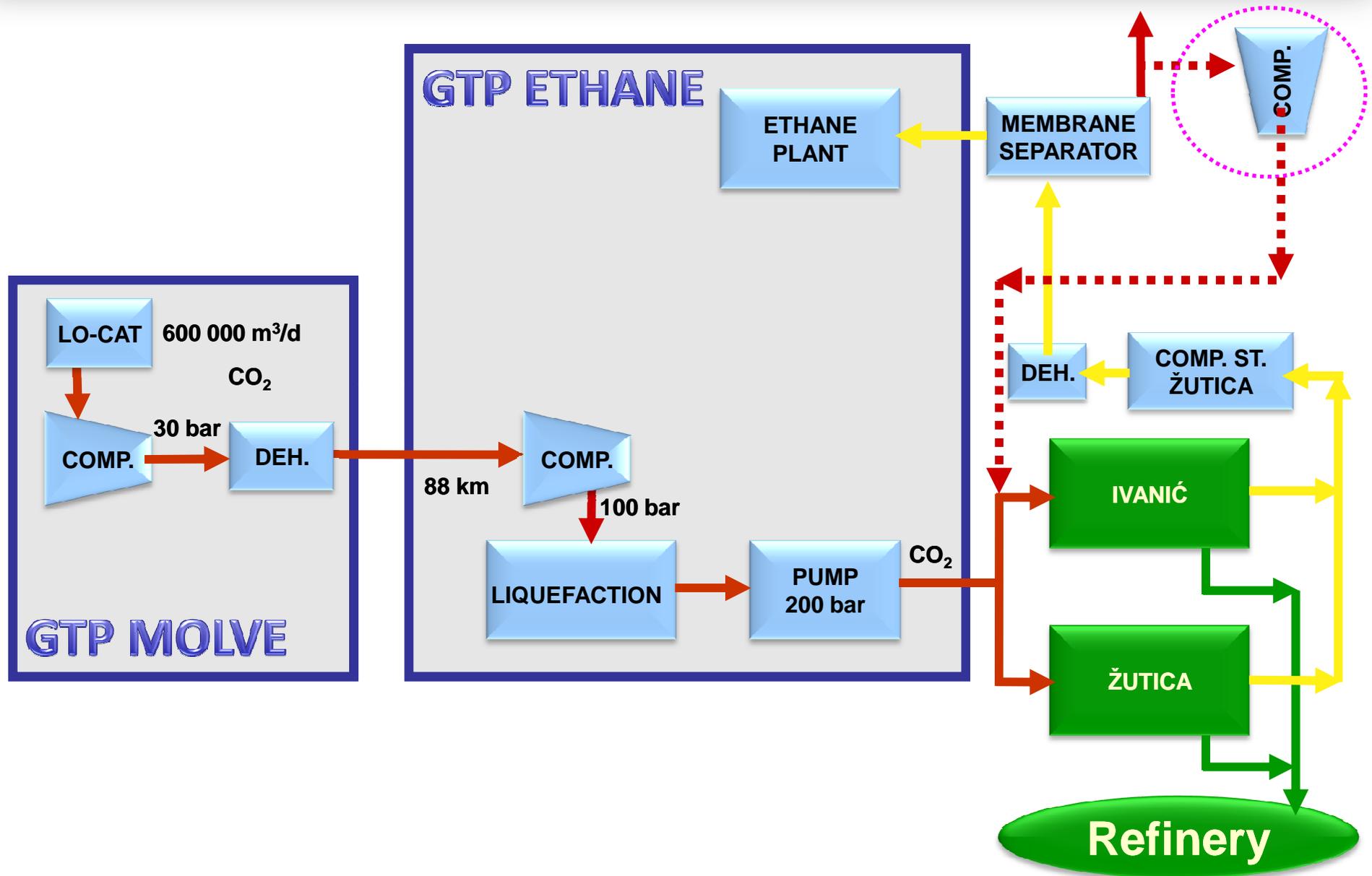
Žutica North (200 000 m<sup>3</sup>/day of CO<sub>2</sub>) + Ivanić (400 000 m<sup>3</sup>/day of CO<sub>2</sub>)

Žutica South (600 000 m<sup>3</sup>/day of CO<sub>2</sub>) 2 years after start of WAG on Ivanić and Žutica North





# EOR Project - technical content and simplified scheme



# BEGINNING OF THE IMPLEMENTATION PHASE OF THE EOR PROJECT



## COMPRESSOR STATION FOR CO<sub>2</sub> MOLVE



## COMPRESSOR STATION FOR CO<sub>2</sub> ETHANE + MEMBRANE SEPARATOR UNITS

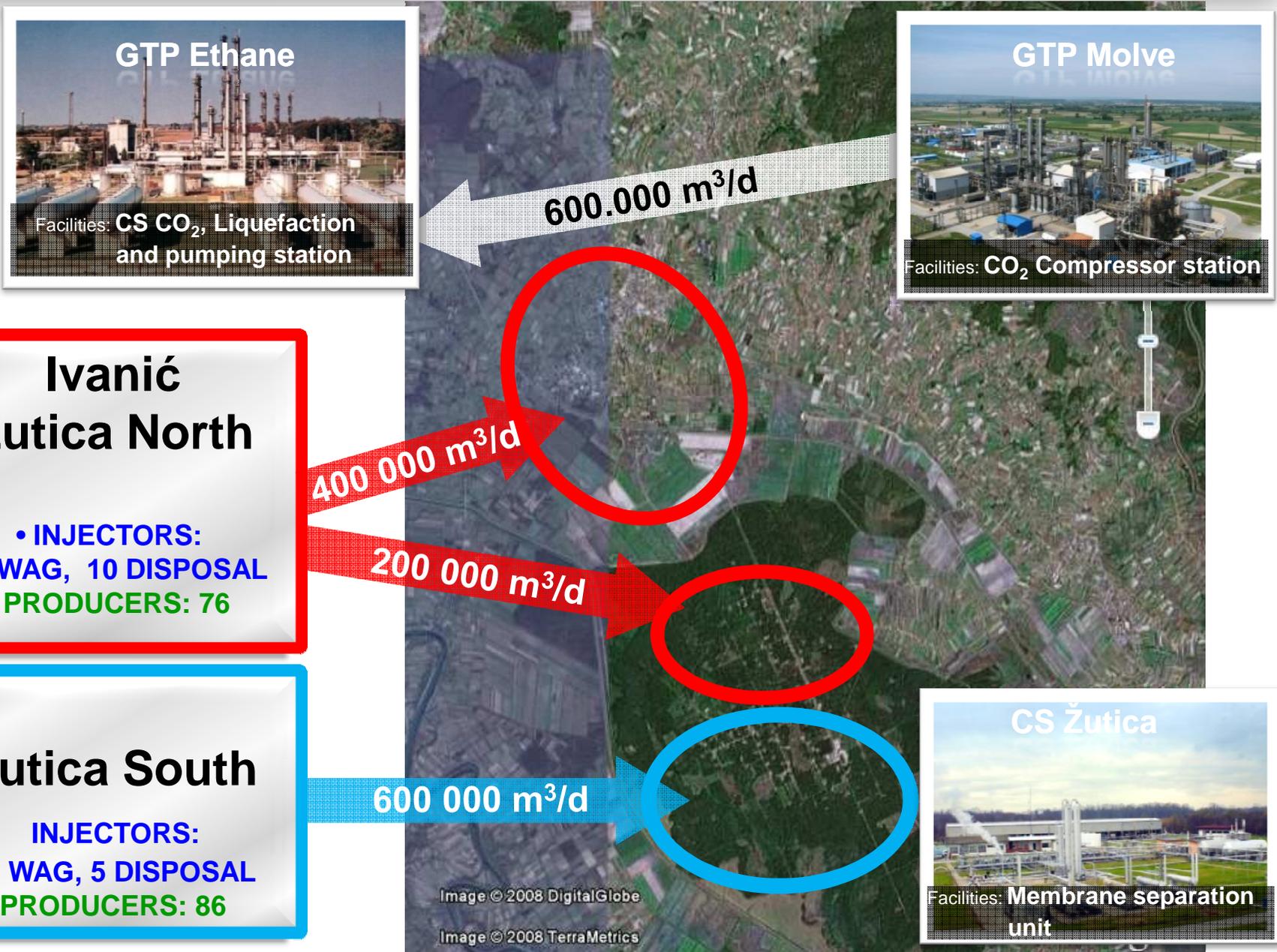


## CO<sub>2</sub> PIPELINES

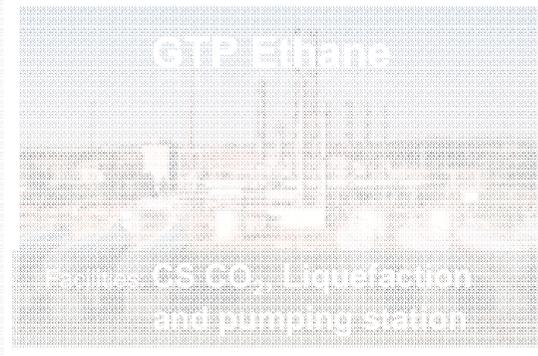


**22<sup>nd</sup> MAY, 2012 !**

# EOR Project – SCOPE OF THE PROJECT



# SCOPE OF WORK ON GTP MOLVE



1st PHASE

Ivanić  
Žutica North

• INJECTORS:  
26 WAG, 10 DISPOSAL  
PRODUCERS: 76

400 000 m<sup>3</sup>/d

200 000 m<sup>3</sup>/d

2nd PHASE

Žutica South

INJECTORS:  
23 WAG, 5 DISPOSAL  
PRODUCERS: 86

600 000 m<sup>3</sup>/d



**Facility for compression  
and dehydration of  
carbon dioxide at GTP  
Molve III on hydrocarbon  
exploitation field Molve**

**Conversion of pipeline  
from GTP Molve III to  
gas treatment plant  
Ethane in Ivanić Grad.**

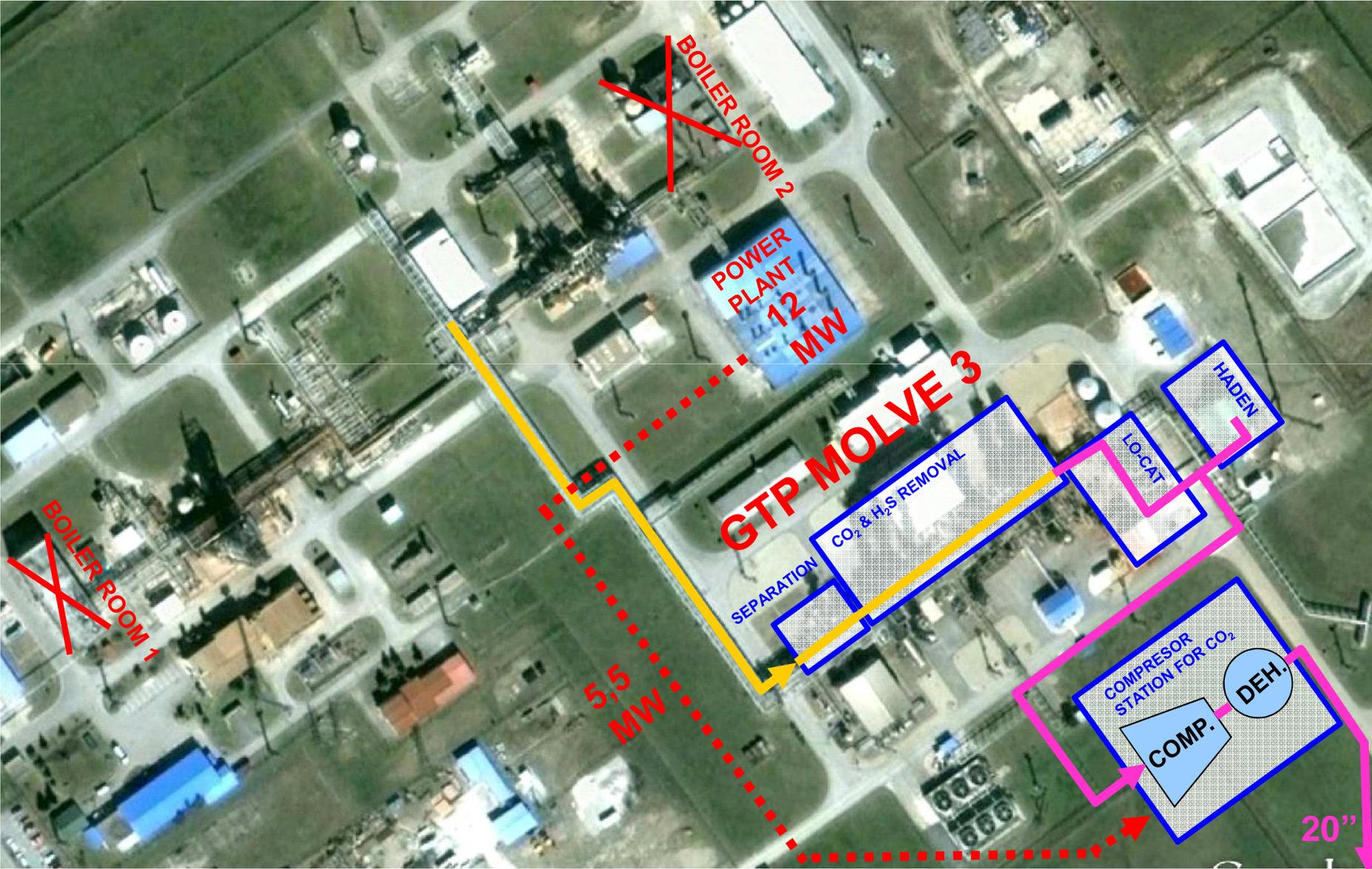
BEFORE THE CONSTRUCTIONS ....



**CONNECTION POINT**  
for CO<sub>2</sub> separation at the  
LO-CAT unit

**FUTURE  
COMPRESSOR  
STATION FOR  
CO<sub>2</sub>**

# GTP MOLVE – CO<sub>2</sub> SOURCE



# Site in stages of construction



## Scheme of the CO<sub>2</sub> transport

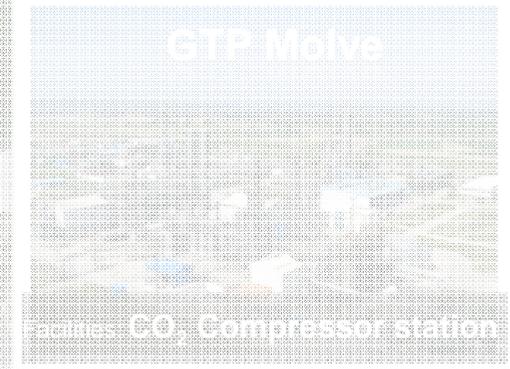
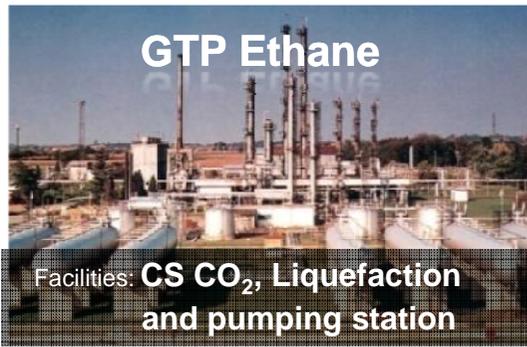
**Current pipeline**  
**88 km - 20" - 500 DN**

Tested with "smart pig"

Transport CO<sub>2</sub> in gaseous state at 30 bar



# SCOPE OF WORK GTP ETHANE



**1st PHASE**

**Ivanić  
Žutica North**

• INJECTORS:  
26 WAG, 10 DISPOSAL  
PRODUCERS: 76

**2nd PHASE**

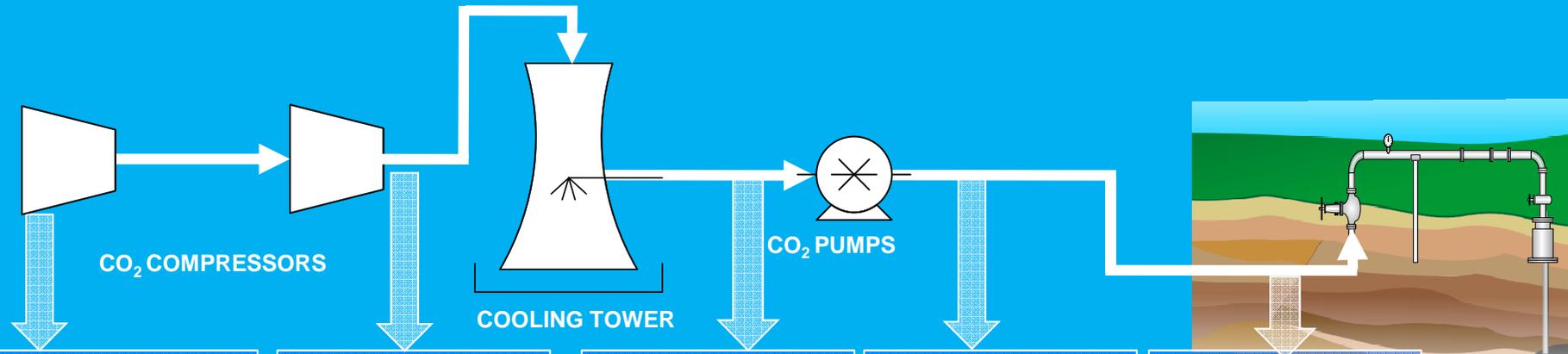
**Žutica South**

INJECTORS:  
23 WAG, 5 DISPOSAL  
PRODUCERS: 86



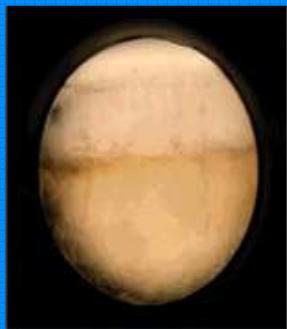
Facility for compression,  
liquefaction and  
transport of carbon  
dioxide at gas treatment  
plant Ethane in Ivanić  
Grad

# GTP ETHANE & CO<sub>2</sub> PHYSICAL STATES



**Gasous CO<sub>2</sub> GTP Molve**

p = 29 bar  
t = 15 – 20 °C



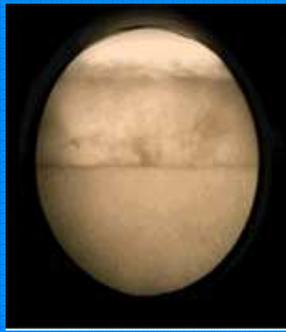
**Supercritical CO<sub>2</sub>**

p = 100 bar  
t = 49 °C



**CO<sub>2</sub> as a mixture**

p = 100 bar  
t = 33 °C



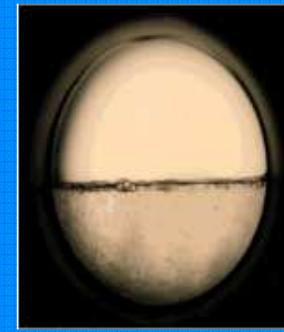
**Supercritical CO<sub>2</sub>**

p = 200 bar  
t = 35 °C



**LIQUID CO<sub>2</sub>**

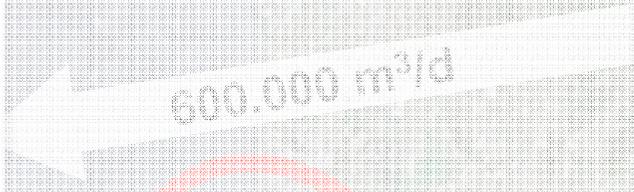
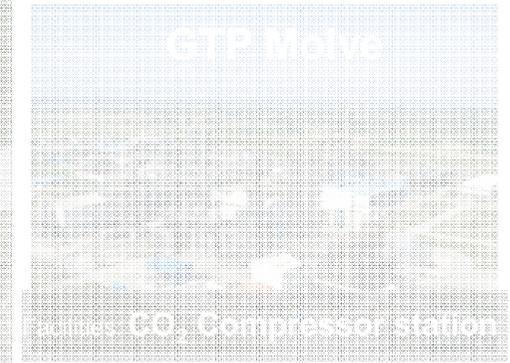
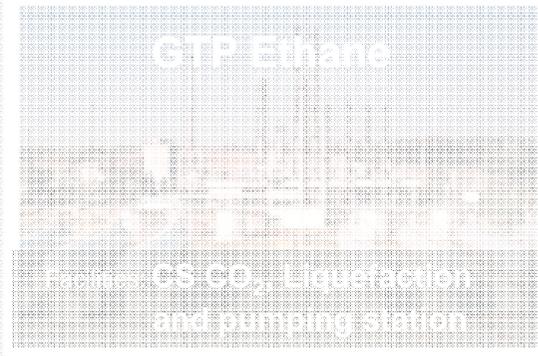
p = 198 bar  
t = 12 - 18 °C



# Site details comparison



# SCOPE OF WORK ON THE PIPELINES



**1st PHASE**

**Ivanić Žutica North**

• INJECTORS:  
26 WAG, 10 DISPOSAL  
PRODUCERS: 76



**2nd PHASE**

**Žutica South**

INJECTORS:  
23 WAG, 5 DISPOSAL  
PRODUCERS: 86



Injection pipelines,  
reconstruction of  
production and  
measurement wells into  
injection wells

Reconstruction of existing  
wellsites for purpose of  
enhanced oil and gas  
recovery by injection of  
carbon dioxide and water  
on exploitation fields  
Ivanić and Žutica.



September 2013  
41300 m Completed

33500 m

Excavated (pipelines welded)

3400m

100%

100%

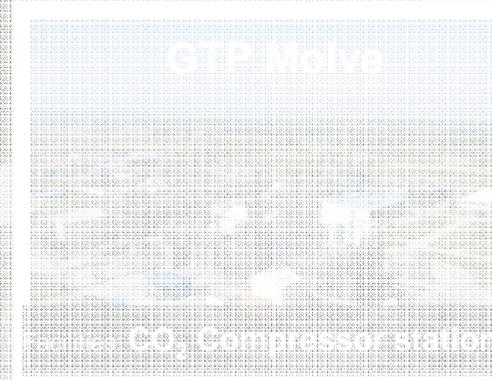
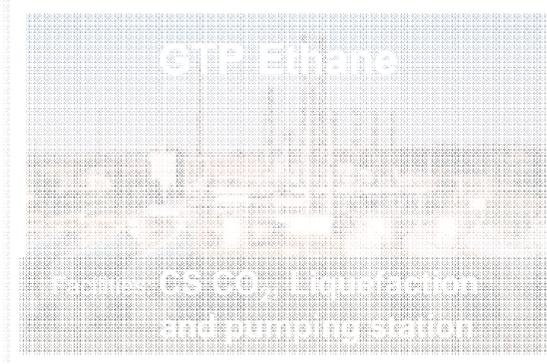
# Construction of pipeline network



## Žutica



# SCOPE OF WORK ON MEMBRANE SEPARATOR UNIT



1st PHASE

Ivanić  
Žutica North

• INJECTORS:  
26 WAG, 10 DISPOSAL  
PRODUCERS: 76



2nd PHASE

Žutica South

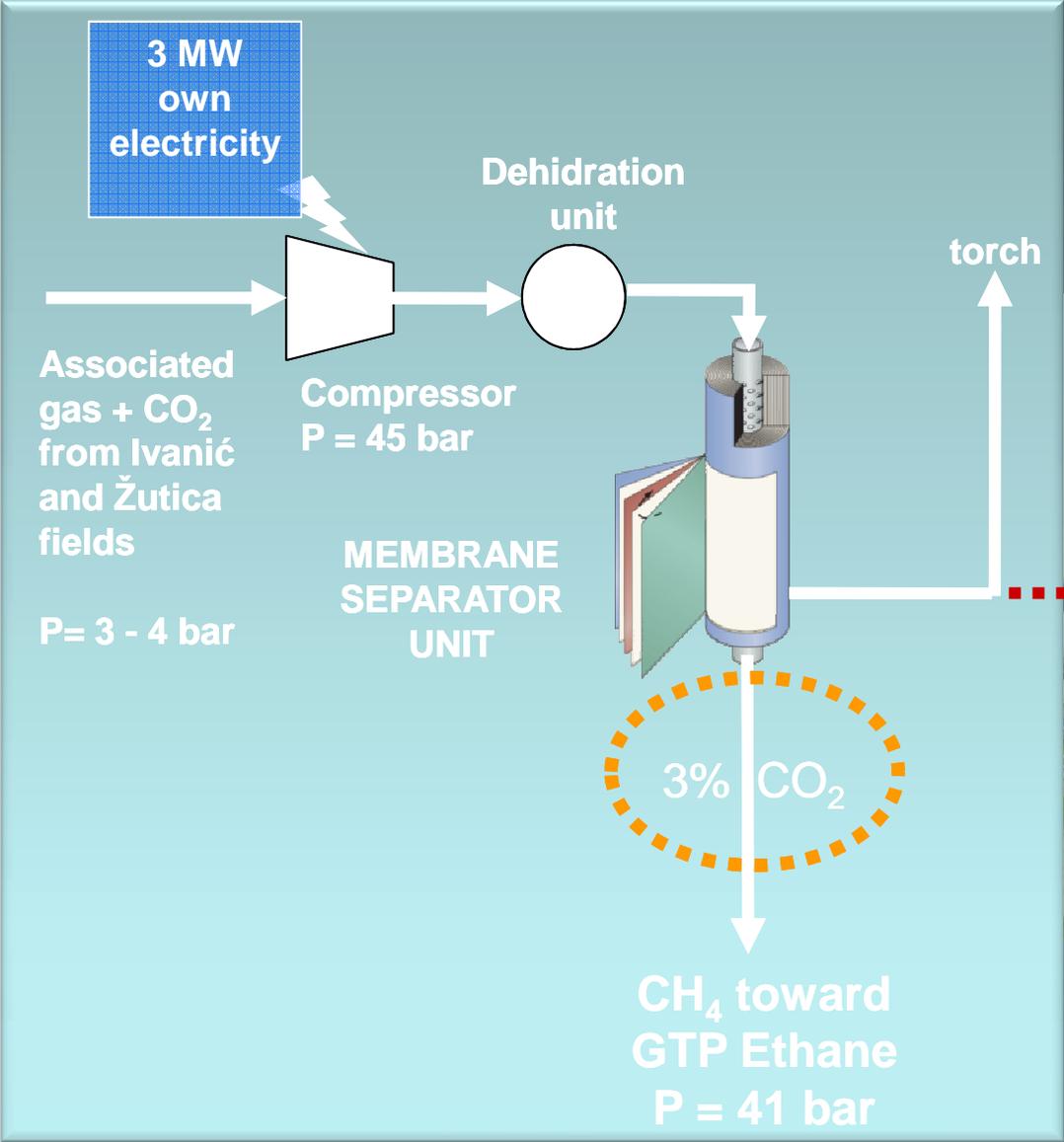
INJECTORS:  
23 WAG, 5 DISPOSAL  
PRODUCERS: 86



**Installation of Membrane  
Separator Unit on the  
existing Compressor  
Station Žutica**

**start of construction was  
in Nov 2012**

# MEMBRANE SEPARATOR UNIT



# MEMBRANE SEPARATOR UNIT



# EOR SUB-SURFACE ACTIVITIES 2012

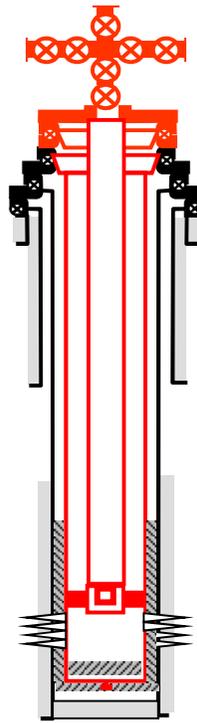
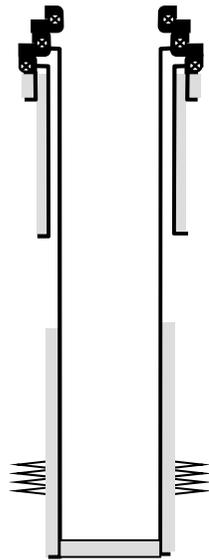
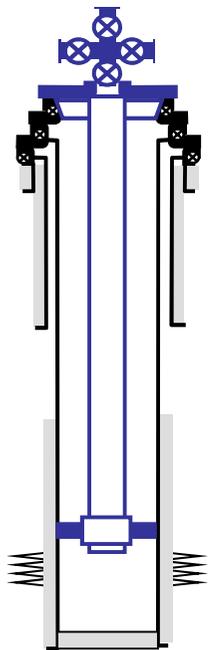


- **mandatory** (based on Mining project ) → re-lining with NEW CASING,
- **prepared and designed** by INA internal resources - **Drilling & Well Services Management**,

BEFORE

RE-LINING

AFTER



- Pilot re-lining on the well **Žu-111** →

Successfully finished in April 2012 !

# EOR SUB-SURFACE ACTIVITIES 2013



- **38 wells** → re-lining with NEW CASING
- Started on September 12<sup>th</sup> 2013



Re-lining on the 1<sup>st</sup> well **Iva-85β** (disposal)

# Results of 1<sup>st</sup> phase implementation

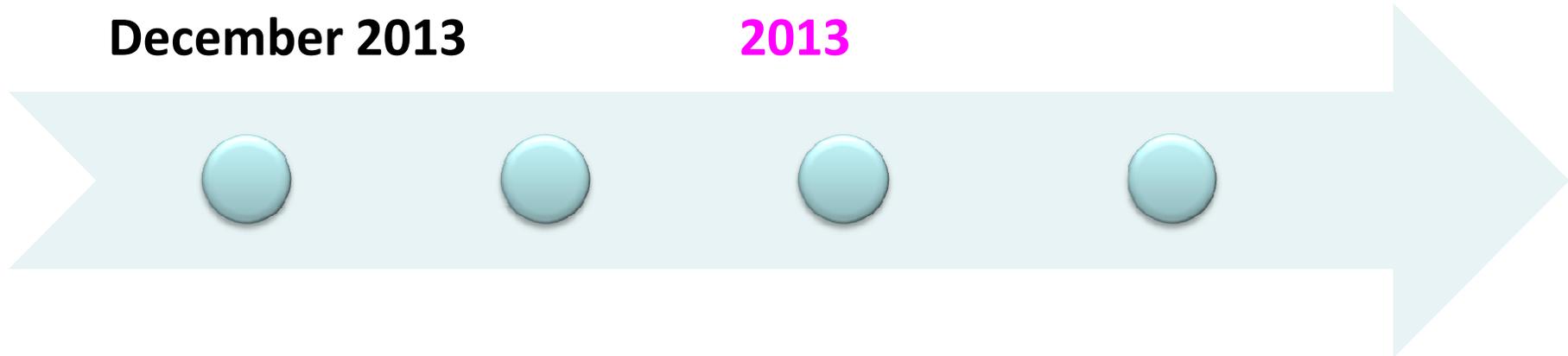


**Construction of  
surface facilities**  
June 2012 –  
December 2013

**Pre startup and  
commissioning**  
Nov/Dec  
2013

**Well completion**  
Sep 2013 –  
March 2014

**Start of CO<sub>2</sub>  
injection**  
**APRIL**  
**2014**



**THANK YOU FOR YOUR ATENTION !!!**

