

DELFI PILOT “A CROSS BORDER FIELD”

Perfomed by : INA – MOL Subsurface Team

Prepared by: Petar Pavić

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Luzern, Switzerland

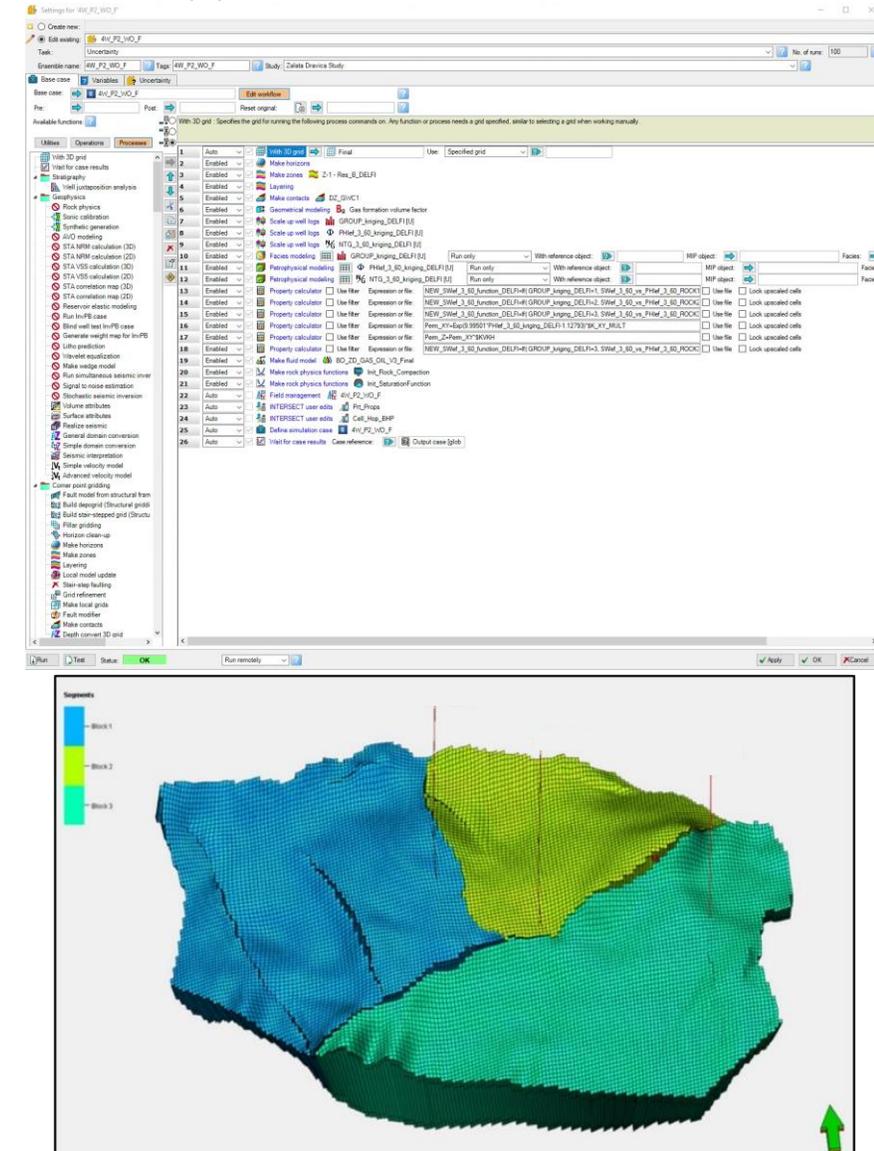


INTRODUCTION

- There are multiple hydrocarbon fields - owned by MOL and INA - split by the border of Hungary and Croatia. Among them the “Z-D” field, discovered a decade ago, and ready to be fully developed and put on production.
- “Z-D” is a gas condensate field with highly heterogenous Miocene age breccia-conglomerate lithology.
- Three wells have been drilled up to date: 2 production wells with considerable productivity and a dry appraisal well.
- New well has been drilled in May 2022.
- During the subsurface preparatory tasks (pre-drill phase) Nov 2021-Feb 2022, **the re-evaluation of the field was combined with a company-level piloting of Schlumberger’s DELFI environment.**
- The exercise had a double aim:
 - Kick-off a MOL-INA integrated revisit of field development - a continuous daily collaboration among disciplines;
 - **Test the DELFI environment benefits to support the future software strategy of the MOL Group.**
- The multidisciplinary team tested the software from seismic, petrophysics, reservoir geology and reservoir engineering aspects, including field development planning. The team was geographically separated, as half of the participants work in Budapest, and another half in Zagreb.
- The pilot hasn’t stopped with the production forecasts, “FDPlan” – DELFI native web-based application has been tested in order to evaluate project KPI’s.

DELFI ENVIRONMENT AND TECHNICAL DISCIPLINES

Petrel application on VM's:



Planned activities:

PROJECT PHASE	NOVEMBER 2021					DECEMBER 2021				JANUARY 2022				FEB 2022	
	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7
Geophysical Interpretation	Seismic attribute analysis														
	Seismic inversion for PDR distribution & facies analysis														
	Petrophysical interpretation in Quantif.Elan														
Petrophysical Interpretation	Image interpretation														
	Full wave acoustic														
	Geomechanics interpretation														
	Well & seismic data QC and integration in Petrel														
Static modeling	Facies modelling (optional)														
	Petrophysical modelling														
	3D Volumetric calculations with uncertainty analysis														
Dynamic modelling	Initialization														
	Production forecasting														
Field development scenarios	Field Development Planning														

Disciplines involved in DELFI testing:

- Geophysics
- Petrophysics
- Geology
- Reservoir Engineering
- Economics
- Management/decision makers

DELFI Environment:

- Cloud solution.
- Access to applications across all domains via Remote Desktop – Petrotechnical Suite
- All applications used for all disciplines are same as on premises (Petrel, INTERSECT etc..) but accessed via subscription on “cloud” VM’s.
- Flexibility in picking packages needed for conducting technical evaluation.
- Shared storage space for all disciplines.
- Collaboration tools for different disciplines (sharing data, result and realizations).
- **By introducing “parallelization” of simulations, RE evaluation has a new perspective.**
- **FDPlan – KPI evaluation (connection between management / decision makers, subsurface technical team and economics).**
- **FDPlan and parallelization of simulations caught great attention in process of DELFI evaluation**

THE WORKFLOW

FDPlan Study Overview

FDPlan - is tool that connects results from dynamic simulation, economical inputs, including all possible business decisions that should be considered.

Calculates and visualizes economical models and KPI's based on inputs.

And finally, it is used to analyze results and pick the best scenario for future development.

Information [Study Information](#)

Details	
Stage In Progress - Appraisal Phase	Status In Progress
Stage End Feb 28, 2022	FID Feb 28, 2022
Description Development/Appraisal of Zalata Dravica Gas Field	

Commercial
License Cross Border PSA
Blocks -
Operator INA/MOL
Partners -

Field

Field Name Zalata-Dravica	Type Greenfield	Environment Onshore	Terrain -	Latitude 45.71	Longitude 17.91
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KPOs (3) [Manage Benchmark](#) | [Manage KPOs](#)

ATNPV More Than 20 M\$	ATIRR More Than 15 %	UPC Less Than 6 \$/BOE
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Scenarios (0 of 36 Selected) [Manage Scenarios](#)

S1 2W_BT_P1_W_F ... Completed on Feb 15, 2022

S2 2W_BT_P1_W/O_F ... Completed on Feb 15, 2022

S5 2W_ZD_P1_W_F ... Completed on Feb 15, 2022

S6 2W_ZD_P1_W/O_F ... Completed on Feb 15, 2022

S9 2W_PTLB_P1_W_F ... Completed on Feb 15, 2022

S10 2W_PTLB_P1_W/O_F ... Completed on Feb 15, 2022

S13 3W_BT_P1_W_F ... Completed on Feb 15, 2022

No scenarios selected

Select scenarios that you want to take to the stage gate.

[Manage Scenarios](#)

Team (4) [Manage Roles](#)

Galvin Shergill gshergill@slb.com Roles: Study Managers	Petar Pavic petar.pavic@ina.hr Roles: Study Managers	Silvan Mikulic silvan.mikulic@ina.hr Roles: Study Managers	Zsolt Bihari zsbihari@mol.hu Roles: Study Managers
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FDPLAN – MANAGING TEAM

Setting up participants and their roles:

- Each participant can be either Study Manager or Contributor
- Study Manager sets up scenarios and promotes them to contributors.
- Contributors calculate results and propose best one to manager for further processing

This concept allows fast collaboration and connectivity between technical personnel and Management

The screenshot displays the 'Manage Team' interface. On the left, there is a 'Select Role' section with two options: 'Study Managers' and 'Study Contributors'. On the right, the 'Assign Users and Groups' section features a search bar labeled 'Search for a user' and a list of four assigned users, each with a unique icon and a close button (X):

Role	User Name	Email
Study Managers	Galvin Shergill	gshergill@slb.com
Study Managers	Petar Pavic	petar.pavic@ina.hr
Study Contributors	Silvan Mikulic	silvan.mikulic@ina.hr
Study Contributors	Zsolt Bihari	zsbihari@mol.hu

FDPLAN – MANAGEMENTSETTING UP SCENARIOS AND DECISIONS

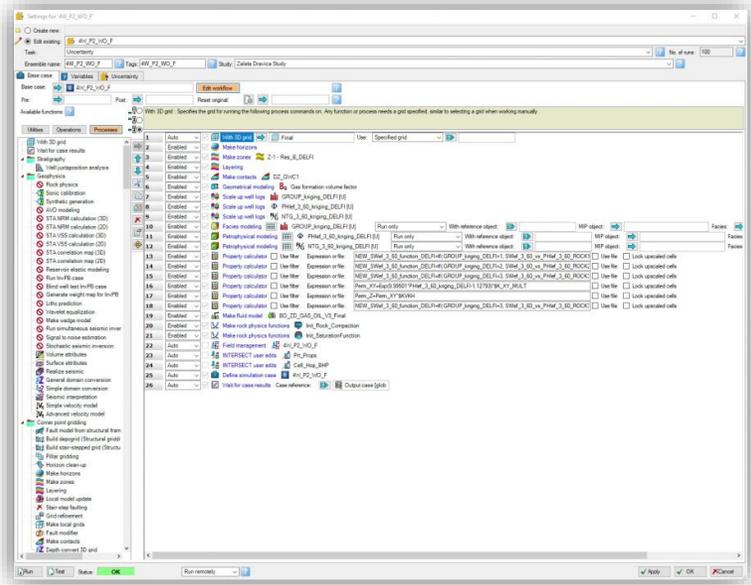
Study decision: number of wells, type of water disposal, wellhead compressors etc...

- After setting up all scenarios (combination of decisions), they are promoted for calculation in dynamic model to appropriate contributor.
- Contributor then gets the message through system with details on requested scenario.
- Based on scenario details, contributor sets the workflow and calculates the requested forecast.

Scenarios:
For example: 6 wells in production, water disposal in existing dry well, starting with phase one and hydraulically fracked...

PETREL – SETTING UP SCENARIOS BASED ON FDPLAN DECISIONS AND RUNNING THEM IN PARALELLY IN CLOUD

Setting up in Petrel - Uncertainty And Optimization ensembles for well count, date of first gas, and with and without frack as an option:



All workflows (ensembles) are run in cloud HPC each comprised of 100 realizations to capture full span of uncertainties

- 2W_P1_WO_F
- 2W_P1_W_F
- 3W_P1_W_F
- 3W_P1_WO_F
- 4W_P1_WO_F
- 4W_P1_W_F
- 6W_P1_W_F
- 6W_P1_WO_F
- 4W_P2_WO_F
- 4W_P2_W_F
- 6W_P2_WO_F
- 6W_P2_W_F

Status overview of all runned workflows

Name	Status	Realizations processed	Actions
6W_P1_WO_F	Results	100/100	...
6W_P2_W_F	Results	100/100	...
4W_P2_WO_F	Results	100/100	...
3W_P1_WO_F	Results	100/100	...
3W_P1_W_F	Results	100/100	...
2W_P1_WO_F	Results	100/100	...
4W_P1_W_F	Results	100/100	...
6W_P2_WO_F	Results	100/100	...
4W_P2_W_F	Results	100/100	...
6W_P1_W_F	Results	100/100	...
4W_P1_WO_F	Results	100/100	...
2W_P1_W_F	Results	100/100	...

Geological and RE uncertainties:
Geological unct. parameters

Type	Pr	Int	Name	Base value	Distribution	Arguments
SEED variable	☒	☐	SSEED	50		
Uncertain	☒	☐	SGW	-3160	Uniform	Min -3200 Max -3092.1
SEED variable	☒	☐	SSEED1	64		
SEED variable	☒	☐	SSEED2	123456		
SEED variable	☒	☐	SSEED3	1000		
Uncertain	☒	☐	SK_XY_MULT	37	Uniform	Min 1 Max 50
Uncertain	☒	☐	SKVKH	0.1	Uniform	Min 0.05 Max 0.15
Uncertain	☒	☐	SKrw_Sw	0.5	Uniform	Min 0.2 Max 0.7
Uncertain	☒	☐	SSgr	0.05	Uniform	Min 0.01 Max 0.15
Uncertain	☒	☐	SSW_Corey_coef	4	Uniform	Min 2 Max 6

RE unct. parameters and ranges

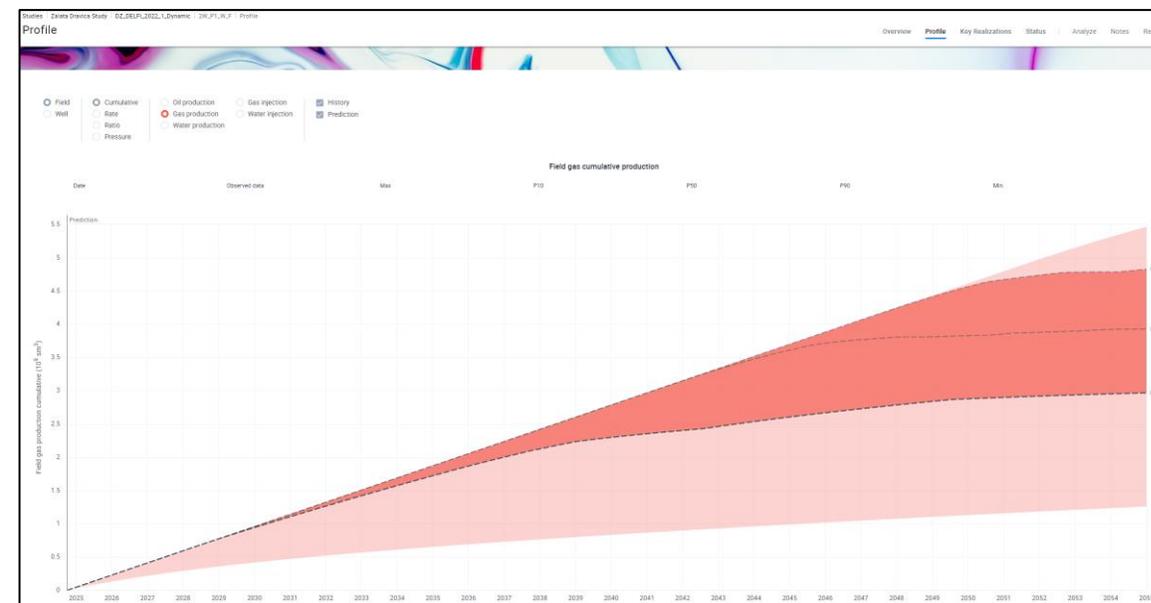
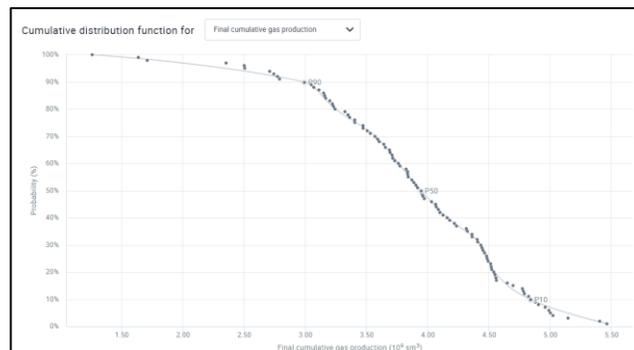
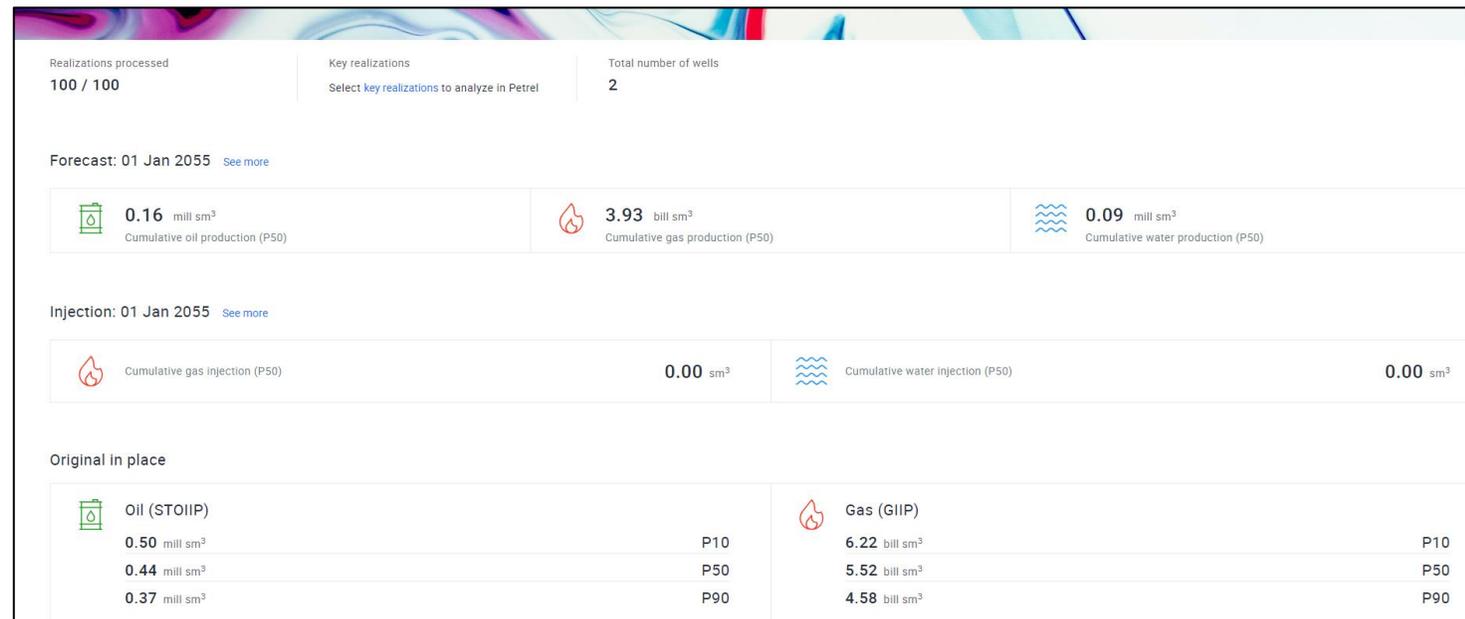
After the results are available, they are proposed, or sent to FDPlan for further processing.

Doing the evaluation on premise this number of simulation would be significantly smaller due to limitation of resources(licences, hardware, etc..)

PARALLELIZATION

- **Parallelization** – simultaneous processing of large number of simulations (Petrel & INTERSECT or ECLISPE processes)
- **Drastic reduction in simulation time** of multiple realizations
- In Z-D project **1200 realizations** were simulated in **one day** (huge time saving)
- Each simulation ensemble is run remotely – **no need for on premises resources** (powerful hardware, storage, etc..)
- Direct connection with FDPlan and data sharing of simulation ensemble results
- Number of available licenses (for simulator) is not concern anymore – different concept – Consumption ‘on demand simulation’

Ensemble result overview:



PREPARING FDPLAN FOR ECONOMICAL CALCULATION

Study

- S1 2W_BT_P1_W_F
- S2 2W_BT_P1_W/O_F
- S5 2W_ZD_P1_W_F
- S6 2W_ZD_P1_W/O_F
- S9 2W_PTLB_P1_W_F
- S10 2W_PTLB_P1_W/O_F
- S13 3W_BT_P1_W_F
- S14 3W_BT_P1_W/O_F
- S17 3W_ZD_P1_W_F
- S18 3W_ZD_P1_W/O_F
- S21 3W_PTLB_P1_W_F
- S22 3W_PTLB_P1_W/O_F
- S25 4W_BT_P1_W_F
- S26 4W_BT_P1_W/O_F
- S27 4W_BT_P2_W_F
- S28 4W_BT_P2_W/O_F
- S29 4W_ZD_P1_W_F

Scenario Overview

Workflow

Name	Version	Description	Number of Realizations
Field Enhanced Economic Evaluat...	1	Field Enhanced Economic Evaluat...	30

- Production Forecast
New
Feb 14, 2022 at 11:04
- General Capex
New
Feb 14, 2022 at 10:10
- General Opex
New
Feb 15, 2022 at 15:30
- Economic Framework
New
Feb 11, 2022 at 12:04
- Price Forecast
New
Feb 14, 2022 at 10:38
- Reference Dates
New
Feb 11, 2022 at 12:04
- Economic Indicators
New
Feb 11, 2022 at 12:04

Economics

- Economics Results
Feb 15, 2022 at 15:55

General-Capex

INSTRUCTIONS				
General CAPEX				
A	B	C	D	E
Date	Item Description	Dev Drilling Success M\$	Facilities M\$	Pipelines M\$
Jan 01, 2021				
Jan 01, 2022		7372.38	3360.00	
Jan 01, 2023		3250.00	9630.00	22050.00
Jan 01, 2024		0.00	6730.00	19520.00
Jan 01, 2025		0.00	830.00	
Jan 01, 2026		20867.07	3090.00	
Jan 01, 2027		0.00	550.00	
Jan 01, 2028		0.00	220.00	
Jan 01, 2029			4000.00	
Jan 01, 2030				
Jan 01, 2031				

Each scenario has:

- Corresponding simulation ensemble (production forecast)
- General CAPEX
- General OPEX
- Economic Framework
- Price Forecast
- Reference Dates
- Economic Indicators

All data for economic inputs are in tabular format.

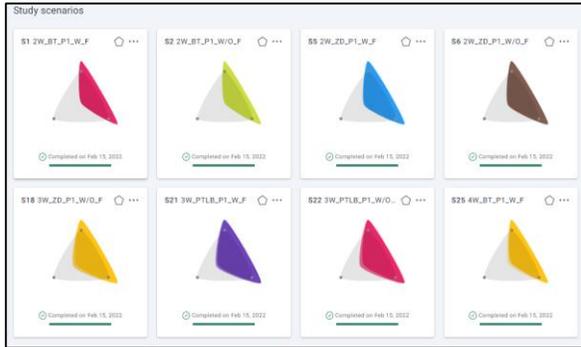
30 realizations are picked from 100 cases as simple random (30 is maximum).

Based on all inputs (economical and sim. forecasts) KPI's were calculated for all 36 cases

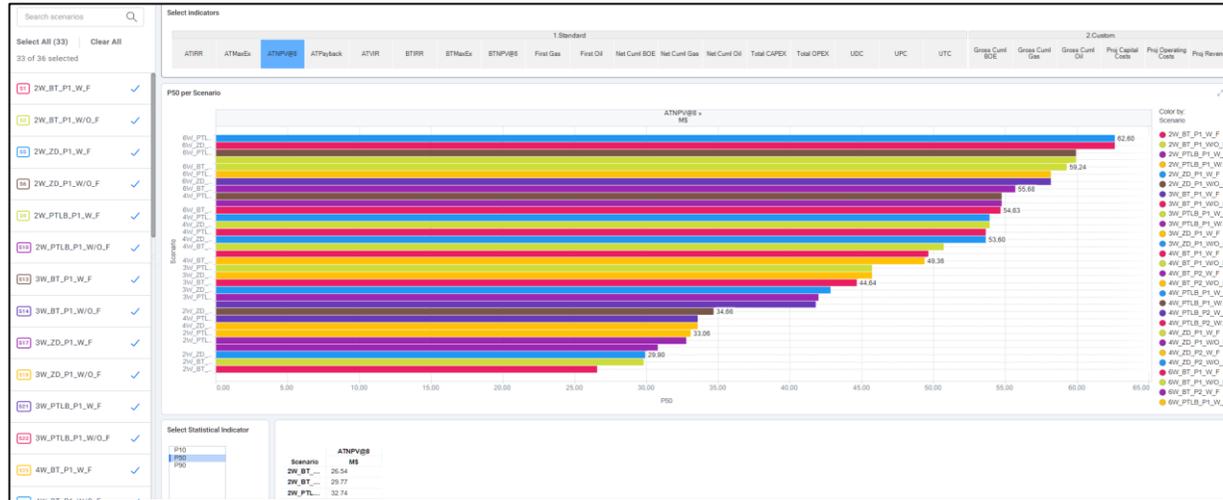
RESULTS – EXTENSIVE RANGE OF AVAILABLE RESULT OUTPUTS FOR ANALYSIS

- In FDPlan there are numerous visualization tools for analysis of results in order to **very quickly gain insight** in to key economical/technical drivers for the particular study.
- In our project this has speed up process of determining value and impact of each decision point.

Spider charts:



Comparison of KPO for each scenario



Tabular output:

← Return to Study Scenarios in study Zalata Dravica Final
Compare Scenarios

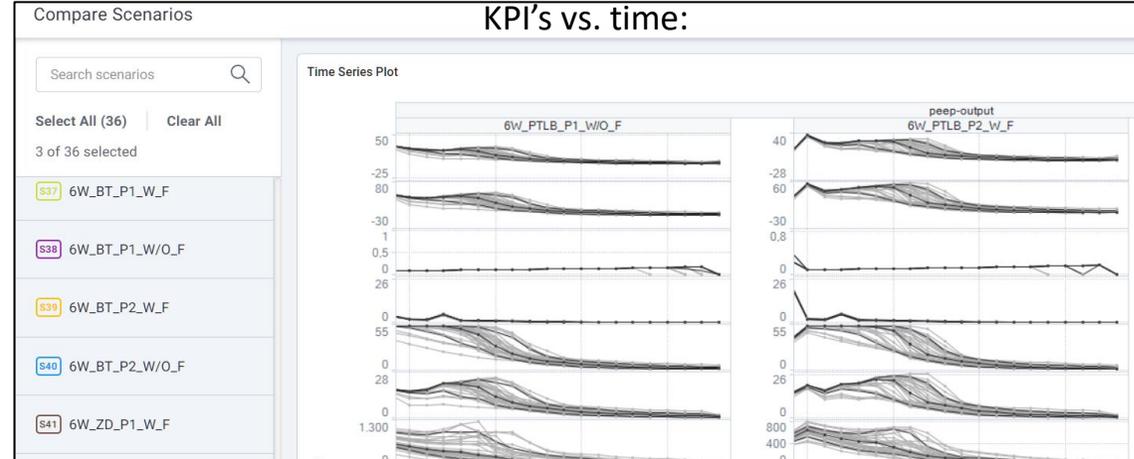
Search scenarios

Select All (36) Clear All

4 of 36 selected

- S37 6W_BT_P1_W_F
- S38 6W_BT_P1_W/O_F
- S39 6W_BT_P2_W_F
- S40 6W_BT_P2_W/O_F
- S41 6W_ZD_P1_W_F

ResultSet	PropertyName	EntityType	EntityName	StepDate	Unit
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	1.10.2035.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	17.9.2034.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	15.2.2025.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	17.8.2037.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	17.6.2029.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.10.2037.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.3.2039.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.3.2035.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	1.3.2043.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.12.2037.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.1.2044.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.9.2043.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.8.2040.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	17.1.2036.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.7.2032.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	22.8.2032.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	17.3.2034.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	16.2.2034.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.8.2041.0...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	17.11.2037...	MSCF
6W_ZD_P2_...	PRODUCTION...	FIELD	FIELD	2.6.2048.0...	MSCF



CONCLUSIONS

- ✓ Same access to Petrel software on DELFI platform to the same functionalities on the software installed locally on PC-workstations (applies to all disciplines: Geophysics, Petrophysics, Geology, Reservoir Engineering);
- ✓ Project Explorer in DELFI - Functionality that could add value and give an opportunity of simultaneous work on the one Petrel project at the same time;
- ✓ Noticeable differences in Reservoir Engineering workflow: Parallelization greatly speeds up the whole process (several months became several days);
- ✓ FDPlan - Tool native to DELFI platform for managers which connects RE outputs, Economic inputs and calculates all economical outputs while offering good visualization of results for gaining insight into project main KPI's much faster;
- ✓ At the time there were software functionality issues which were promptly resolved;
- ✓ There is room for improvement in the future, mostly in web-based applications, for example FDPlan and workflow can be optimized for more productive user experience.

CREDITS

Many thanks to all Schlumberger experts who participated and helped with their generous support and technical knowledge during the Delfi evaluation!

MOL Group participants

INA Zagreb:

- Stipica Brnada (geophysicist)
- Viktorija Kojundžić (petrophysicist)
- Željka Marić-Đureković (petrophysicist)
- Luka Bubnić (petrophysicist)
- Tamara Babić-Puntarec (geologist)
- Marko Živković (project manager)
- Petar Pavić (reservoir engineer)

MOL Budapest:

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- Akbar Muhammad Nur Ali (petrophysicist)
- Szabolcs Borka (geologist)
- Zsolt Bihari (reservoir engineer)
- István Nemes (project manager)

THANK YOU!

