INDUSTRIJA NAFTE, d.d.

South-East Europe E&P Sector

Bilogora Gas Field Production System

- From Scratch to the Final Concept -

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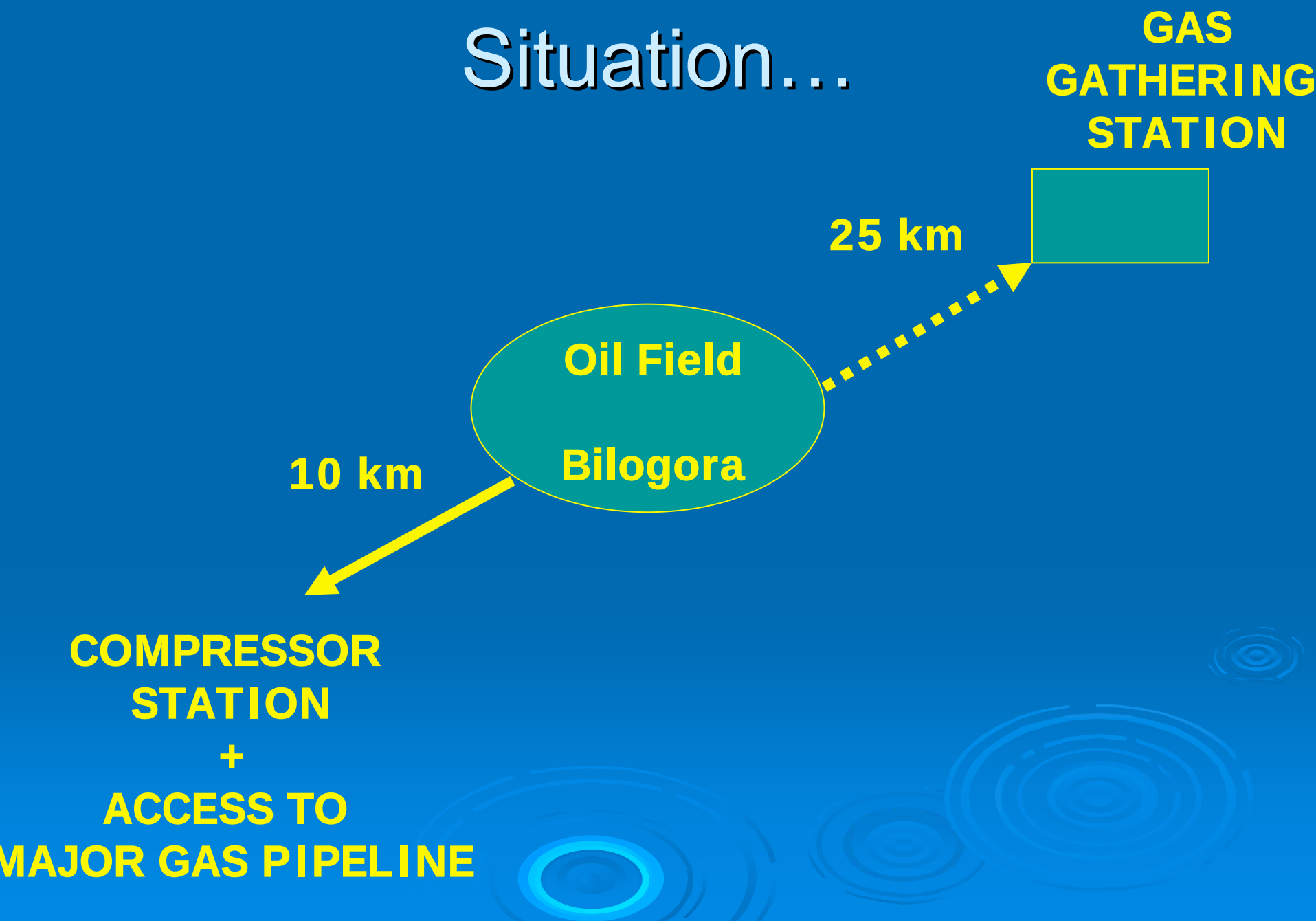
Bilogora field

Bilogora Oil Field

- 1972. Oil Production Start-Up, Gas Lift
- 2002. Gas Production Testing in Three Wells
  - One well ---- 16% CO_2
    35 ppm H_2S
- Question:
  - Possible rates ?
  - How to gather and process ?
  - Where and how to transport ?

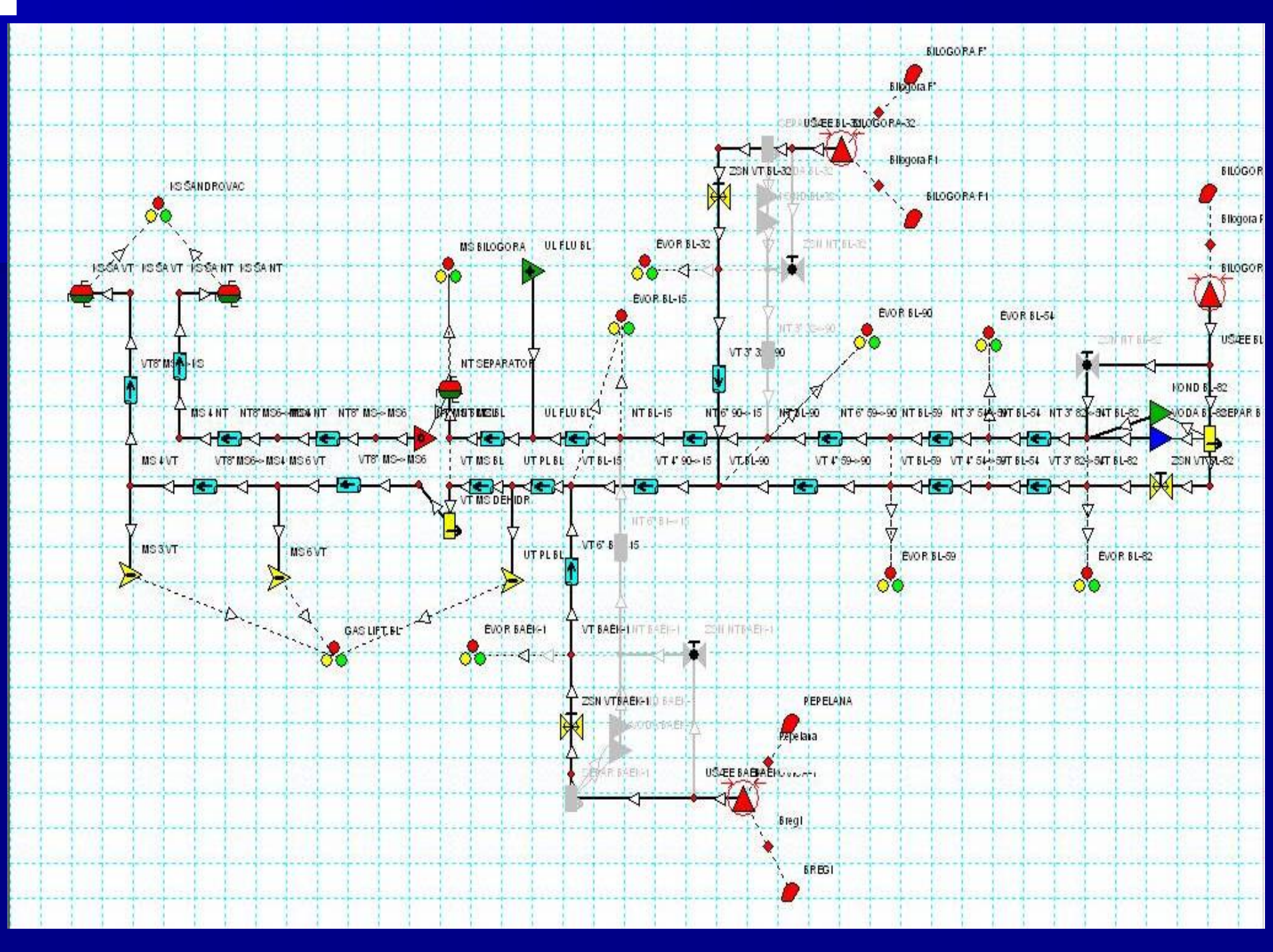
Situation…


GAS
GATHERING
STATION
25 km
Oil Field
Bilogora
10 km
COMPRESSOR
STATION
+
ACCESS TO
MAJOR GAS PIPELINE

Two Options

1. Well BI-82 (CO_2 16 %) – to gas gathering station (25 km), other 2 wells to existing gas lift system

2. Commingled production through existing gas lift system with rate constraint of well BI-82


BILOGORA F"
Bilogora F"
BILOGORA-32
USEE BL-32
Bilogora F1
BILOGORA F1
ZSN VT BL-32
IS ŠANDROVAC
IS ŠA VT
IS ŠA VT
IS ŠA NT
IS ŠA NT
MS BILOGORA
UL FLU BL
EVOR BL-32
EVOR BL-15
EVOR BL-90
EVOR BL-54
NT SEPARATOR
VT 3" 3...90
NT 6" 90-15
NT BL-90
NT 6" 59-90
NT BL-59
NT 3" 54-59
NT BL-54
NT 3" 82-54
NT BL-82
MS 4 NT
NT 8" MS-MS6
UL FLU BL
NT BL-15
MS 4 VT
VT 8" MS6-MS4
MS 6 VT
VT 8" MS-MS6
VT MS BL
UT PL BL
VT BL-15
VT 4" 90-15
VT BL-90
VT 4" 59-90
VT BL-59
VT 4" 54-59
VT BL-54
VT 3" 82-54
VT BL-82
ZSN VT BL-82
VT MS DEHIDR
MS 3 VT
MS 6 VT
UT PL BL
VT 6" B...15
EVOR BL-59
EVOR BL-82
GAS LIFT BL
EVOR BAEI-1
VT BAEI-1
ZSN VT BAEI-1
PEPELANA
Pepelana
Bregi
BREGI

The Decision

- Option 2:

  Produce through gas lift system
  - Lower investment
  - Higher recovery due to lower dp

  - Lower initial rates
    - BI-82 rate constraint; so total CO_2 content is within approved limits

The Idea

- Connect gas wells to gas lift system:
  - Phase I ; pwh > 50 bar
    - Build TEG gas dehydration system and use gas for gas lift
  - Phase II; pwh< 50 bar
    - Gas production through low pressure gas lift pipeline
    - Booster compressor?

The good news

- More wells…
  - Different reservoirs, different well characteristics
  - Some wells connected to GS, some not
  - No CO_2

From The Beginning…

- Find the way to test wells through the existing oil gathering system without flaring
- A lot of pipelines:
  - Found Ex looping pipeline,
  - Minor Reconstructions to get free pipeline for temporarily wells' testing

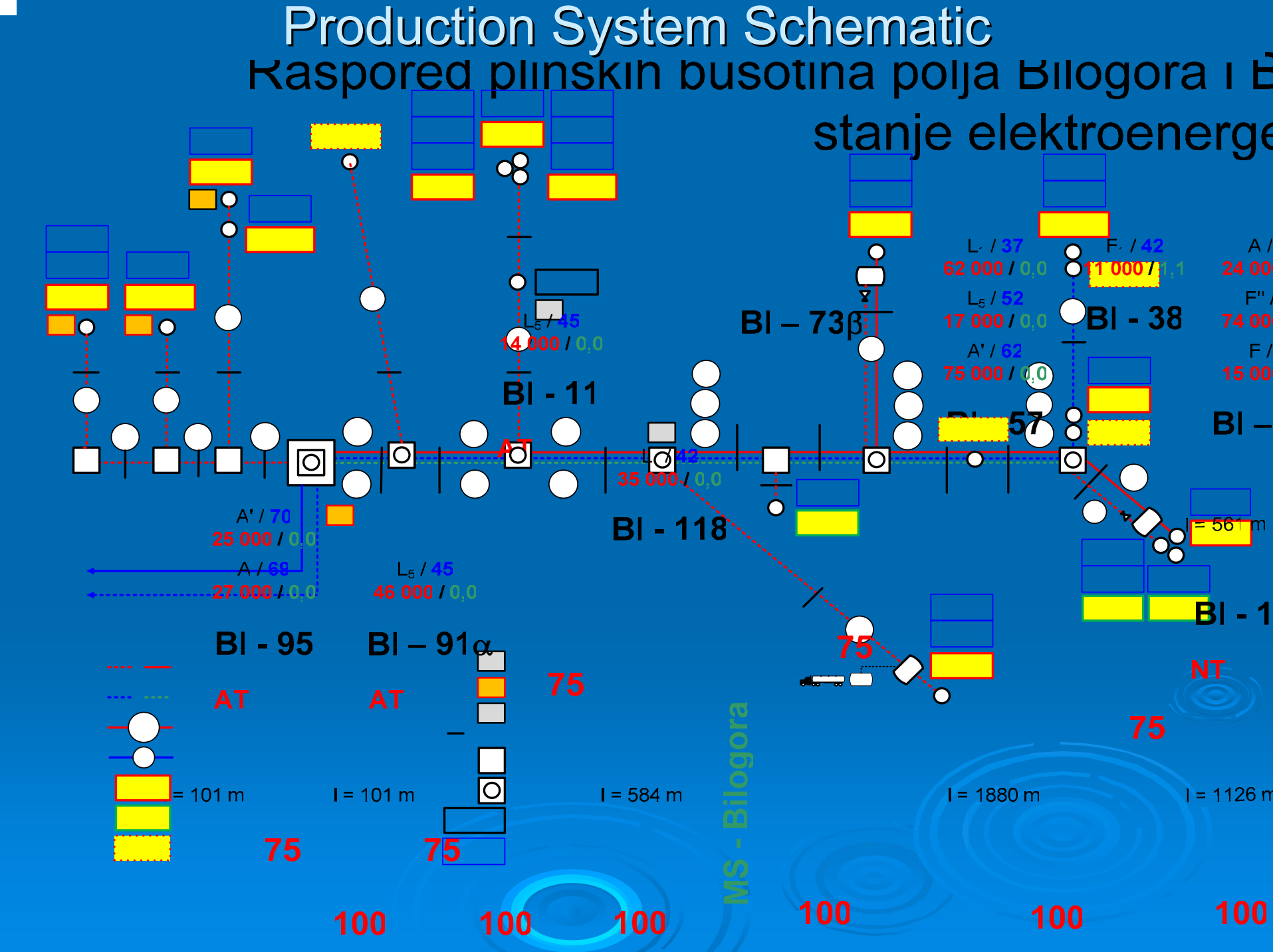
The Task

- Get the information on rates, pressures and possible problems:
  - Hydrates formation
  - Sand production
  - Liquid production
  - Wellhead pressure trends
  - Do the well testing, evaluate reservoirs
  - Impact on oil producing wells
  - Test the existing pipelines capacity and pressure drops
  - Build the concept of future gas gathering system
  - Rebuild the IPM model

We have defined…

- Number, length and size of pipelines needed
- Number and type of vessels needed:
  - TEG gas dehydration of HP wells
  - Free Water Knock Outs for wells producing liquid
  - On site Water and Condensate Tanks for distant wells
  - Electricity to each well
  - Pumps for chemicals injection

Production System Schematic



Lessons learned

- Gas production can be tested through oil producing installations
- Oil production drop at Bilogora – up to 25% for increase in p_{sep} from 3 to 5 bar
- IPM results - a key parameter for production system design

The next step

Building the new IPM model

Integrated Production Model

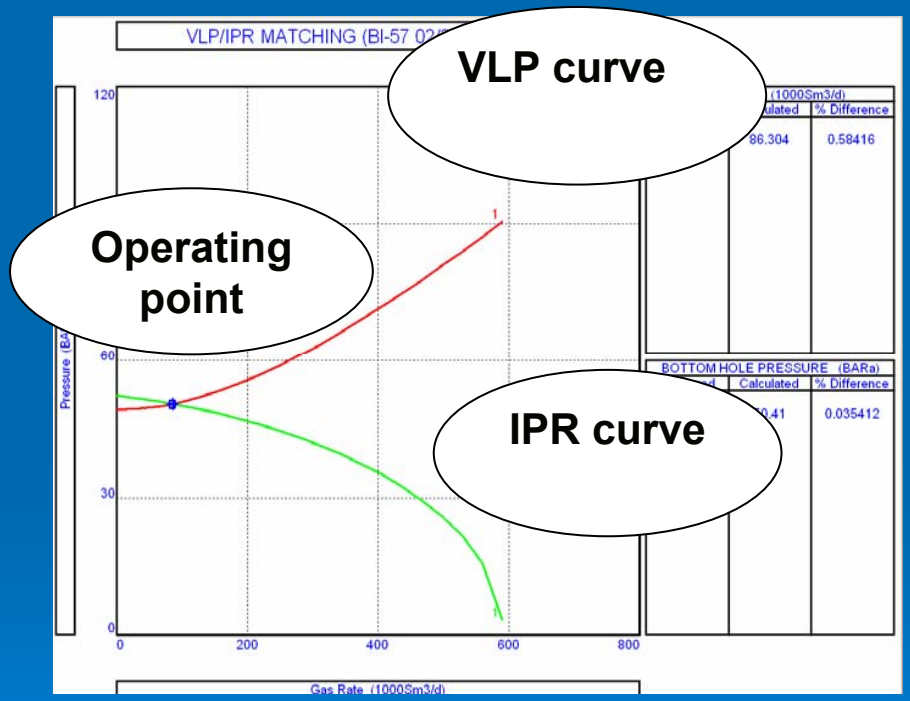
Introduction

- Objective – to promote the new way of the working (IPM, multidisciplinary)
- To give production dynamics prediction
- To optimize production
- IPM (PVTP, Prosper, MBAL, GAP)

Bilogora – Bačkovica field

- Field location – 20 km east from Bjelovar (Podravina district)
- Anticline
- Fluid features:
- methane
- well BI-82 – fluid contains 15,43 % CO_2

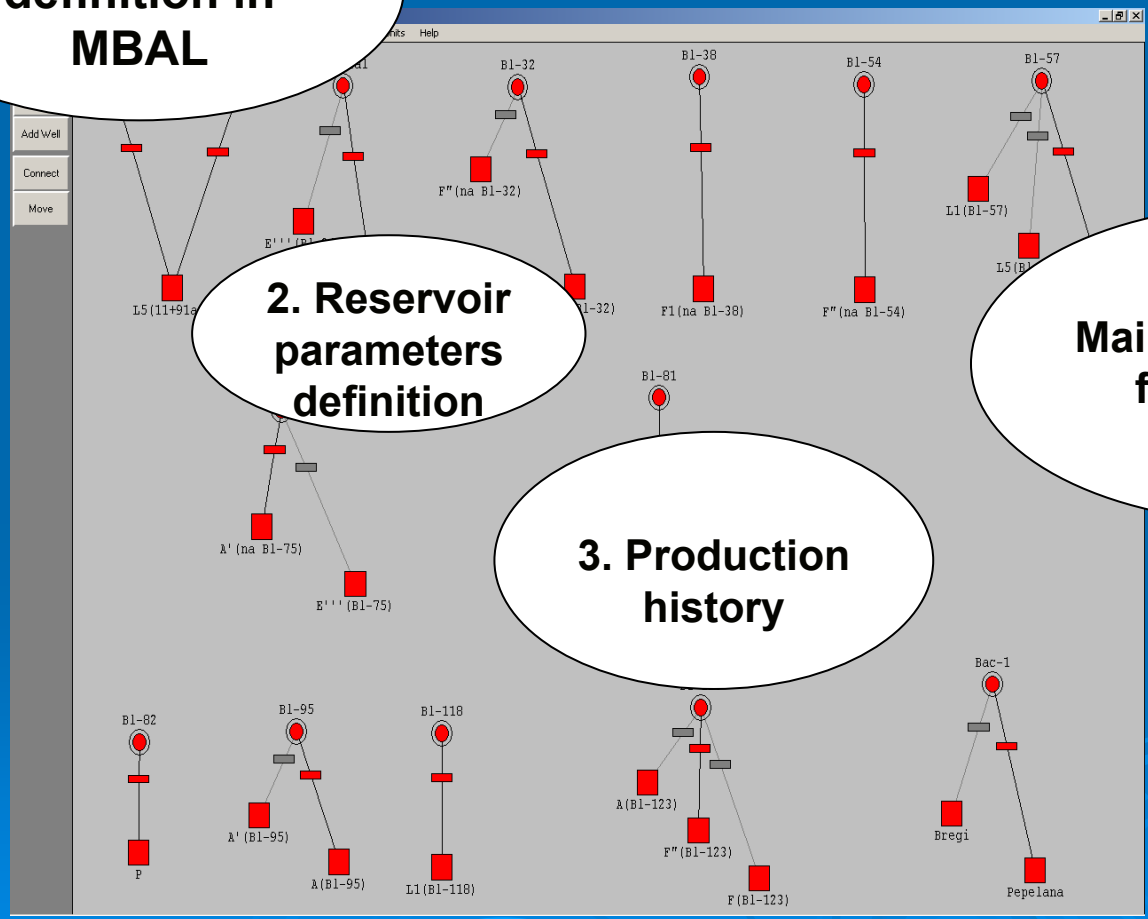
Prosper – well models



- VLP curve
- IPR curve
- Matching VLP/IPR
- Operating point
- Production optimization
- System analysis
- Completion

MBAL – reservoir model

1. Fluid definition in MBAL

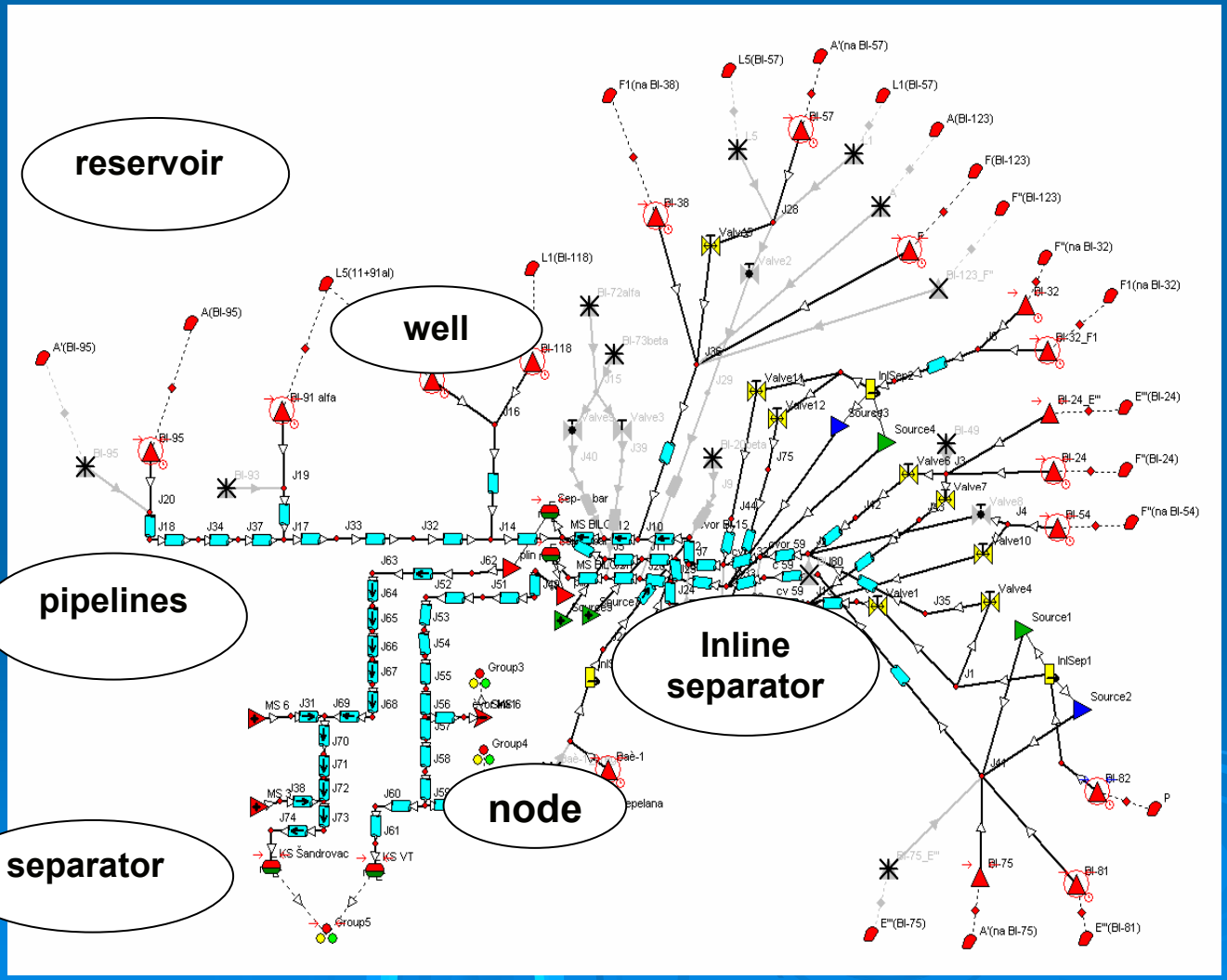


2. Reservoir parameters definition

3. Production history

Main MBAL screen for wells and reservoirs

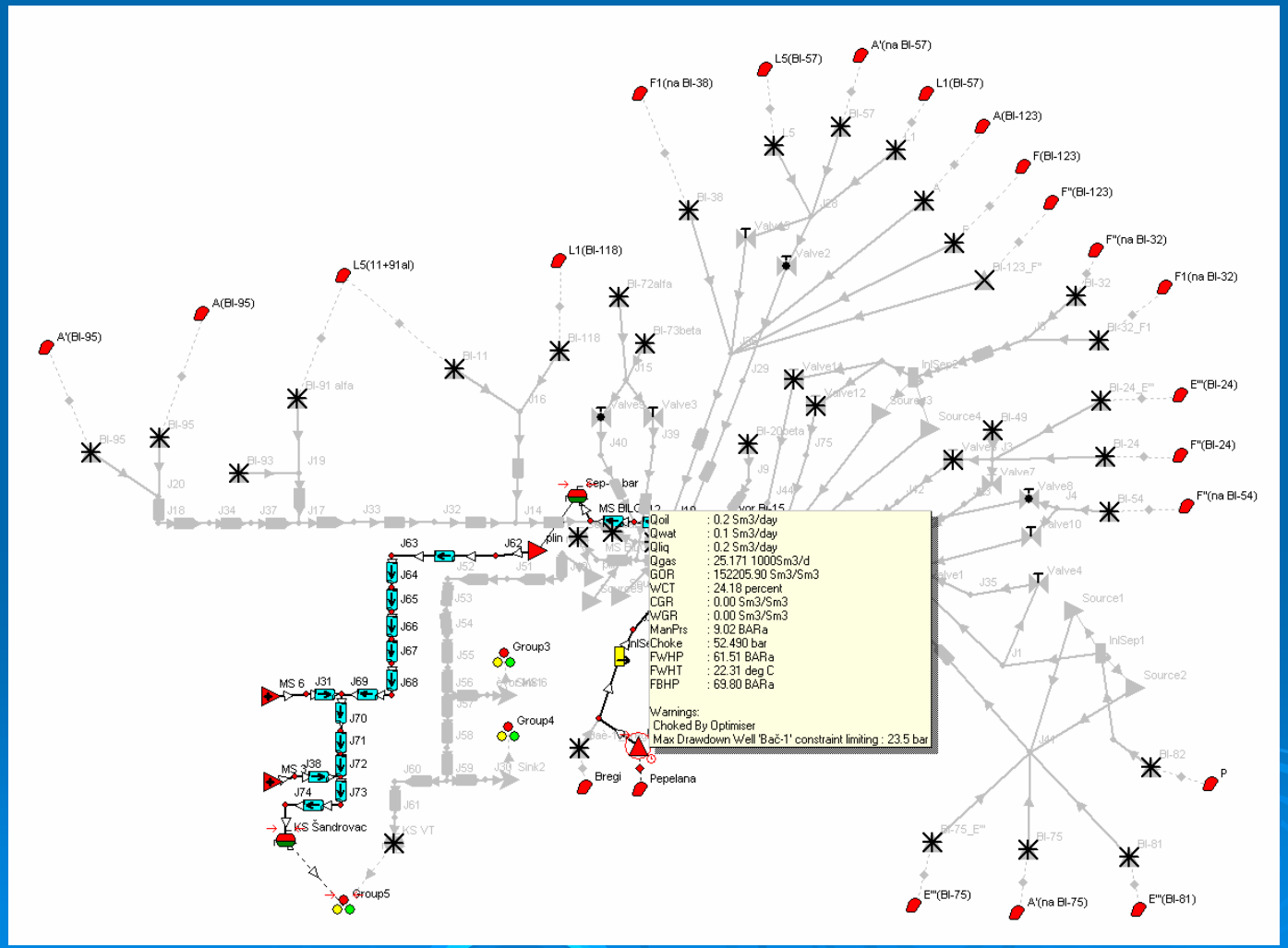
GAP – Integrated Production Model



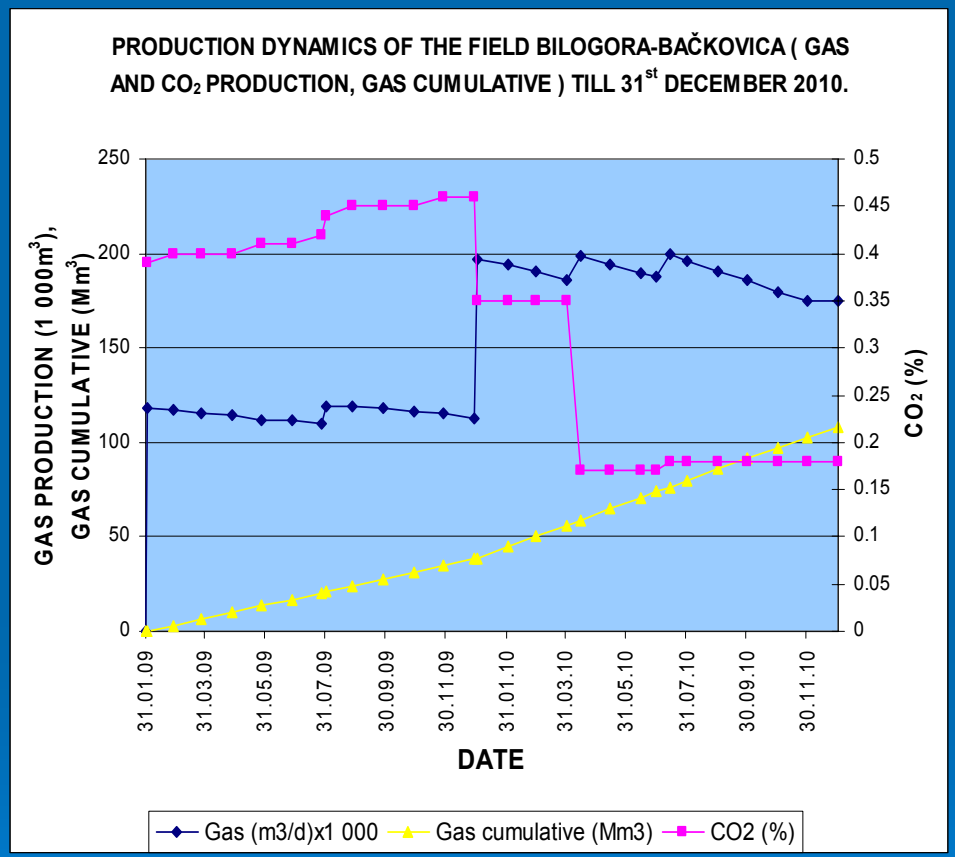
Data input

- Well models – Prosper
- Reservoir model – MBAL
- Pipelines (pressure, temperatures, pipe elevations)
- Separators
- Constraints (time)

Results


L5(BI-57)
A'(na BI-57)
F1(na BI-38)
L1(BI-57)
A(BI-123)
F(BI-123)
F''(BI-123)
F''(na BI-32)
F1(na BI-32)
L1(BI-118)
L5(11+91al)
A(BI-95)
A'(BI-95)
E'''(BI-24)
F''(BI-24)
F''(na BI-54)
Sep- bar
MS BILO
Qoil : 0.2 Sm3/day
Qwat : 0.1 Sm3/day
Qliq : 0.2 Sm3/day
Qgas : 25.171 1000Sm3/d
GOR : 152205.90 Sm3/Sm3
WCT : 24.18 percent
CGR : 0.00 Sm3/Sm3
WGR : 0.00 Sm3/Sm3
ManPrs : 9.02 BARa
InlSe Choke : 52.490 bar
FWHP : 61.51 BARa
FWHT : 22.31 deg C
FBHP : 69.80 BARa
Warnings:
Choked By Optimiser
Max Drawdown Well 'Bač-1' constraint limiting : 23.5 bar
Group3
Group4
Group5
Sink2
MS 6
MS 3
KS Šandrovac
KS VT
Bregi
Pepelana
InlSep1
Source1
Source2
P
E'''(BI-75)
A'(na BI-75)
E'''(BI-81)

Results



- Production dynamics
- CO_2, gas production
- Gas cumulative

Conclusion

- Production optimization
- Dynamic production prediction
- Updating – hydrodynamic measurements
- Budget prediction
- Completion and workover dynamics prediction
- Base for economic model
- Possibility of reservoir and production monitoring

THANK YOU