

DOT.CBM™

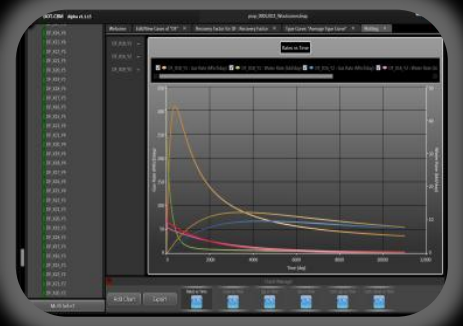
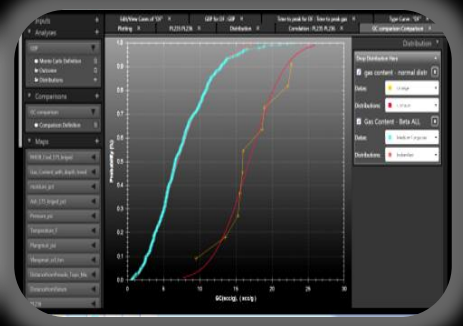
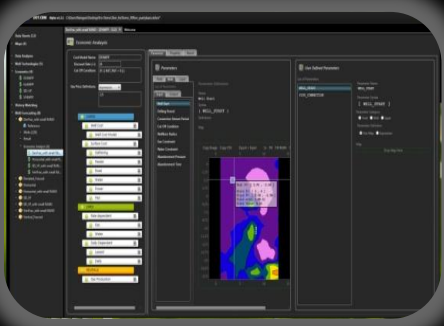
Development Optimization Toolkit for CBM



- Data Analysis for Reservoir Characterisation
- Property Mapping and Visualisation
- Production Forecasting
- History Matching
- Costs and Economics
- Development Planning Optimisation

DOT.CBM : Integrated platform for CBM field assessment

A user-friendly, efficient solution for forecasting, history-matching and field development optimisation



Production Forecasting

- Generate rapid full-field, static model based forecasts
- Advanced material balance production forecasting, multi-well and multi-layer
- Fast numerical scheme for transient production behaviour
- Perform uncertainty and variability assessments
- Forecast alternative well & completion concepts, with a comprehensive constraints handling capability

Field Development Planning Optimisation

- Forecast alternative drilling schedule, well technology and spacing concepts
- Automated type curve generation
- Identify optimum drilling and completion concepts
- Support decision under uncertainty

Economic Evaluation

- Perform field and sector economic evaluation using a variety of pre-defined and user-defined indicators
- Detailed and scalable complexity of cost templates.
- Development concept ranking for Field Development Planning decisions

Well Technology Selection

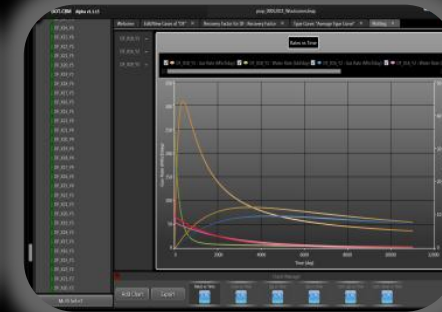
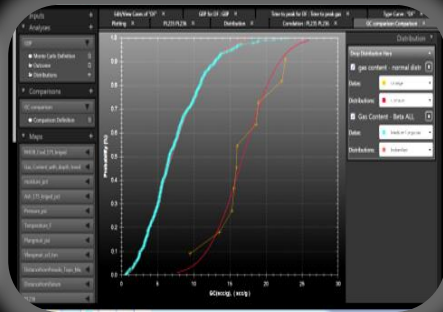
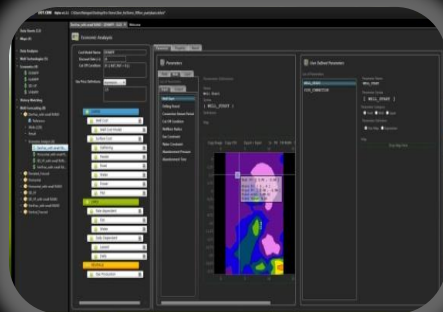
- Rapidly create well plans using an automated well trajectory building tool
- Automated Computation of well technology costs across the field



For more information or to arrange for a demonstration of DOT.CBM functionalities in your office please contact us at dot.cbm@leap-energy.com

DOT.CBM : Integrated platform for CBM field assessment

A user-friendly, efficient solution for forecasting, history-matching and field development optimisation



Data Analysis

- Develop property models using powerful data fitting functionalities
- Perform advanced statistical data analysis, correlations and analogue benchmarking
- Generate stochastic simulation for probabilistic volume assessment

Reporting

- Easy export of data, text, figures, tables and maps in most recognized formats
- Drag 'n' drop functionality for copying data and graphics to MS Office applications

Mapping and visualisation

- Visualise, edit and generate maps of reservoir properties
- Perform upscaling and downscaling
- Automated visualisation of reservoir simulation outcomes for high-grading analysis
- GIS functionality and map overlay capability

Production History Matching

- Match pilot well production with multiple solutions
- Generate matching parameter ranges for reservoir characterisation input
- Finite-Elements numerical and Material-balance
- Multiple global search algorithm including evolutionary stochastic methods

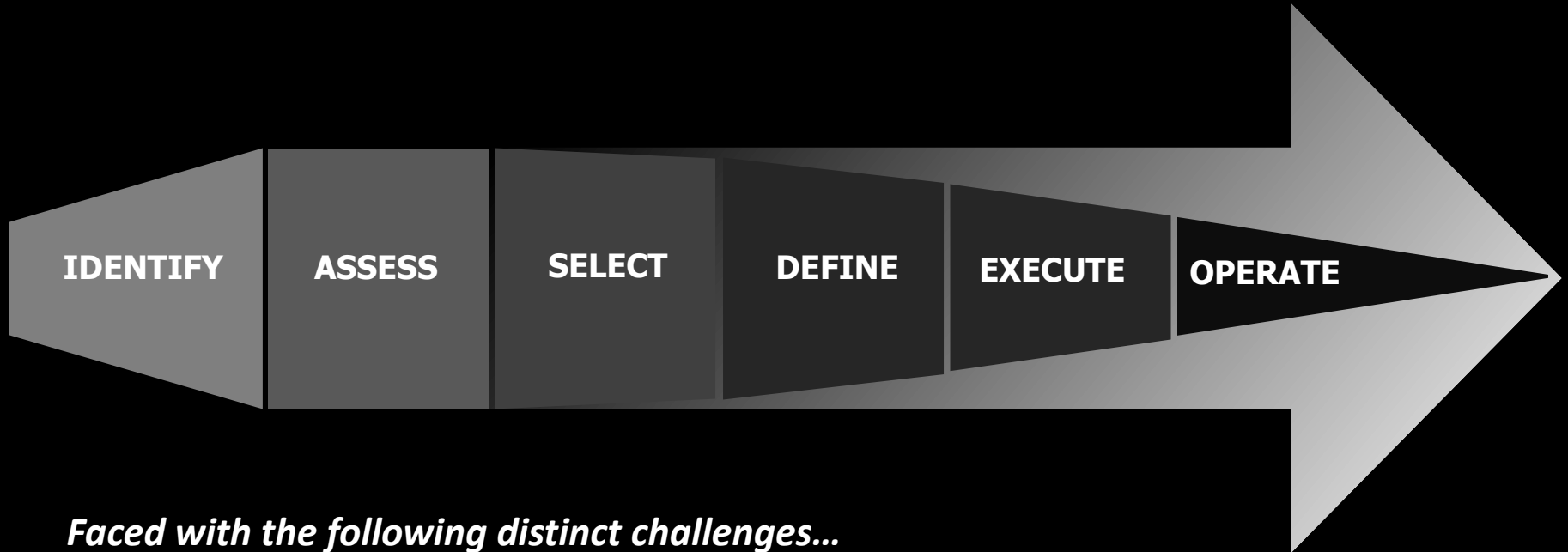


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Genesis of the Tool

Through an extensive exposure to a wide range of project specific CBM challenges

Intervening over a variety of projects, at different phases of the E&P cycle



Faced with the following distinct challenges...

Field Dev. Plans

- 🌐 Project areas can be 100-1000's of km², with large well datasets
- 🌐 Concept Select decisions under uncertainty and ambiguous information
- 🌐 High-grade areas with impact of spatial trends

Portfolio assessment

- 🌐 Rapidly assess and rank assets to high-grade portfolio decisions
- 🌐 Auditable link between reservoir data and type curves

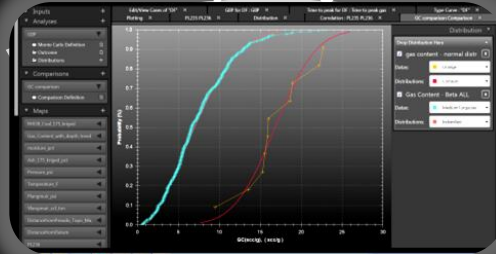
Exploration & Appraisal

- 🌐 Short-time ambiguous and variable production data
- 🌐 Maximise information from pilots, determine reservoir property range of uncertainty from production

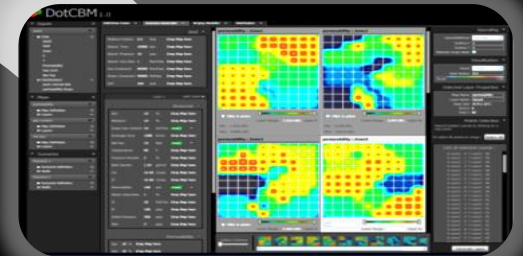
The DOT.CBM vision:

Integration Integration Integration !

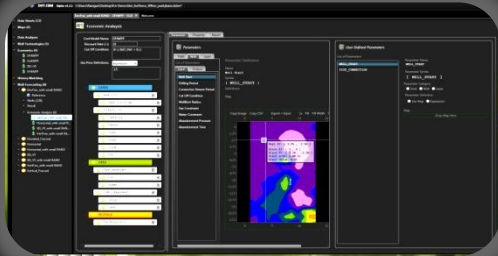
Reservoir Characterisation
Uncertainty management



Static Modelling & Property Mapping



Economics and Development
Optimisation



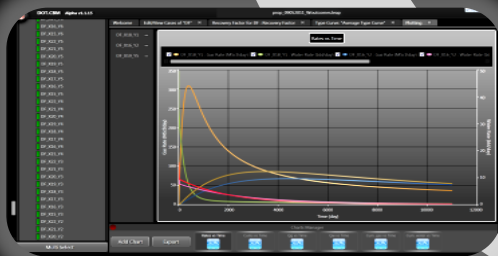
**Best practices in
integration**

**Effective
Visualisation and
Data Analysis**

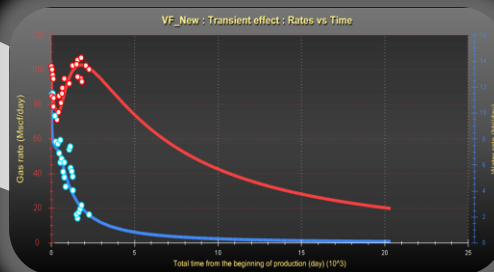
Well Concept
Modelling



Production
Forecasting
Well and Field



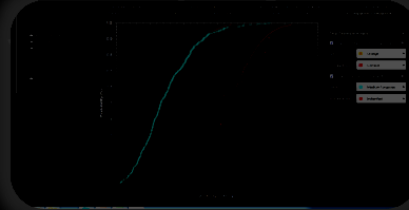
History Matching



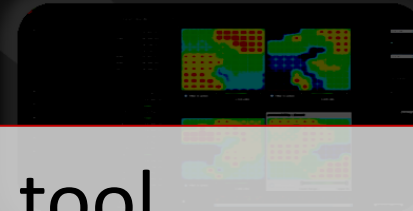
Audit Trail

Storing within the tool the Input and Output data
Generate high-quality reports and visuals

Reservoir Characterisation
Uncertainty management



Static Modelling & Property Mapping

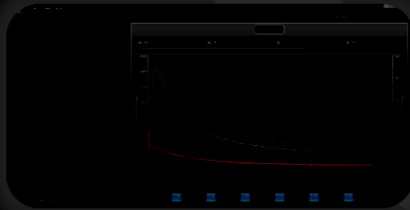


Economics and Development
Optimisation



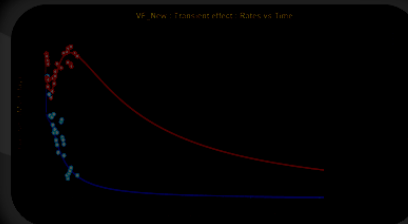
- 🌐 Entire workflow within a single tool
- 🌐 Easy tracking of inputs and resulting outcomes

Production
Forecasting
Well and Field



Visualisation and
Data Analysis

History Matching





DOT.CBM™

Development Optimisation Toolkit for CBM

FORECASTING

Generation of production forecasts at multiple levels

Single Well









Sector

Full-Field

Forecasting Engine

Time-efficient and powerful CBM forecasting capability

Released in this version:

-  Single well, Sector and Full field
-  Map based and distribution forecasting capability
-  Model multi-layer reservoirs
-  Variable well completion, trajectory, spacing
-  Multiple PVT correlations and rock-fluid property models
-  Multiple compressibility and matrix shrinkage models
-  Production and Economical constraints handling
-  1D Numerical modelling option for transient flow

Well forecasting

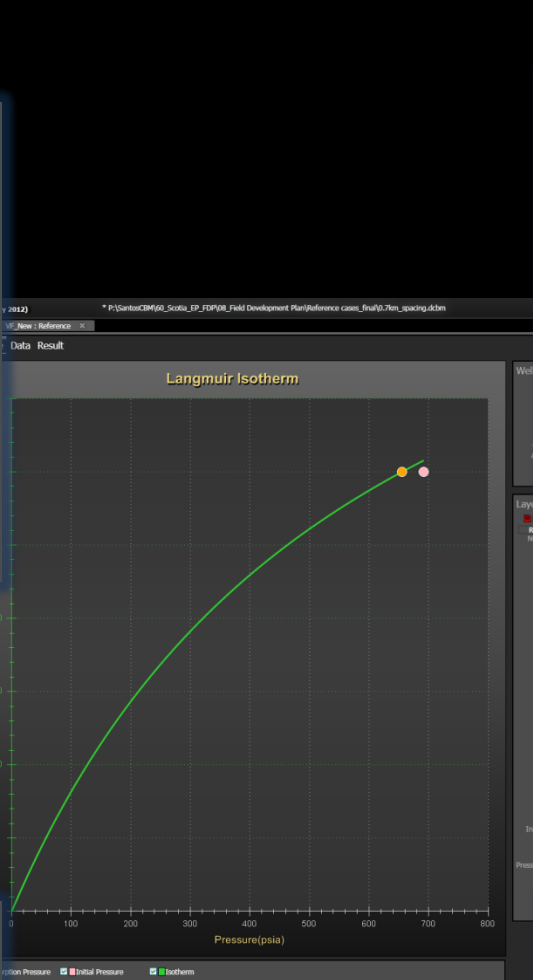
PVT model library

Reservoir Numerical	Rel. Perm	Matrix	Fluid
Gas Viscosity:		LeeAndAl	
Bw:		PressureAndTemp	
Z-Correlation:		RedlichKwong	
Water Lifting:		Turner	
Reservoir Temperature:		106 °F	
Initial Pressure:		691.6 psia	
XCO2:		0 0->1	
YCO2:		0 0->1	
Water Viscosity:		0.5 cP	

Variable gas composition (CO₂)

Matrix shrinkage modelling

Reservoir Numerical	Rel. Perm	Matrix	Fluid
Matrix Model:		SeidleHuitt	
Cm:		Constant	
Exponent:		ExponentIncline	
		PalmerMansoori	
		ShiDurucan	



Constraint handling

Well	Export	Import
Scenario Name:	VF_New	
Well Name:	Reference	
Wellbore Radius:	0.323	ft
Gas Constraint:	10000000000	Mscf/day
Water Constraint:	10000000000	bbl/day
Abandonment Pressure:	14.7	psia
Abandonment Gas Rate:	0	Mscf/day
Abandonment Time:	20000	day
	<input checked="" type="checkbox"/> Use Finite Element	

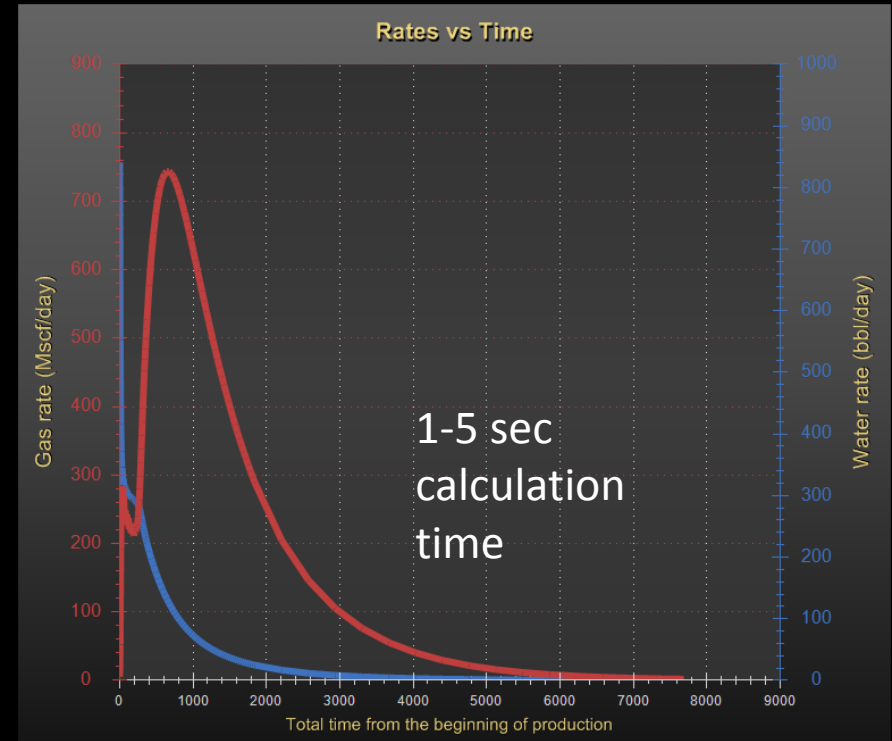
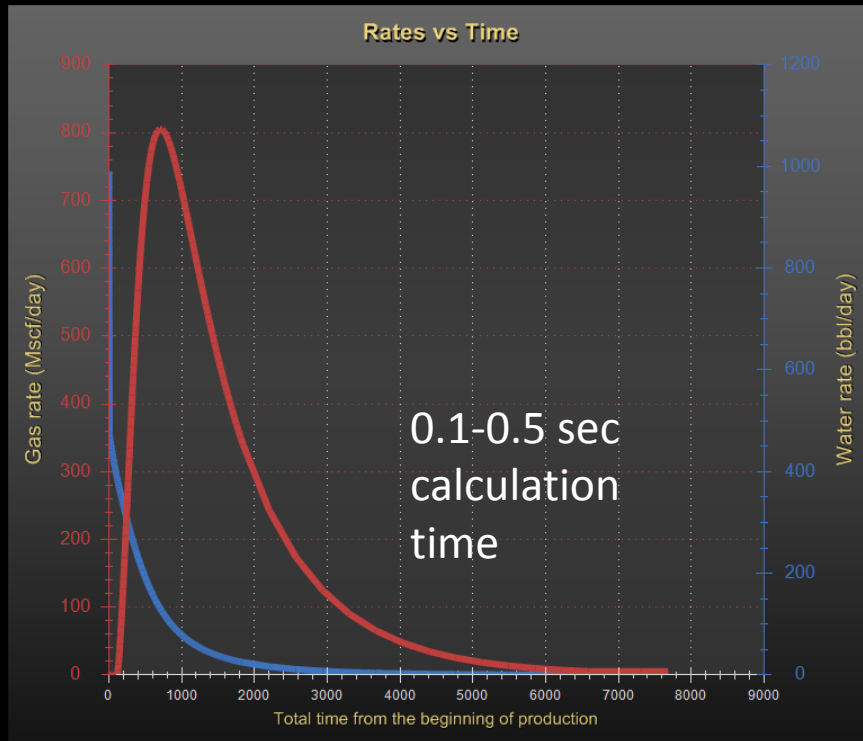
Layers	Reservoir Numerical	Rel. Perm	Matrix	Fluid
Pwf:	100	psia		
Drainage Area:	121.08164	acre		
Net Pay:	35.51	ft		
Bulk Density:	1.22	g/cm3		
Reservoir Temperature:	106	°F		
Fracture Porosity:	0.005	0-1		
Cw:	36.06	1/psia		
CH:	2.45	1/psia		
Neighbore Permeability:	2.20	mD		
Neighbore Porosity:	0	0-1		
Skin Radius:	10	ft		
Skln:	5			
Permeability:	30	mD		
Swt:	1	0-1		
Initial Pressure:	691.6	psia		
Depth:	0	ft		
Initial Gas Content:	300	scf/ton(0)		
Ash:	0	%		
Moisture:	0	%		
Vt:	577	scf/ton(0)		
Pc:	600	psia		
XCO2:	0	0-1		
Initial Gas Content (Raw):	300	scf/ton(0)		
M (Raw):	577	scf/ton(0)		
Saturation:	50.48	%		
Pressure Drop to Desorption:	36.37	psia		
Dewatering Index:	0.06147			
CO2P:	2.159	Bar		

Numerical modelling option

Numerical	
Nb Elements:	200
Mesh ratio:	1.05
First time step:	0.0001 day
Max time step:	365 day
Time ratio:	1.1
Tolerance:	0.001
Max Nb Iterations:	20

Well forecasting – numerical and material balance

Technologies developed to minimise forecasting time

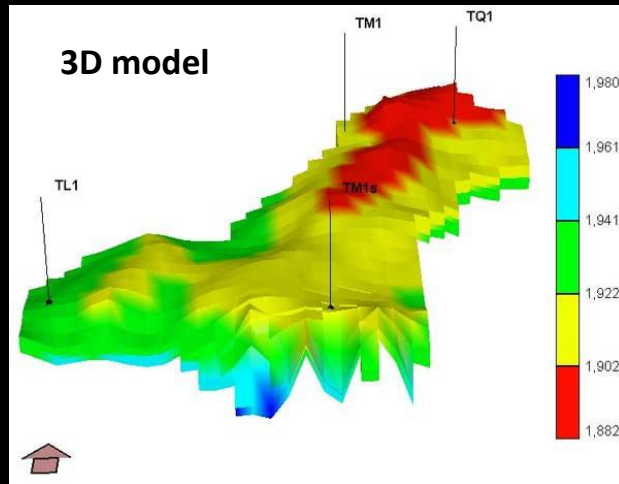


- 🔧 Modified King Formulation
- 🔧 Extensively tested against other commercial applications
- 🔧 Multi-layer, CH₄ and CO₂, multi-PVT correlation, multi-well configurations and matrix shrinkage models

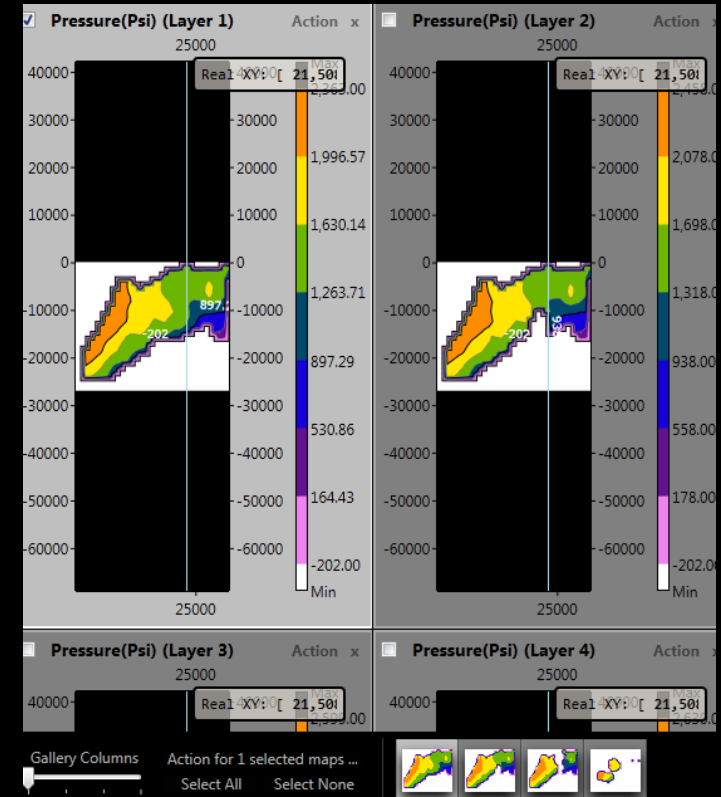
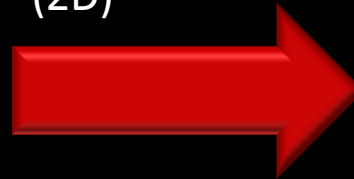
- 🔧 In-house developed Finite Element numerical model
- 🔧 Captures transient behaviour of tight coals
- 🔧 Ideal for matching of short-term pilot production

Well forecasting – Generated from maps

Innovation in the workflow



Output maps
(2D)

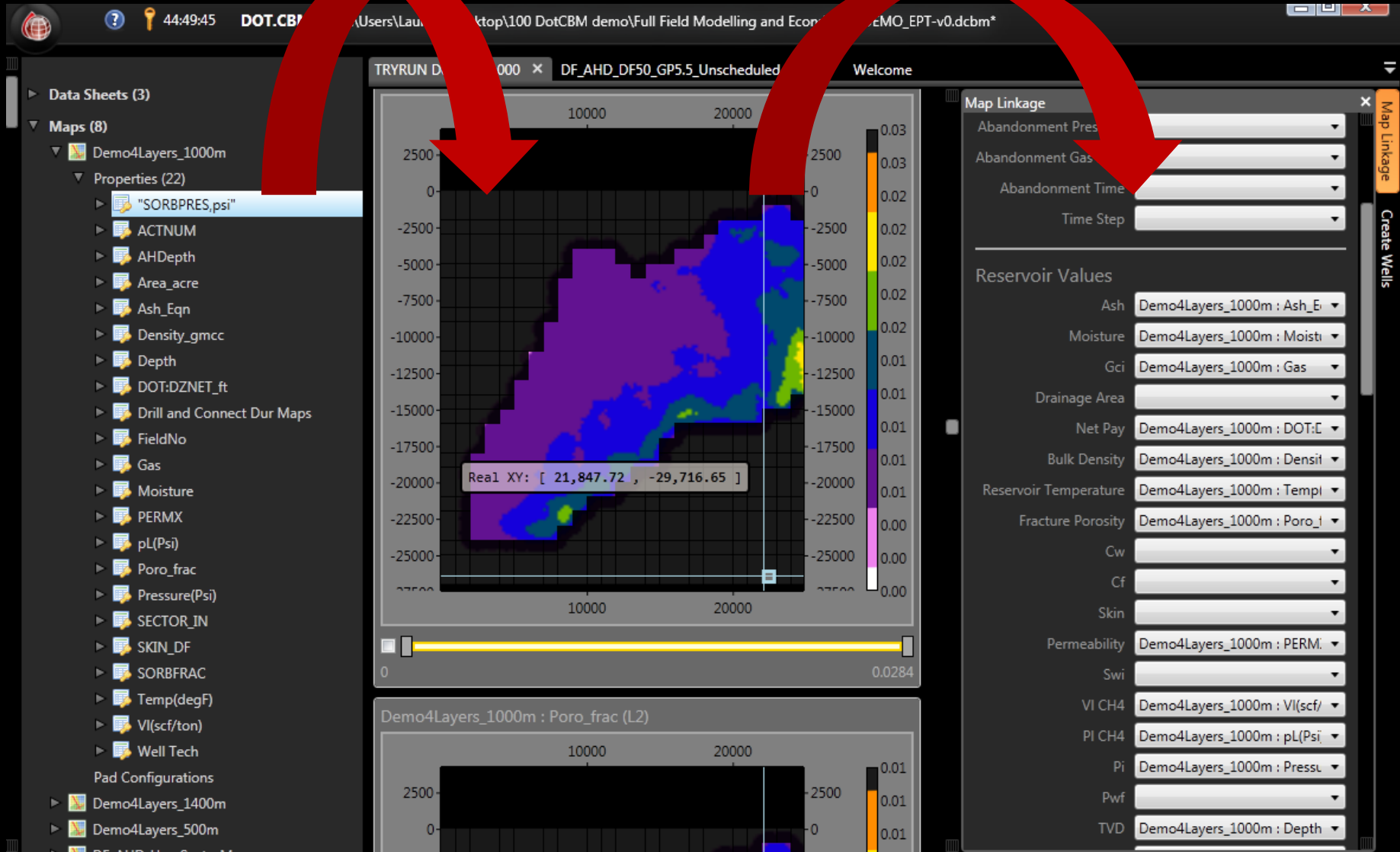


- 🔗 Simplification and dramatic speed improvement
- 🔗 Workflow tested vs. full 3D numerical and shows results consistency under life of field forecasting assumption
- 🔗 Not a full substitute for detailed 3D studies but designed for CSG field development planning decision making

Generate full-field forecasts

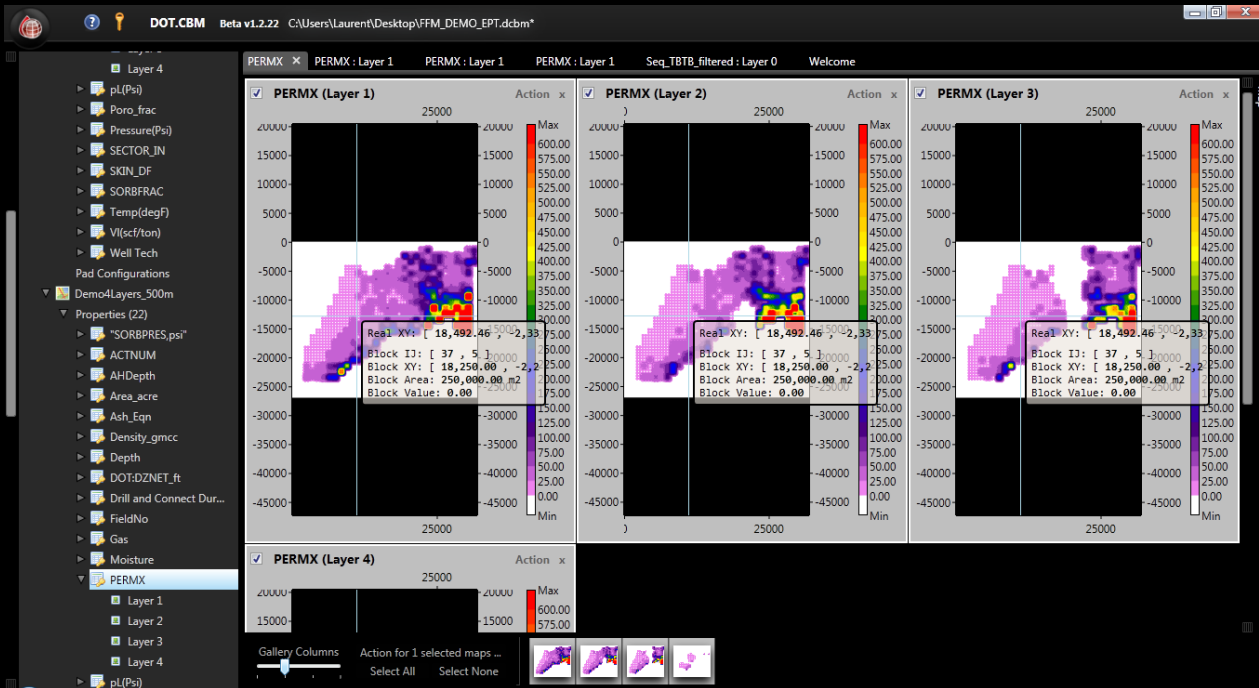
Property map from Static Model

Associated with values seen by the well (grid-block=drainage area)



Map Based Forecasting

Rapid forecast generation – multi-well set-up



- Generate forecast for field with 100's of wells in minutes
- No convergence issues
- Visual representation of spatial variability ; of inputs and outcomes



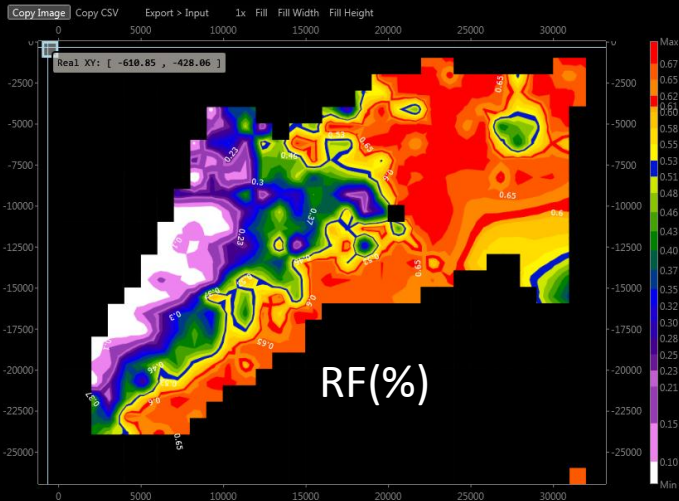
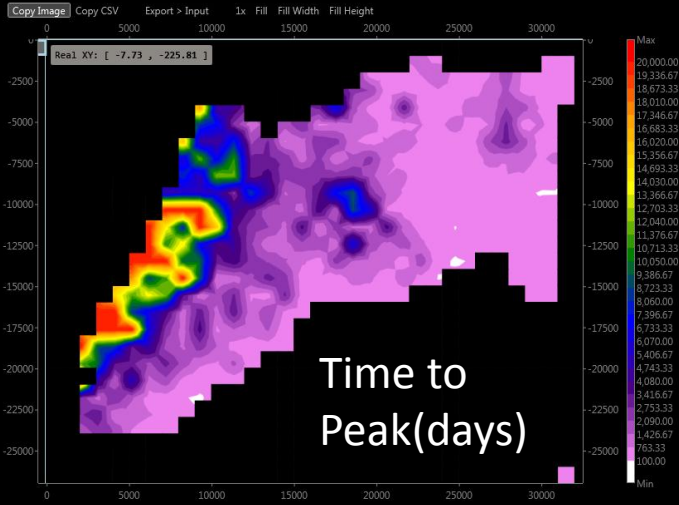
Fast computing capability – Desktop performance

1500 wells forecast, 4 active layers, 50 years
~8 minutes

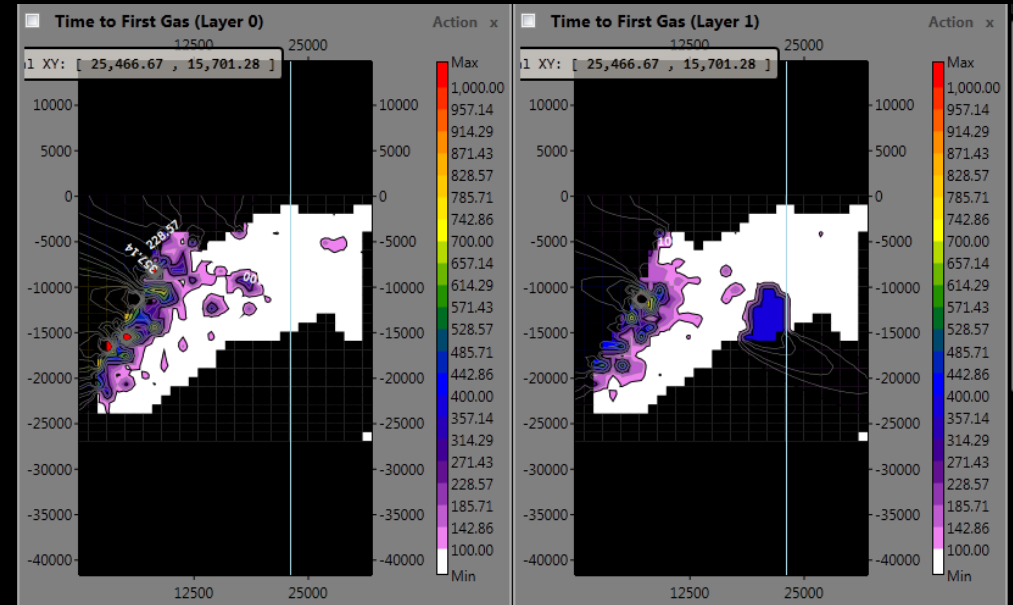
400 wells
~2 minutes

Map Based Forecasting

Results visualisation : AREAL TRENDS



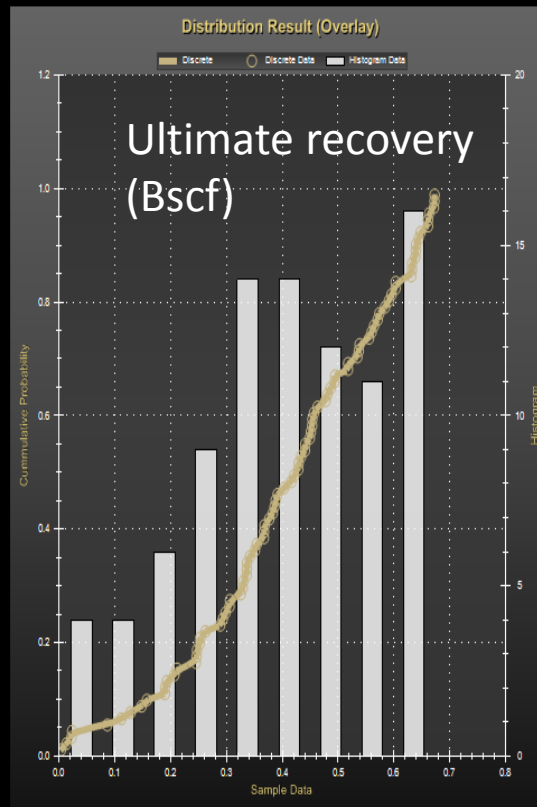
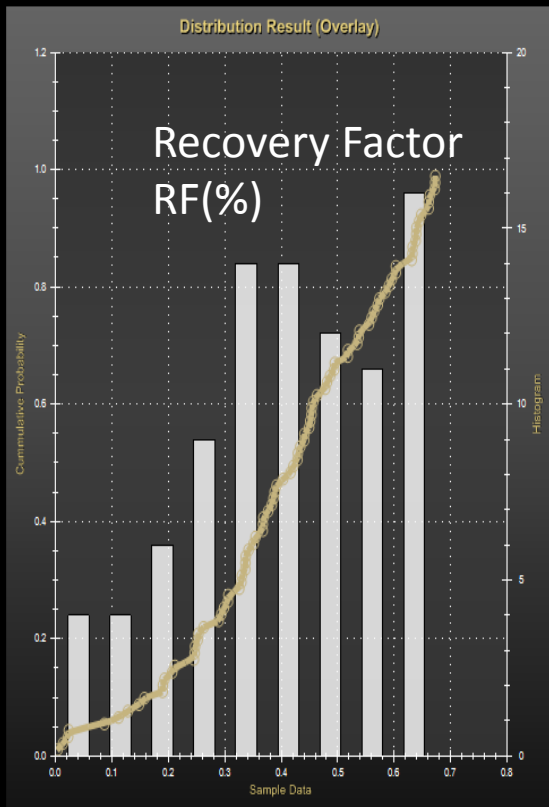
- Visualise areal trends of computed production responses
- Recovery Factor, Peak Gas, Time to Peak (..) automatically computed
- Layer by layer results obtained



Map Based Forecasting

Results visualisation : Production STATISTICS

- 🌐 Generate statistics of results for the field/sector/groups of wells
- 🌐 Layer by layer results can be obtained
- 🌐 Auto-Fitting of PDF with classic distributions: Beta, Log Normal, Normal



PDF data

Settings

Information

The table below display a list of data from the selected distribution.

Value (X)	Probability (Y)
0.00	0.01
0.01	0.02
0.02	0.03
0.02	0.04
0.06	0.05
0.10	0.06
0.12	0.07
0.13	0.08
0.15	0.09
0.16	0.10
0.19	0.11
0.19	0.12
0.19	0.13
0.20	0.14
0.21	0.15
0.23	0.16
0.25	0.17
0.25	0.18
0.25	0.19

tribution

Unit

Parameter

Data Range

Histogram

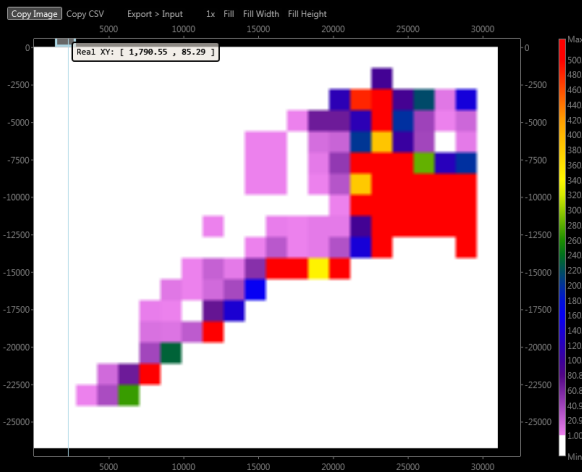
Points

Scaling Up/Down for spacing sensitivities

Rapidly assess the results of developing assets at different spacing

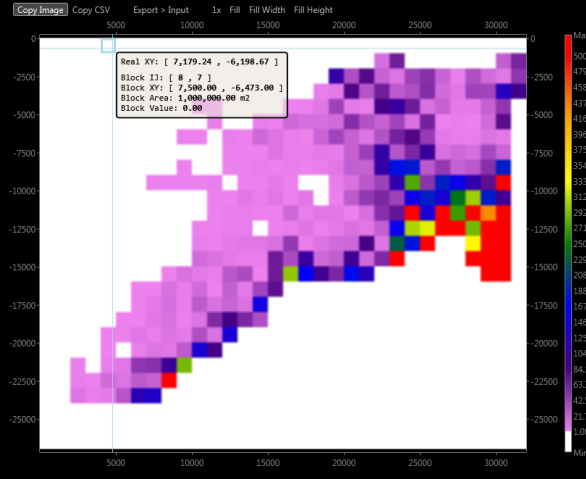
- 🔗 Perform up/down scaling of loaded/created maps within the tool
- 🔗 Send alternative spacing realisations to Forecast

1.4 km spacing



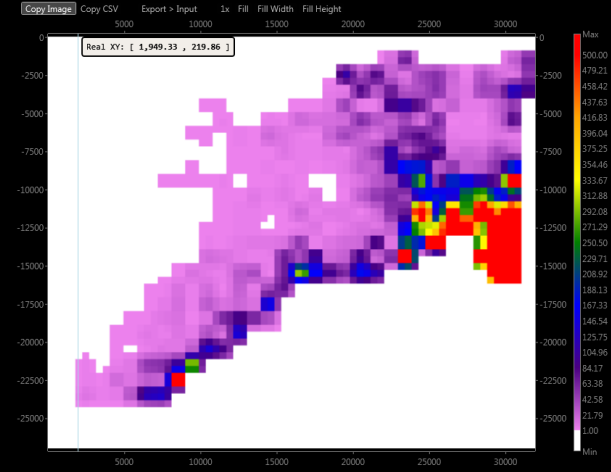
FORECAST

1.0 km spacing



FORECAST

0.5 km spacing



FORECAST

Scaling Up/Down for spacing sensitivities

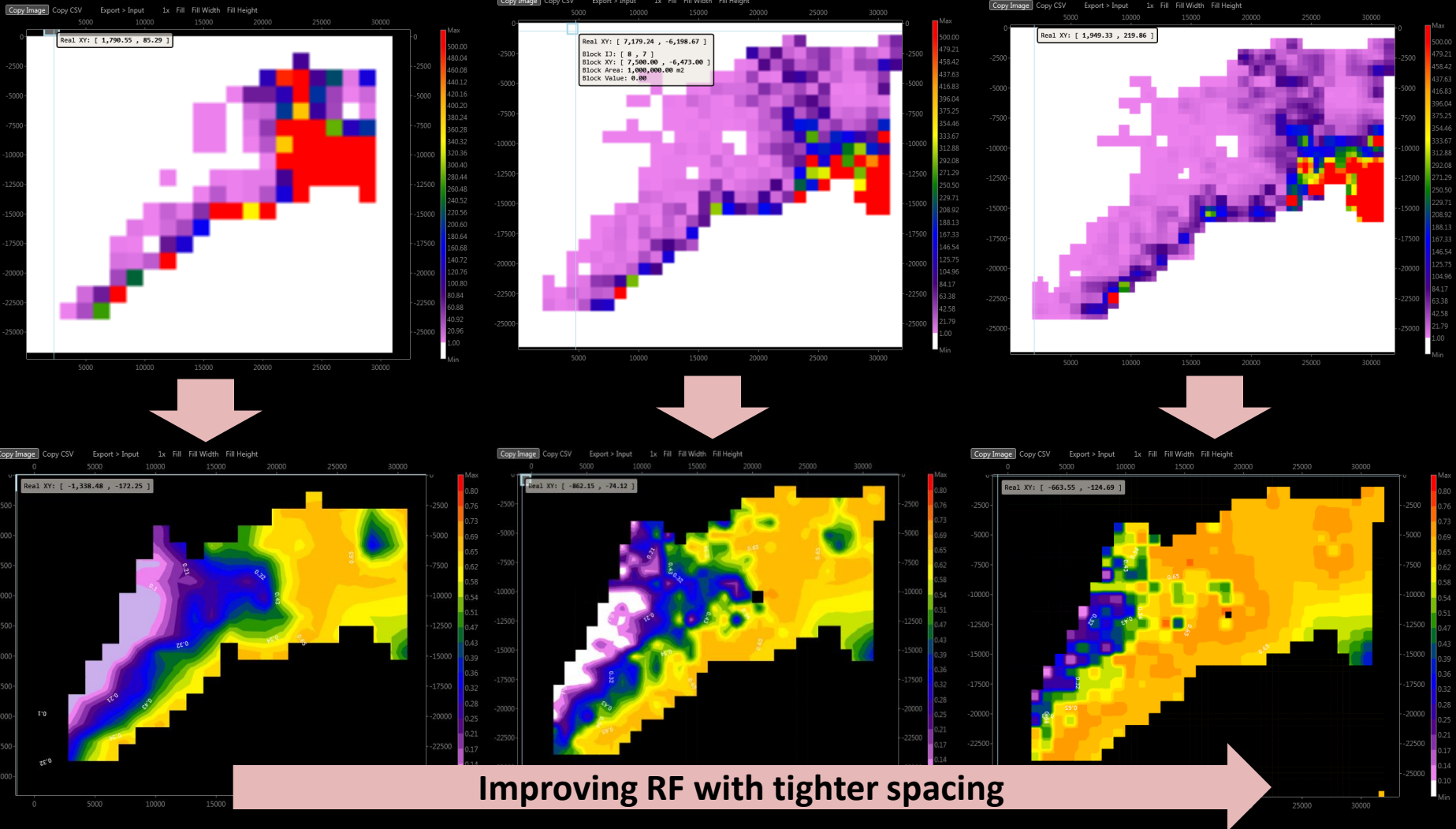
Rapidly assess the results of developing assets at different spacing

Visualise drainage improvement from alternative spacing

1.4 km spacing

1.0 km spacing

0.5 km spacing

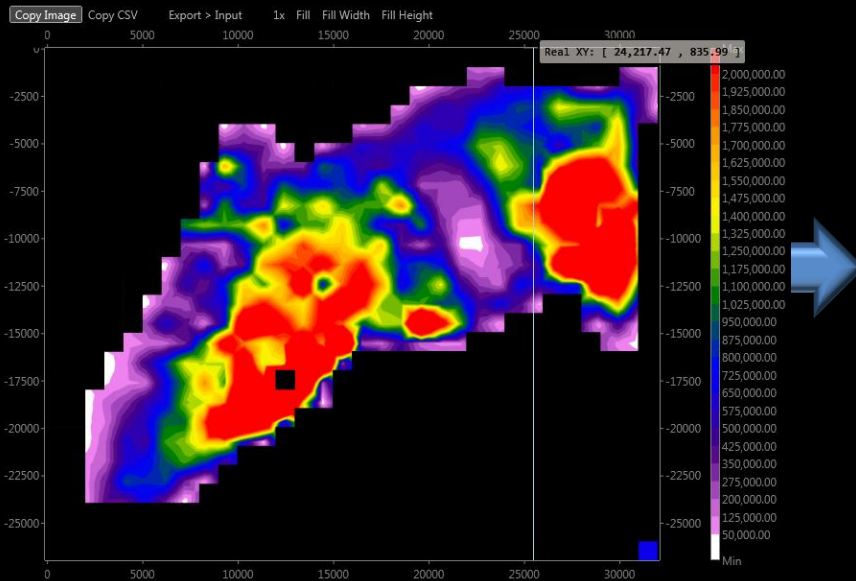


Field forecasting – type curve generation

Generate automatically a type (average) curve for the field

Full Field – Map View (EUR Gas)

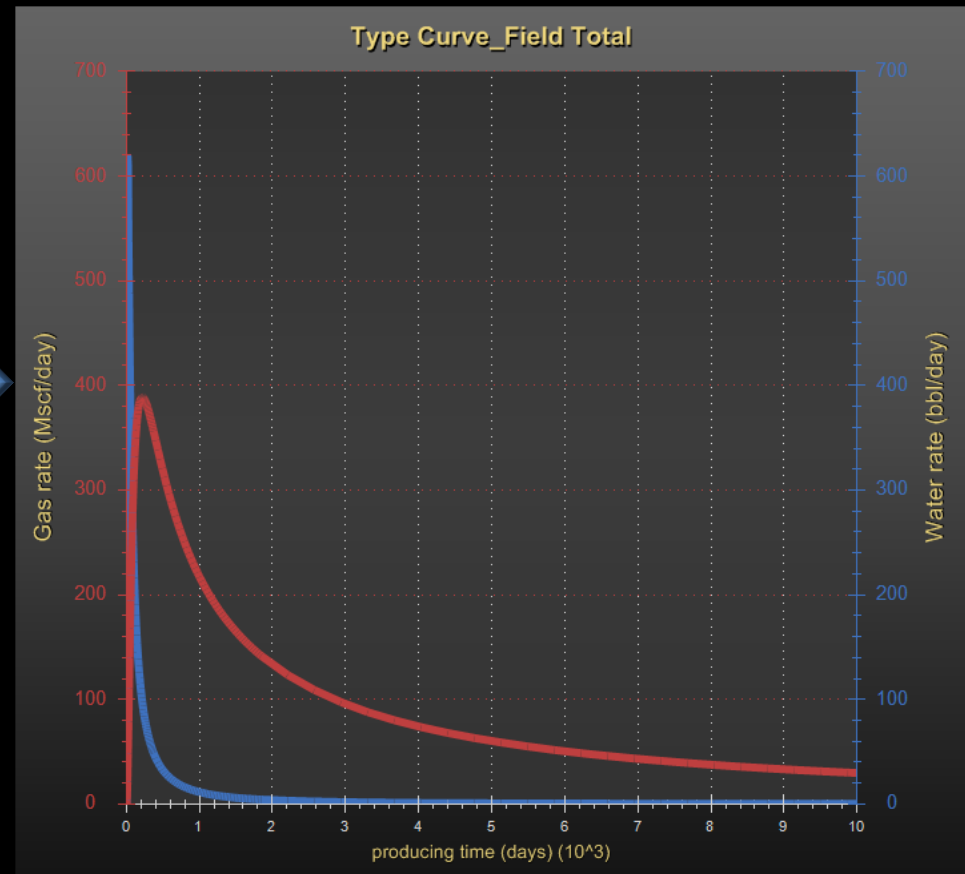
Before sectorisation



Full Field – Type Curve

Calculated as the average curve from all wells

No sectorisation

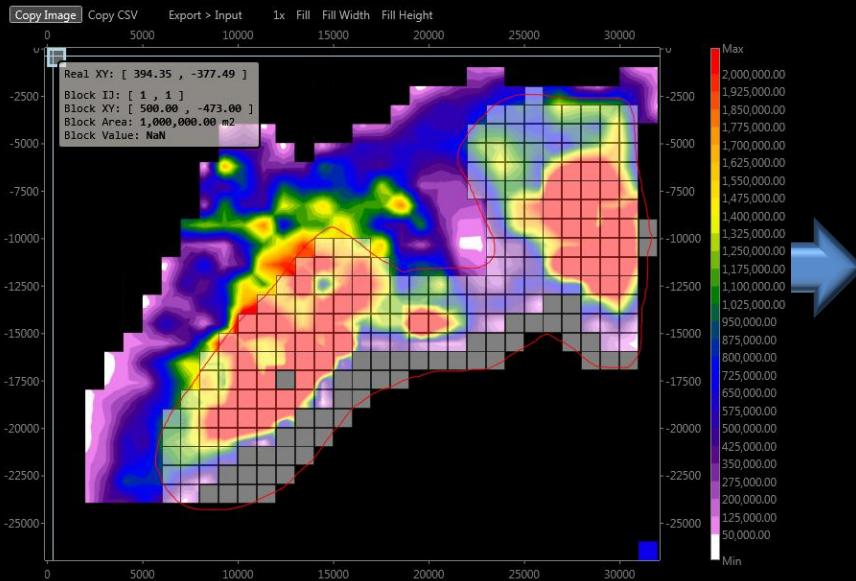


Field forecasting – type curve generation

Generate automatically a type (average) curve for the field

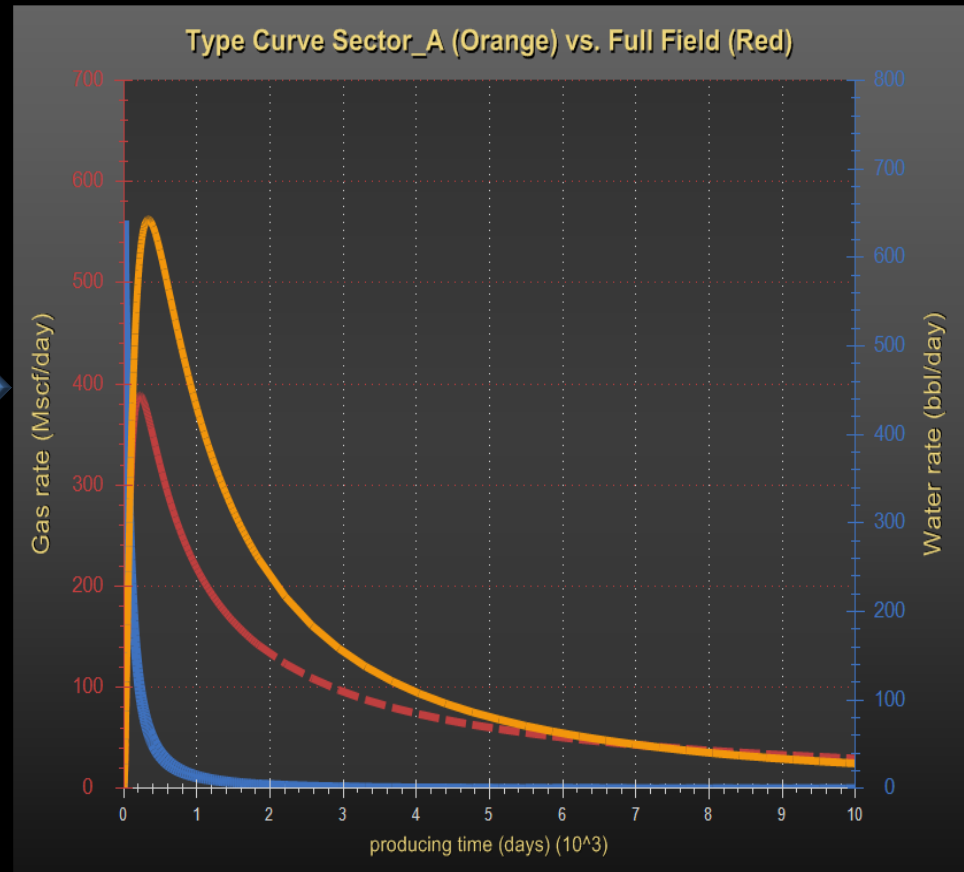
Full Field – Map View (EUR Gas)

After Sectorisation



Sector_A vs. Full Field – Type Curve

Quantifies the improvement associated with sectorisation



Field Forecasting – drilling sequence and schedule

New Field Forecast

Scenario: Demo4L_1000

Algorithm: Sum

Drilling Sequence Type: Based on drilling pace

Number of wells: 2

Base unit time: Monthly

Type Curve Name: Field_Profile_Seq and Sectors

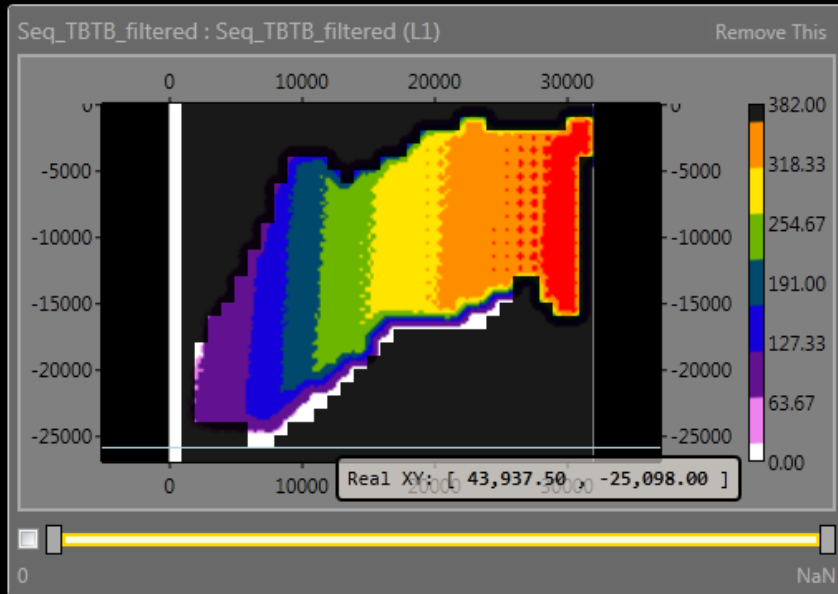
Create

Type curve **Field Profile** has been successfully created. x

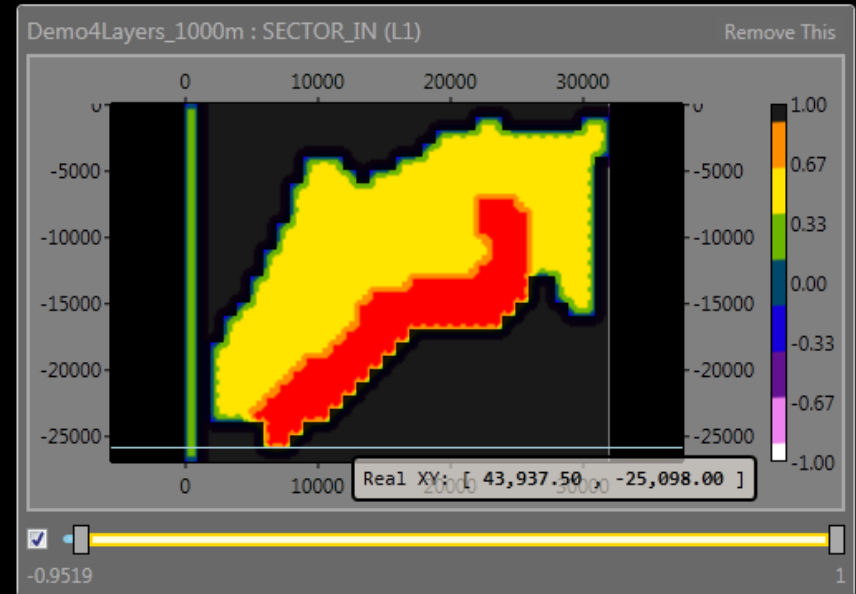
Drilling sequence definition

Customised drilling sequence for the field and sectors

Map calculator can be used to generate optimised sequences



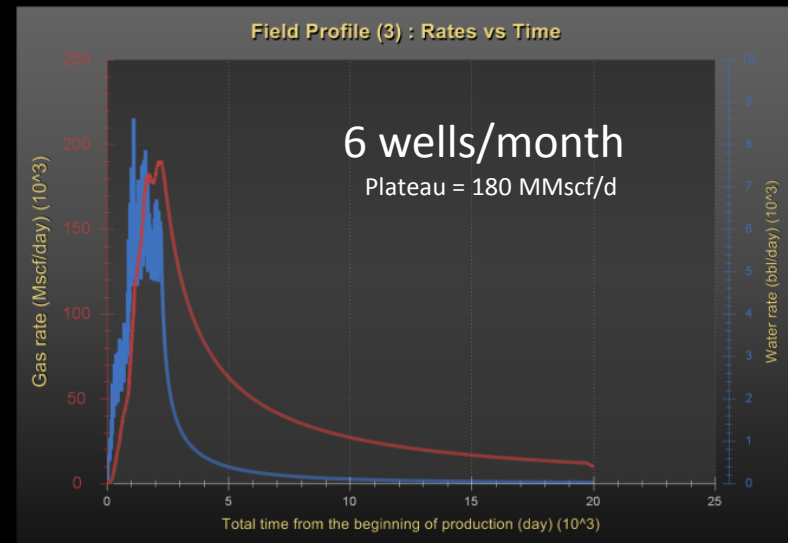
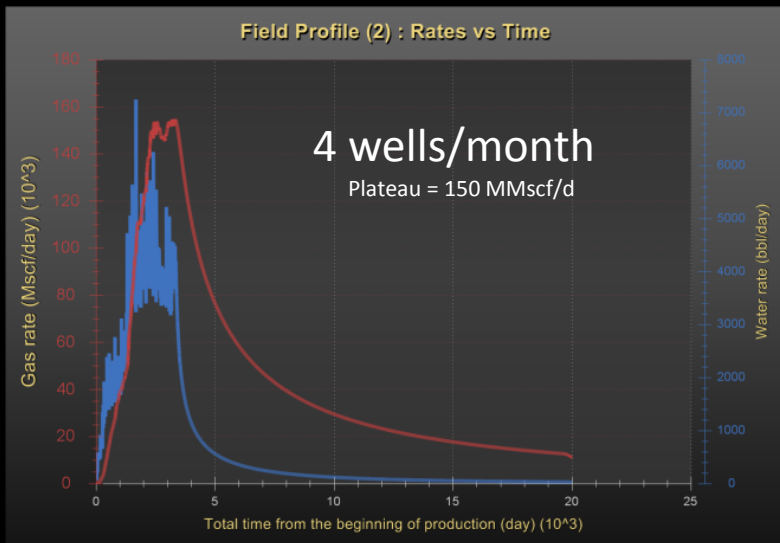
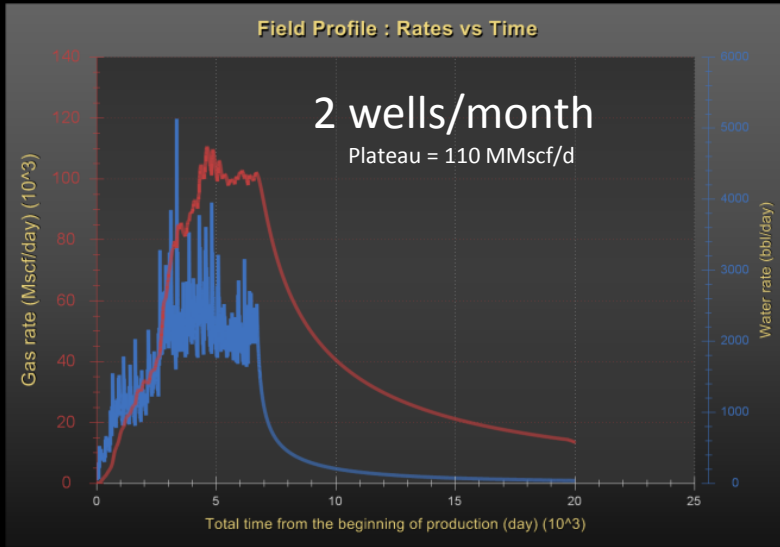
Well sequence map



Sector definition map

Field Forecasting – drilling sequence and schedule

Generate alternative full field/sector forecasts based on drilling pace / rig availability





DOT.CBM™

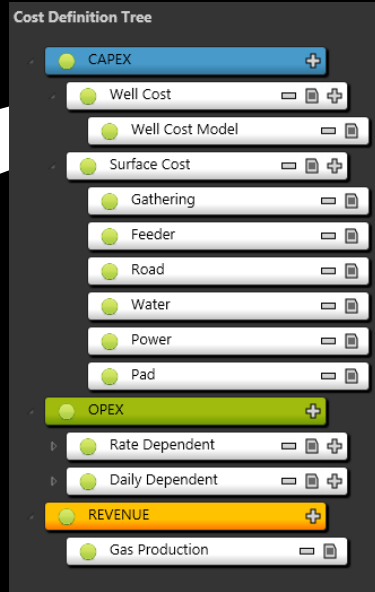
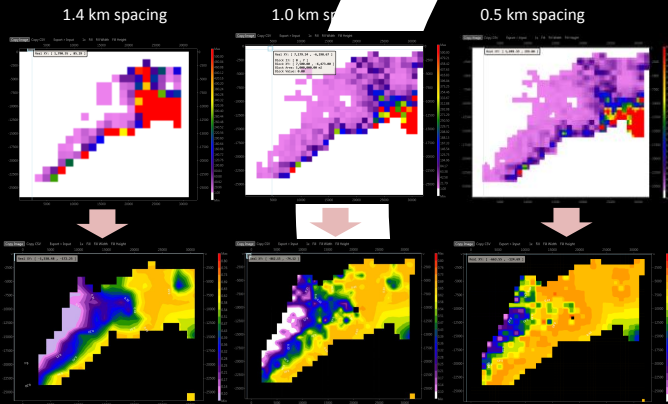
Development Optimization Toolkit for CBM

**DEVELOPMENT
PLANNING OPTIMISATION**

Development Planning Optimisation

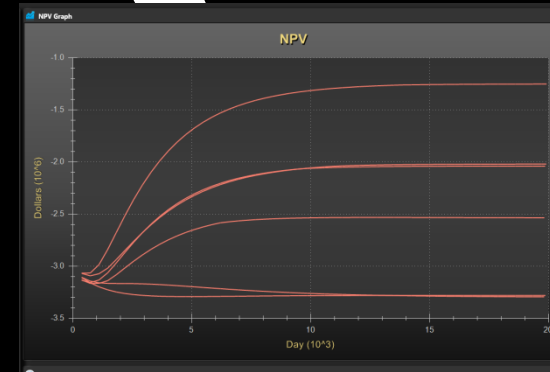
Spacing and Technology Selection

Forecasting alternatives:
Technology Spacing

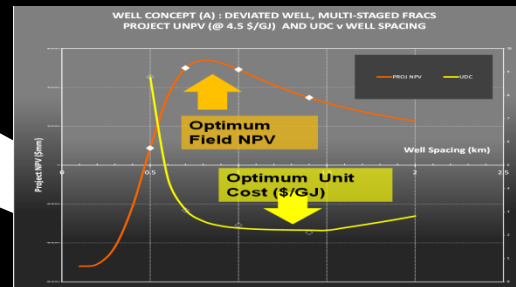


Cost Model

Economics or Value-metrics



Selection of optimum concept



Well concept modelling

Well technology (trajectory, completion, pad design)



Automatic Trajectory Modelling

Auto-generate deviation profiles as a function of : coal depth, technological constraints such as Max DLS, Initial well deviation, maximum angle in coal

Can be linked to maps to generate population of trajectories

Cost Modelling

Ability to define a comprehensive, as complex as required cost model



Cost Modelling conducted at multi-level

- 🌐 Child-parent structure allows to capture dependencies
- 🌐 Powerful ability to link costs to production (ex: Opex \$/Mscf/d)
- 🌐 Full project costs can be included
- 🌐 Designed to screen and support decision making
- 🌐 Emphasis on comparative capability between concepts

Tax and complex commercial construction not included; this is a concept screening tool rather than a financial planning one.

Cost Modelling

Ability to define a comprehensive, as complex as required cost model

Cost Definition Tree

- CAPEX
 - Well Cost
 - Well Cost Model
 - Surface Cost
 - Gathering
 - Feeder
 - Road
 - Water
 - Power
 - Pad
- OPEX
 - Rate Dependent
 - Daily Dependent
- REVENUE
 - Gas Production

Cost Definition Tree

- CAPEX
 - Well Cost
 - Well Cost Model

Name: Well Cost Model

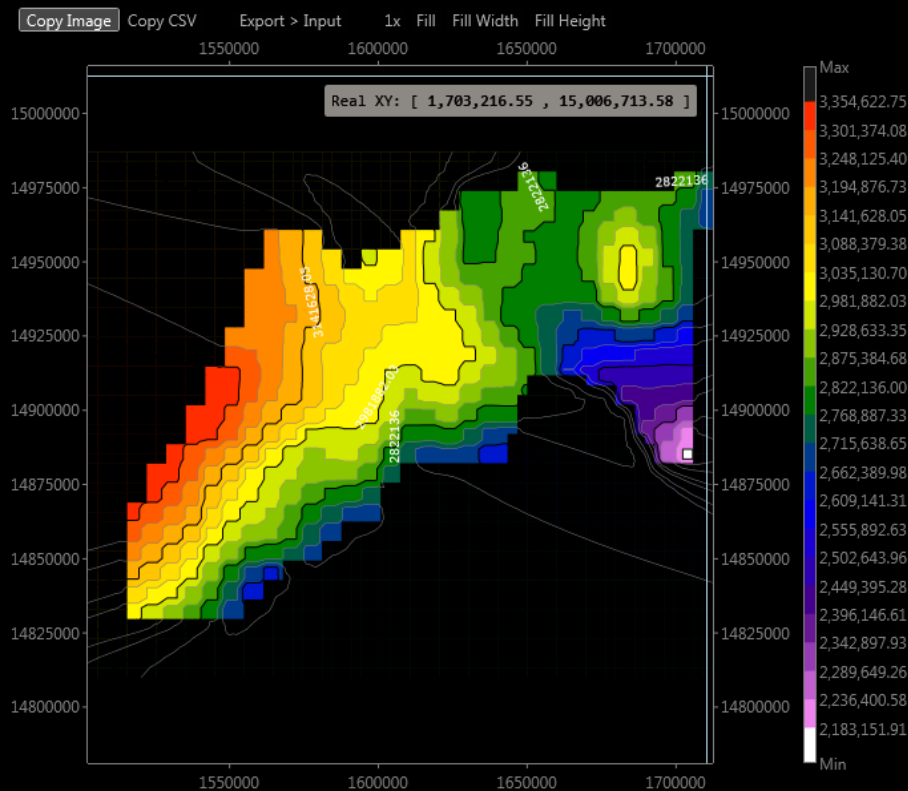
Expression

$$0.000019 * \text{power}(\{\text{AHD_DF}\} * 0.3048, 3) - 0.113370 * \text{power}(\{\text{AHD_DF}\} * 0.3048, 2) + 824.497712 * (\{\text{AHD_DF}\} * 0.3048) + 706,479.240607$$

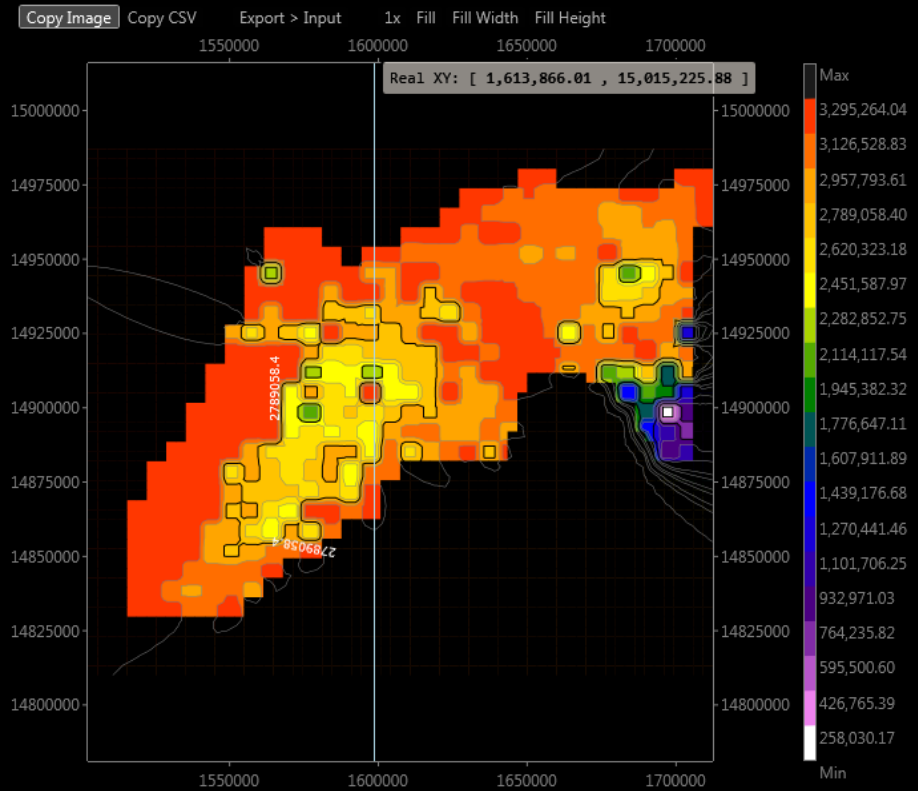
Complex fitting function available for cost modelling

Cost Modelling – areal mapping

Ability to show areal distribution of well and facilities costs on a map basis



Undiscounted CAPEX



Undiscounted OPEX

Economics: screening

Perform economic calculations, allocated back to each well

Calculation of multiple indexes (NPV, UTC, IRR etc..) – at well, sector and field level

The screenshot displays the DOT.CBM software interface for economic analysis. The main window is titled "Economic Analy" and shows a "Forecast Report" for a well. The report lists various wells and their economic status, including NPV, IRR, and Value 100. A "NPV Graph" is visible, plotting Dollars (10^6) against Day (10^3). The graph shows multiple curves representing different wells, with NPV values ranging from approximately -3.5 to -1.0 over a 20-day period. A "Forecasting Status" bar at the bottom indicates that 138 wells are completed and 383 are total, with a time remaining of 00h:01m:18s.

Forecast Report

```
Status : - Forecast Well : I 11, J 15
Status : - Forecast Well : I 11, J 16
Status : - Forecast Well : I 11, J 17
Status : - Forecast Well : I 11, J 18
Status : - Forecast Well : I 11, J 19
Status : - Forecast Well : I 11, J 20
Status : - Forecast Well : I 11, J 21
Notice : IRR is below 0 , Value 0 is returned
Status : - Forecast Well : I 12, J 5
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 12, J 6
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 12, J 7
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 12, J 8
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 12, J 9
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 12, J 10
Status : - Forecast Well : I 12, J 11
Notice : IRR is below 0 , Value 0 is returned
Status : - Forecast Well : I 12, J 12
Status : - Forecast Well : I 12, J 13
Notice : IRR is below 0 , Value 0 is returned
Status : - Forecast Well : I 12, J 14
Status : - Forecast Well : I 12, J 15
Status : - Forecast Well : I 12, J 16
Status : - Forecast Well : I 12, J 17
Status : - Forecast Well : I 12, J 18
Status : - Forecast Well : I 12, J 19
Status : - Forecast Well : I 12, J 20
Status : - Forecast Well : I 12, J 21
Notice : IRR is below 0 , Value 0 is returned
Status : - Forecast Well : I 13, J 6
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 13, J 7
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 13, J 8
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 13, J 9
Status : - Forecast Well : I 13, J 10
Notice : IRR is bigger than 100, Value 100 is returned
Status : - Forecast Well : I 13, J 11
Status : - Forecast Well : I 13, J 12
```

NPV Graph

Dollars (10⁶) vs Day (10³)

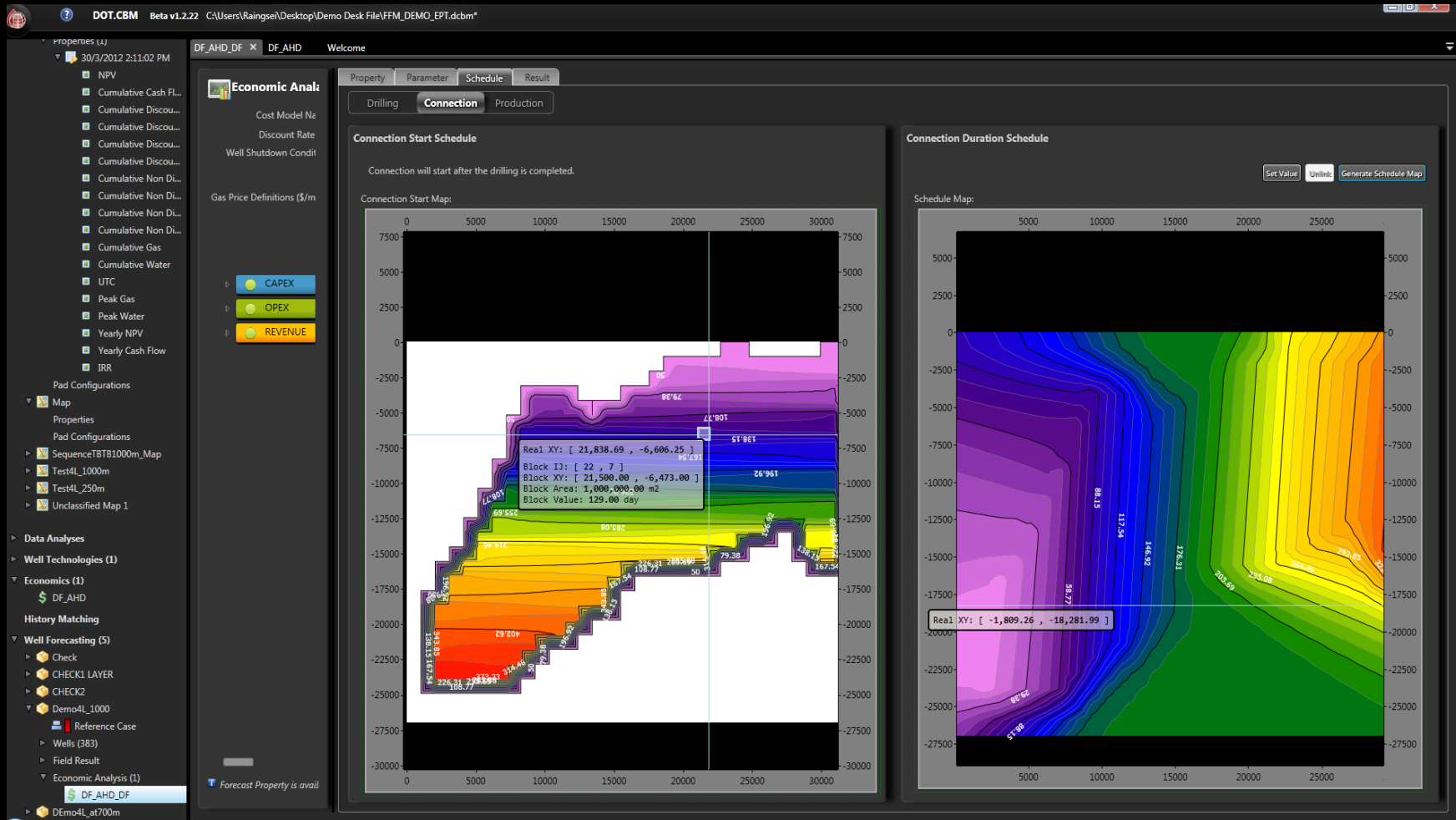
Forecasting Status

Total Well(s): 383
Completed Well(s): 138
Time Remaining: 00h:01m:18s

Full project economics

Requires to generate a field drilling, connection and production sequence

Mapping the drilling, connection and production sequences



Economics: screening and high-grading

Perform economic calculations, allocated back to each well

Area NPV assessment : HIGH-GRADING

DOT.CBM Beta v1.2.22 C:\Users\Rainse\\Desktop\Demo Desk File\FFM_DEMO_EPT.dcbm*

Properties (4)
30/3/2012 2:11:02 PM
NPV
Cumulative Cash Fl...
Cumulative Discou...
Cumulative Discou...
Cumulative Discou...
Cumulative Non Di...
Cumulative Non Di...
Cumulative Non Di...
Cumulative Non Di...
Cumulative Gas
Cumulative Water
UTC
Peak Gas
Peak Water
Yearly NPV
Yearly Cash Flow
IRR

Pad Configurations
Map
Properties
Pad Configurations
Sequence\BTB1000m_Map
Test4L_1000m
Test4L_250m
Unclassified Map 1

Data Analyses
Well Technologies (1)
Economics (1)
DF_AHD
History Matching
Well Forecasting (5)
Check
CHECK1 LAYER
CHECK2
Demo4L_1000
Reference Case
Wells (383)
Field Result
Economic Analysis (1)
DF_AHD_DF
DEMO4L_at700m

DF_AHD_DF x DF_AHD Welcome

Economic Anal

Property Parameter Schedule Result

Cost Model Na
Discount Rate
Well Shutdown Condit

Gas Price Definitions (\$/m

CAPEX
OPEX
REVENUE

Forecast Property is avail

Result Property

Result Name: Scheduled With 50%

Date/Time: 30/3/2012 3:54:49 PM

Descriptions

Edit Delete

List Of Result

Scheduled With 50%

Summary Detail Graph Tool

Field Well

Field Data

Field Total Well Average

Cumulative Discounted CAPEX: 555,129,860.62 \$
Cumulative Non Discounted CAPEX: 557,330,470.00 \$
Cumulative Discounted OPEX: 188,272,690.60 \$
Cumulative Non Discounted OPEX: 1,038,836,790.63 \$
Cumulative Discounted Revenue: 1,091,510,680.58 \$
Cumulative Non Discounted Revenue: 2,338,152,103.84 \$
Cumulative Non Discounted Cash Flow: 741,984,843.21 \$
NPV: 348,108,129.36 \$
Cumulative Discounted Production: 198.46 Bscf
Cumulative Non Discounted Production: 425.12 Bscf
Cumulative Water: 40.87 MMbbl
UTC (Unit Technical Cost): 3.75 \$/Mscf

Field Map

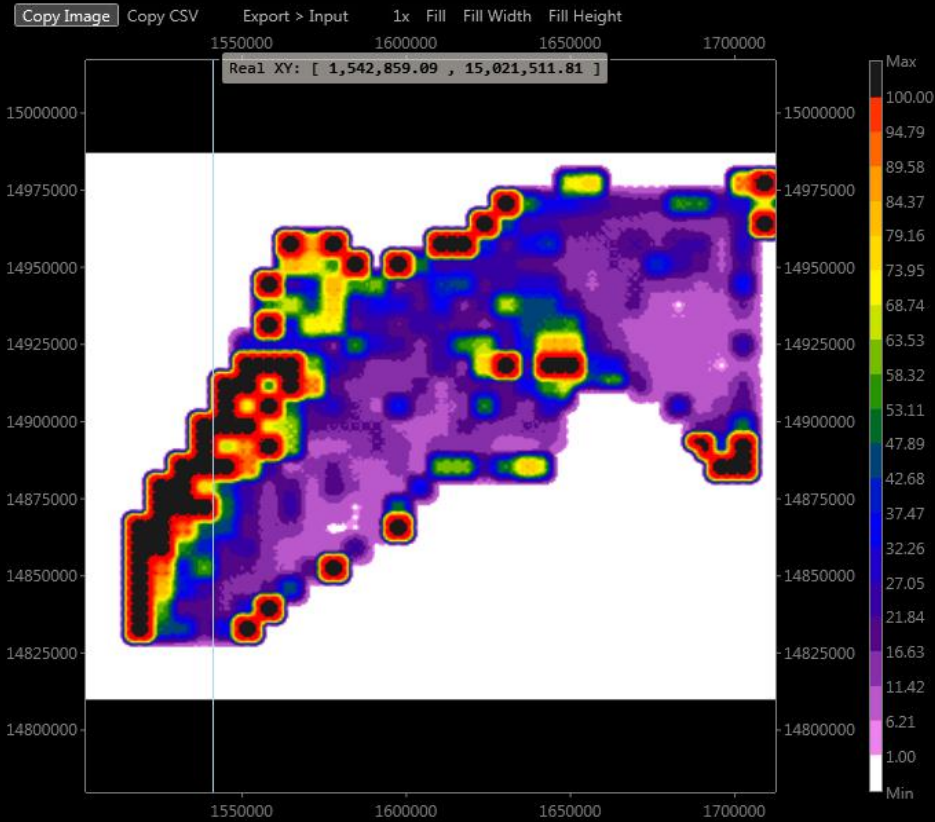
List of Available Maps
NPV

Export Map Delete Map

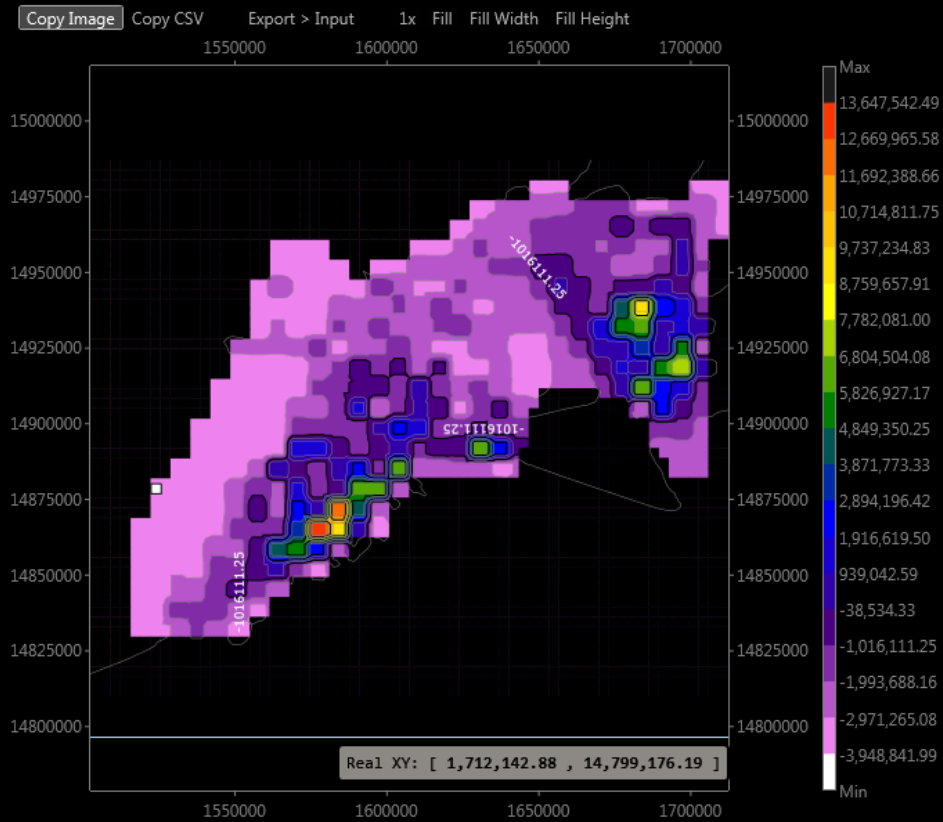
Real XY: [15,258.42, -12,345.16]
Block ID: [16, 13]
Block XY: [15,500.00, -12,473.00]
Block Area: 1,000,000.00 m2
Block Value: 751,026.77

Economic results – areal mapping

This can be used as a basis for field optimisation



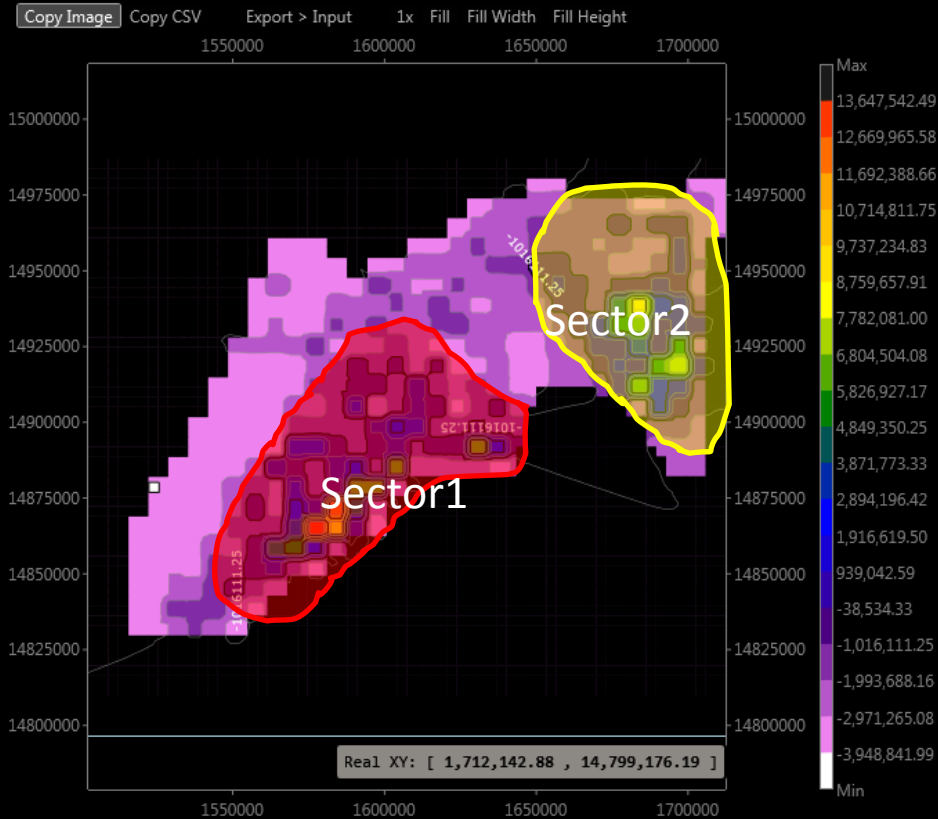
UTC \$/Mscf



NPV (\$)

Sectorisation workflow

Using map based forecast, coupled with Economics



Date/Time: 13/6/2012 12:01:47 PM
Descriptions: Sector 1
Edit Delete

Field Data

Field Total	Well Average
	1,378,558,74.10
Cumulative Non Discounted Revenue	2,863,873,611.83 \$
Cumulative Non Discounted Cash Flow	1,527,700,857.97 \$
NPV	566,466,692.22 \$
Cumulative Discounted Production	306.35 Bscf
Cumulative Non Discounted Production	636.42 Bscf
Cumulative Water	19.58 MMbbl
UTC (Unit Technical Cost)	2.65 \$/Mscf

List Of Result

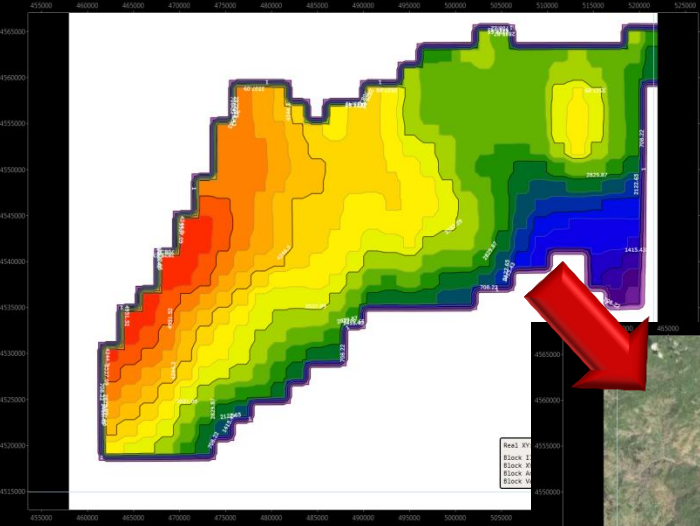
- Full Fields Run
- Sector 1
- Sector 2
- Sector 3

Sector economics are calculated and can be compared to field average

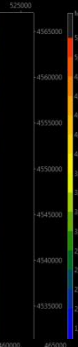
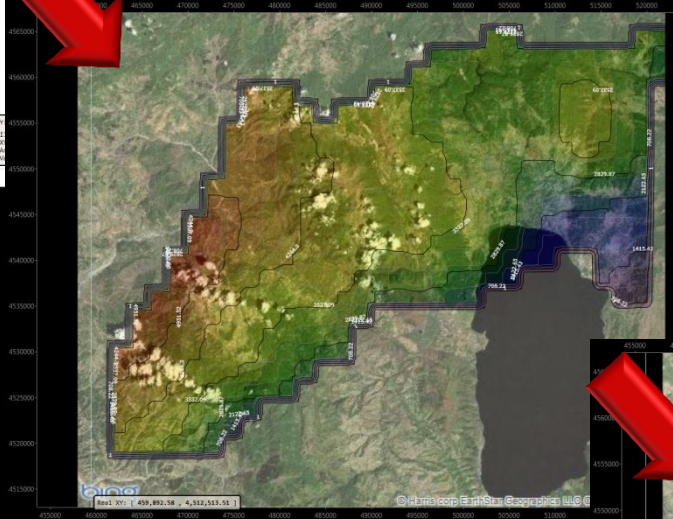
SECTORISATION WORKFLOW

GIS and satellite imaging capability

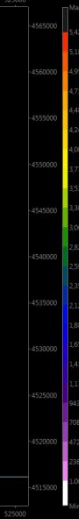
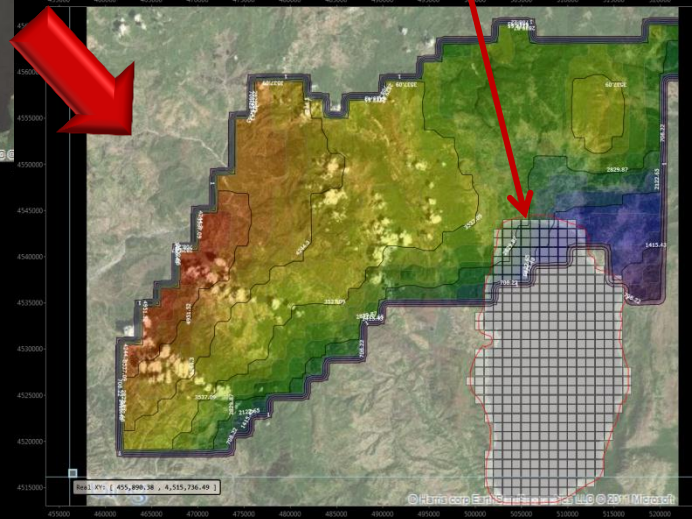
Define avoidance zones for realistic surface developments



Subsurface and surface maps can be coupled with satellite images (GIS), cadastral maps, etc.
Various information layers (e.g. roads, buildings, national parks, etc.) can be added



Restricted/high access cost zones (selected grids)



Surface access restriction zones (cities, mountains, lake, etc.) can be selected based on the available information

Reflect the influence of surface constraints onto development scheme and its value : cost model, well count etc..

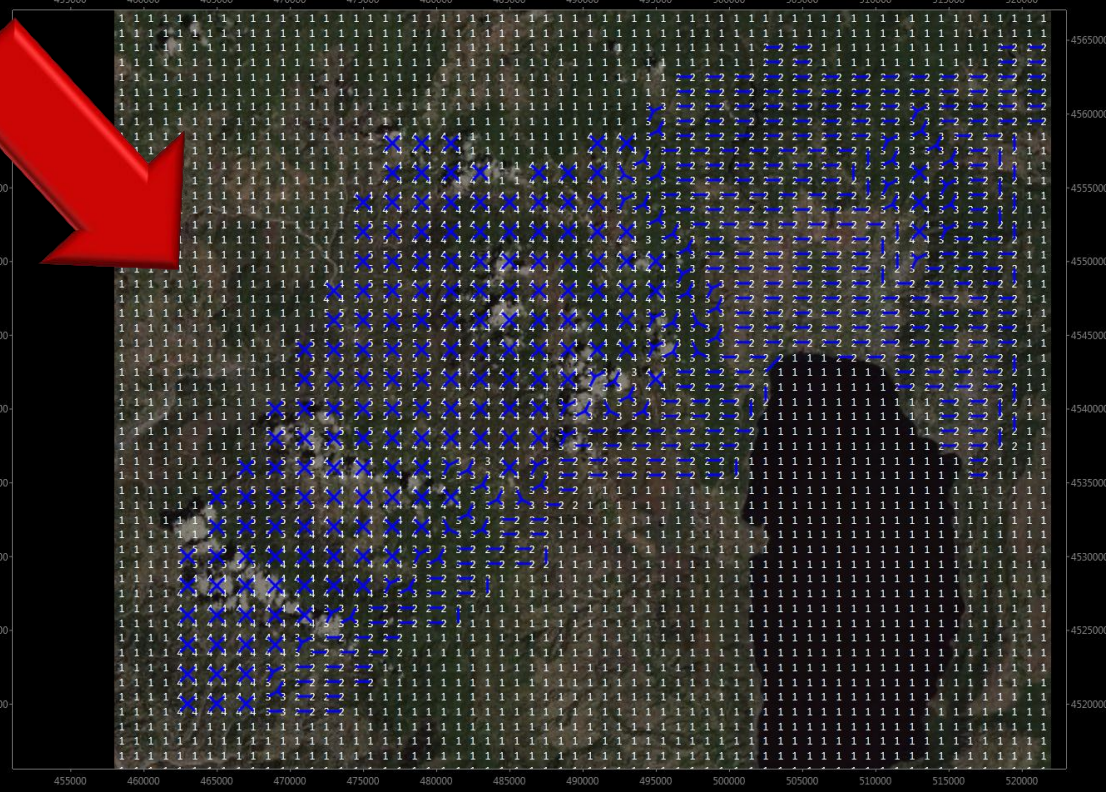
Pad modelling

Pad sizing and pad location selection/optimization



Maximum number of wells per pad is identified based on well concept modelling module.

Number of pads and their locations can be easily selected



FUTURE RELEASE

Optimisation of surface layout based on cost structure



DOT.CBM™

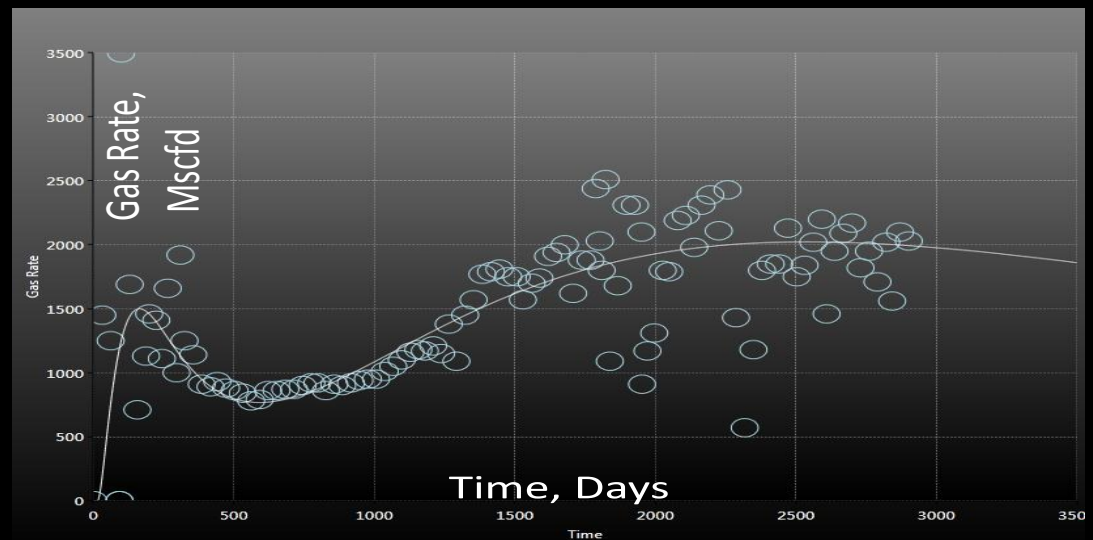
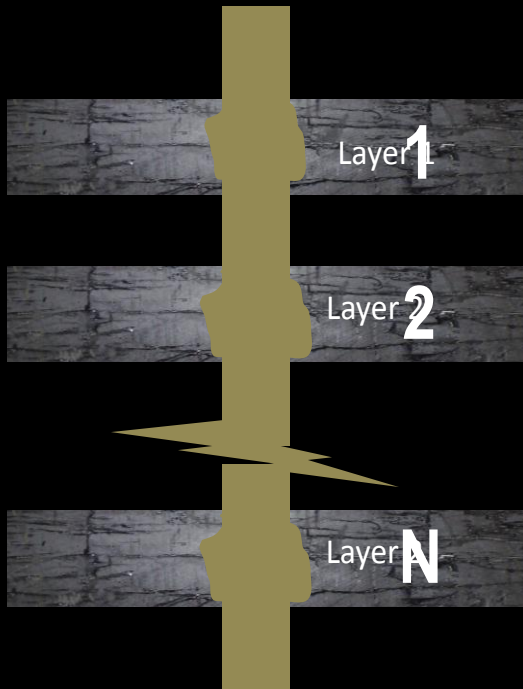
Development Optimization Toolkit for CBM

HISTORY MATCHING

Assisted Stochastic History Matching

Advanced solution developed specifically for CBM well history matching

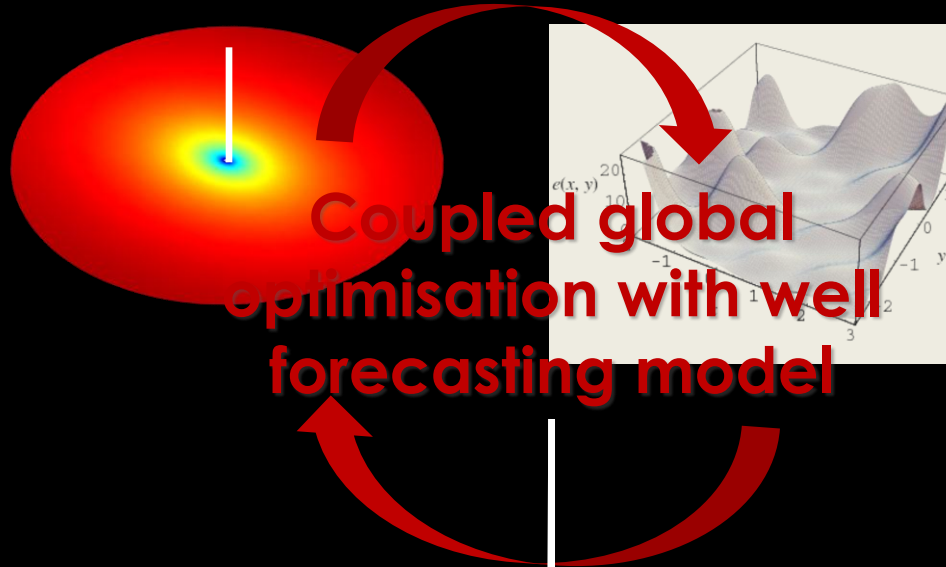
- 🌐 Rapidly generate a comprehensive range of solutions matching production data
- 🌐 All reservoir parameters can be varied -solves with 10+ varying parameters per layer
- 🌐 Investigate and understand multi-layer behaviour
- 🌐 Numerical Finite Elements and Material Balance models available
- 🌐 Multiple coupled evolutionary search algorithms



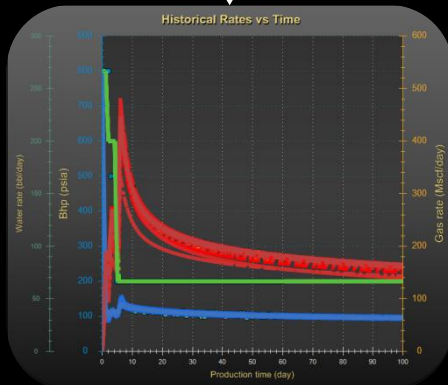
Multiple solutions fitting the historical production

Stochastic History Matching

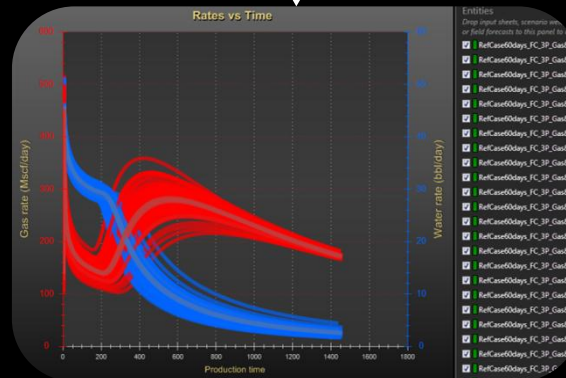
Process allows for 100's of matching cases to be generated in minutes



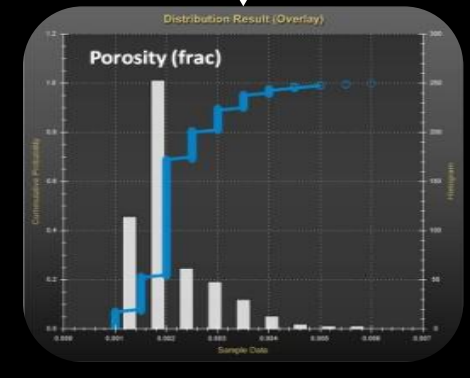
Generate multiple matching realisations



Forecast multiple realisations to assess remaining uncertainty



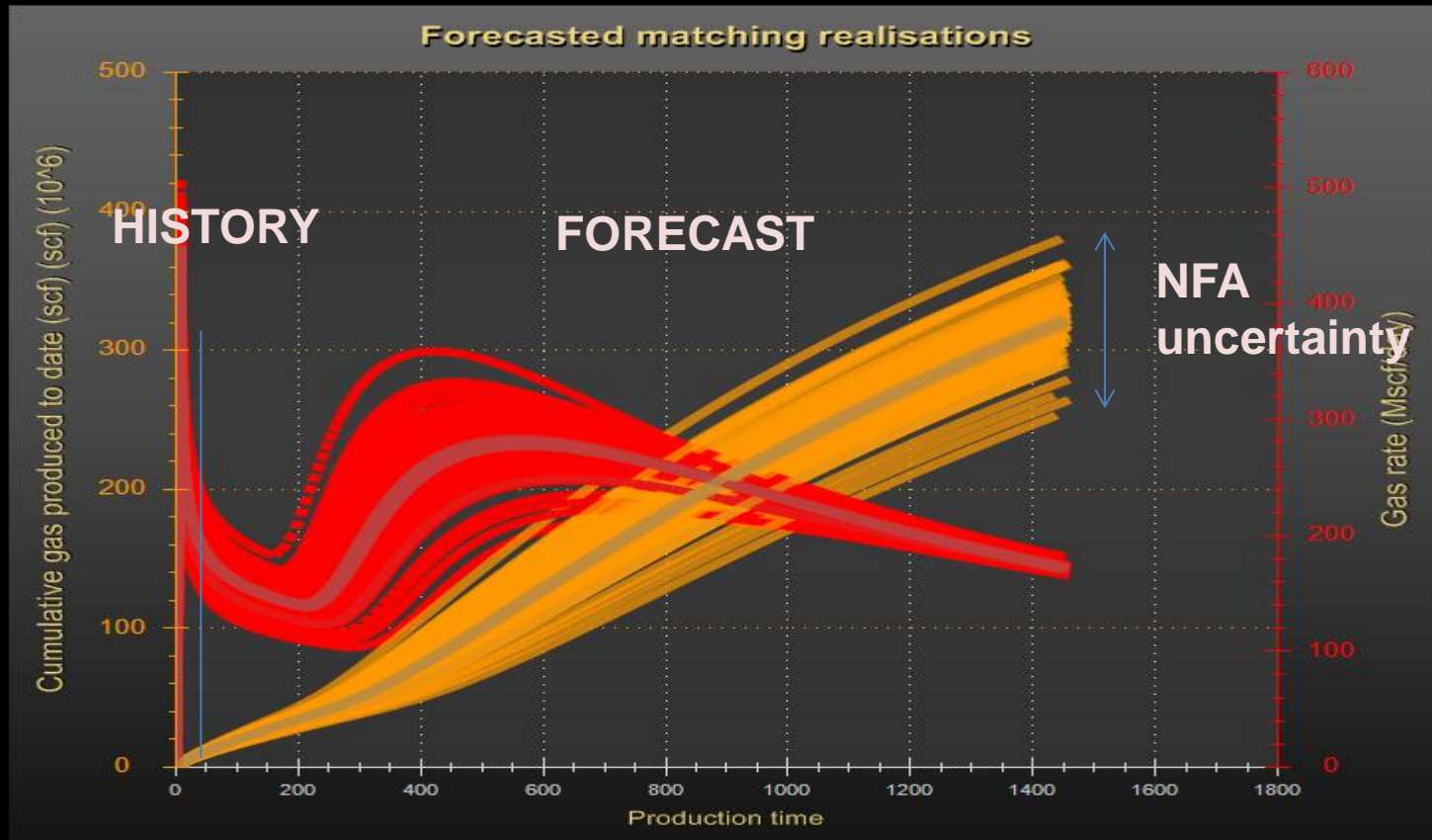
Understand the underlying matching parameter ranges



Forecasted matched models

Generate a range of forecasts based on alternative matching realisations

- 🌐 Rapid assessment of the residual uncertainty associated with NFA forecast
- 🌐 Identification of remaining potential in NFA and further-activity case

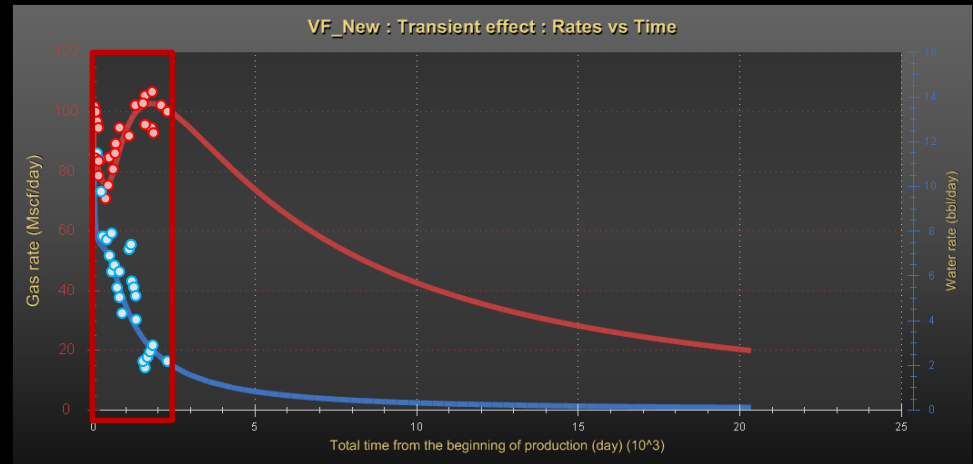


History Matching

Two approaches

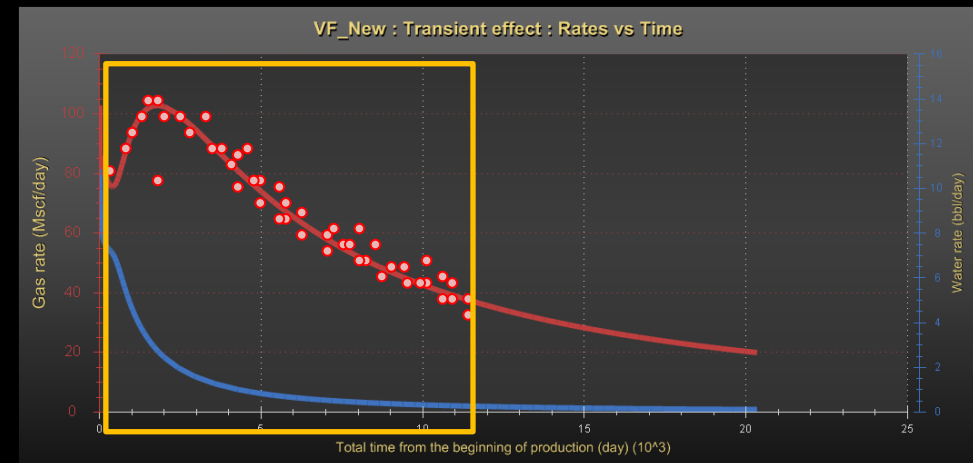
Short-term pilot production (1-6 months)

Especially tighter coals (<5mD)
Use Finite Element (numerical) model
Captures early production time effects



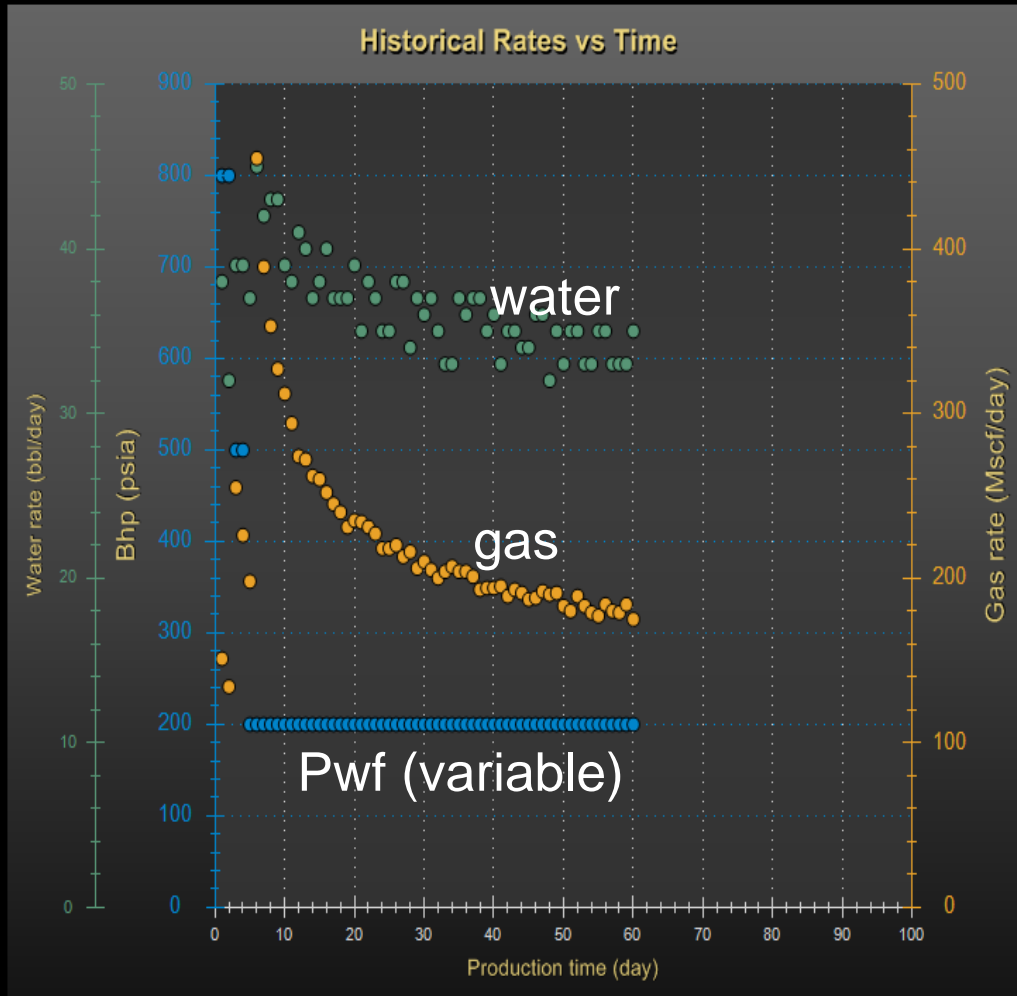
Mid/Long-term pilot production (6-24+ months)

Emphasis on matching later time production profile
Use Material balance forecast



Pilot production matching

Typical problem faced by CSG operators



- **Limited availability of data such as:**
 - Isotherm, gas content
 - Permeability, porosity
- **Production data desired to understand better reservoir parameters and future production potential of wells**
- **But:**
 - Extended, continuous production is a problem for various reasons
 - Ambiguity in the collected production data

Pilot production matching

Our Workflow for the assesment of early production pilots

Reservoir Characterisation

Definition of reference case

Define uncertainty ranges for each parameter

Sensitivity analysis (Tornado Plot)

Identify properties that would impact development metrics

Quantify key uncertainty impact on development metrics

History Matching

Run multiple realisations and generate development metrics

Estimation of best match and expected range of properties based on min error calculated for development metrics

Production Forecasting

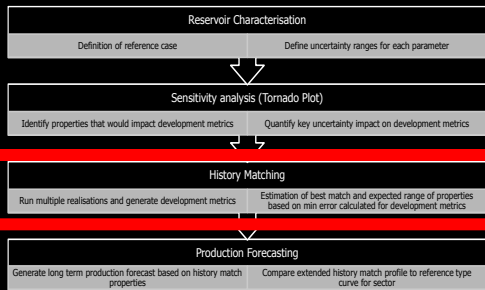
Generate long term production forecast based on history match properties

Compare extended history match profile to reference type curve for sector

Pilot production matching

Our Workflow for the assesment of pilot production

History Matching Non-unique solutions



Zoom on total runs:

12,000++ cases run in 1 minute.



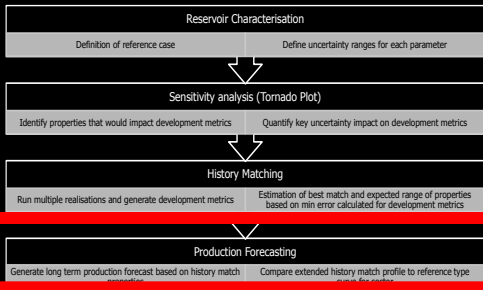
Pilot production matching

Our Workflow for the assesment of pilot production

Forecasting Multi-realisation

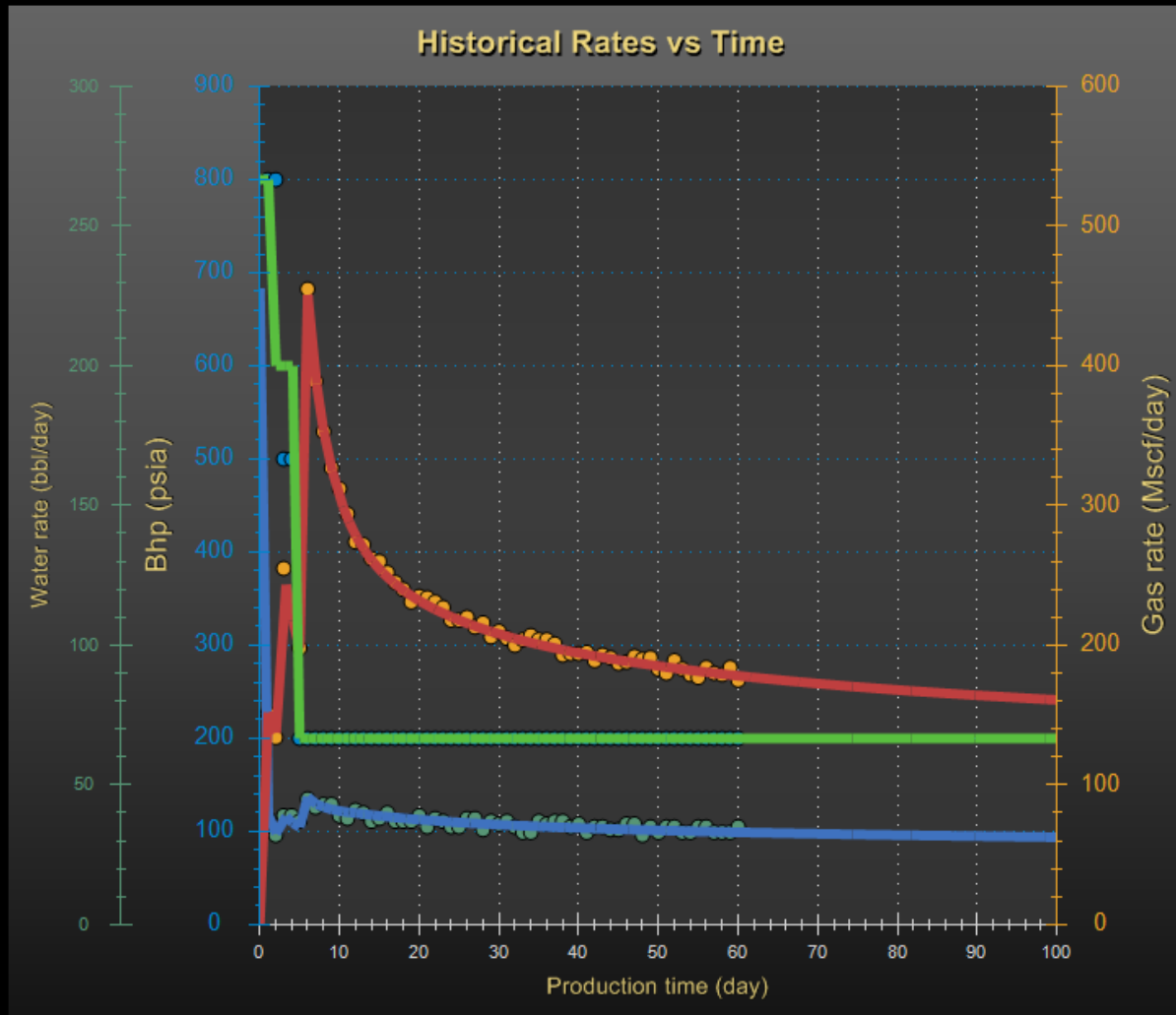
Why match multi-realisation
and then forecast them ?

Isn't one match good enough...?



Pilot production matching

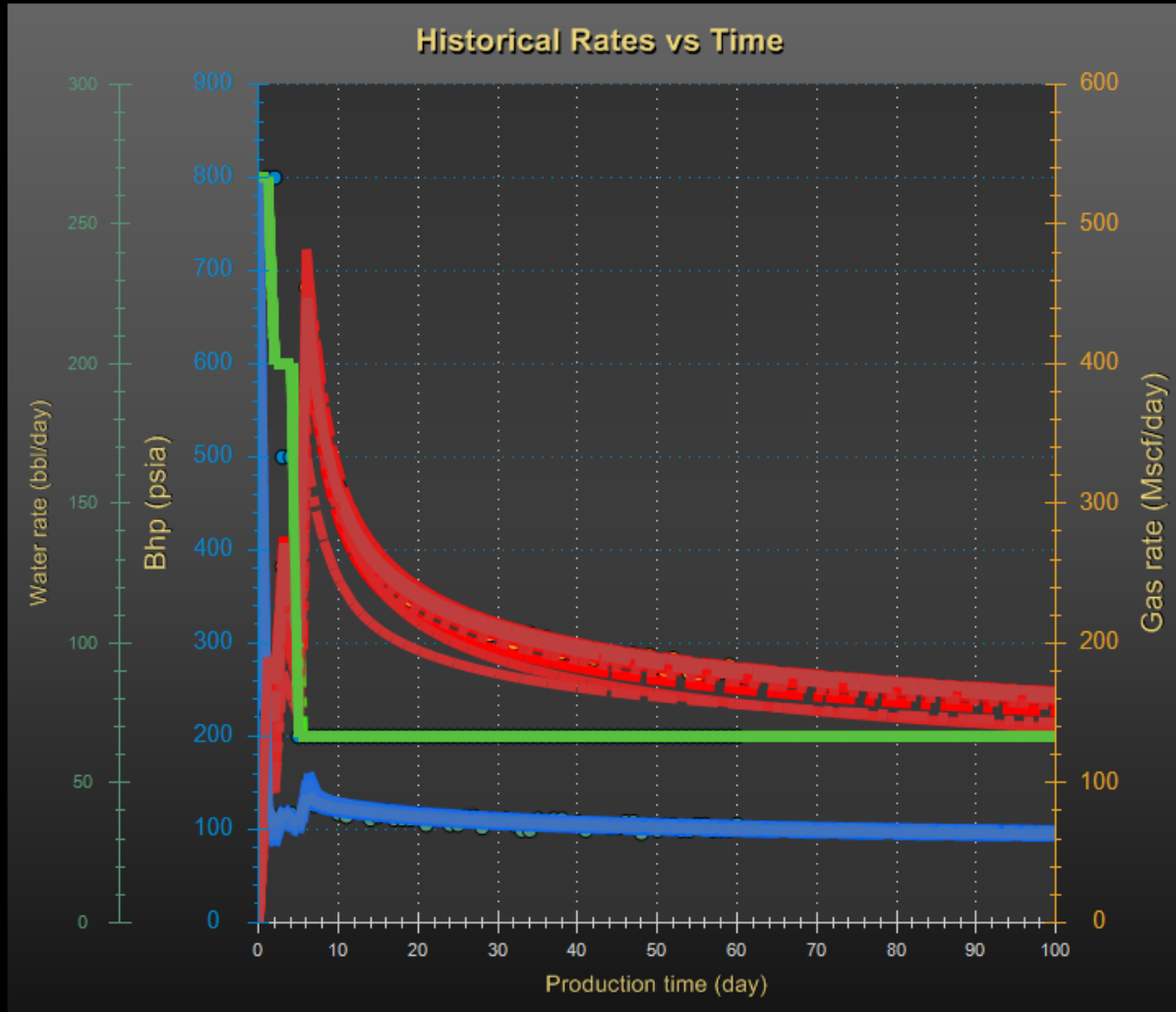
Example of multi-parameter matching



- **Single well match and it's forecast**
- **Useful but is this the only solution?**
- **Given the uncertainty on CSG reservoir characteristics**

Pilot production matching

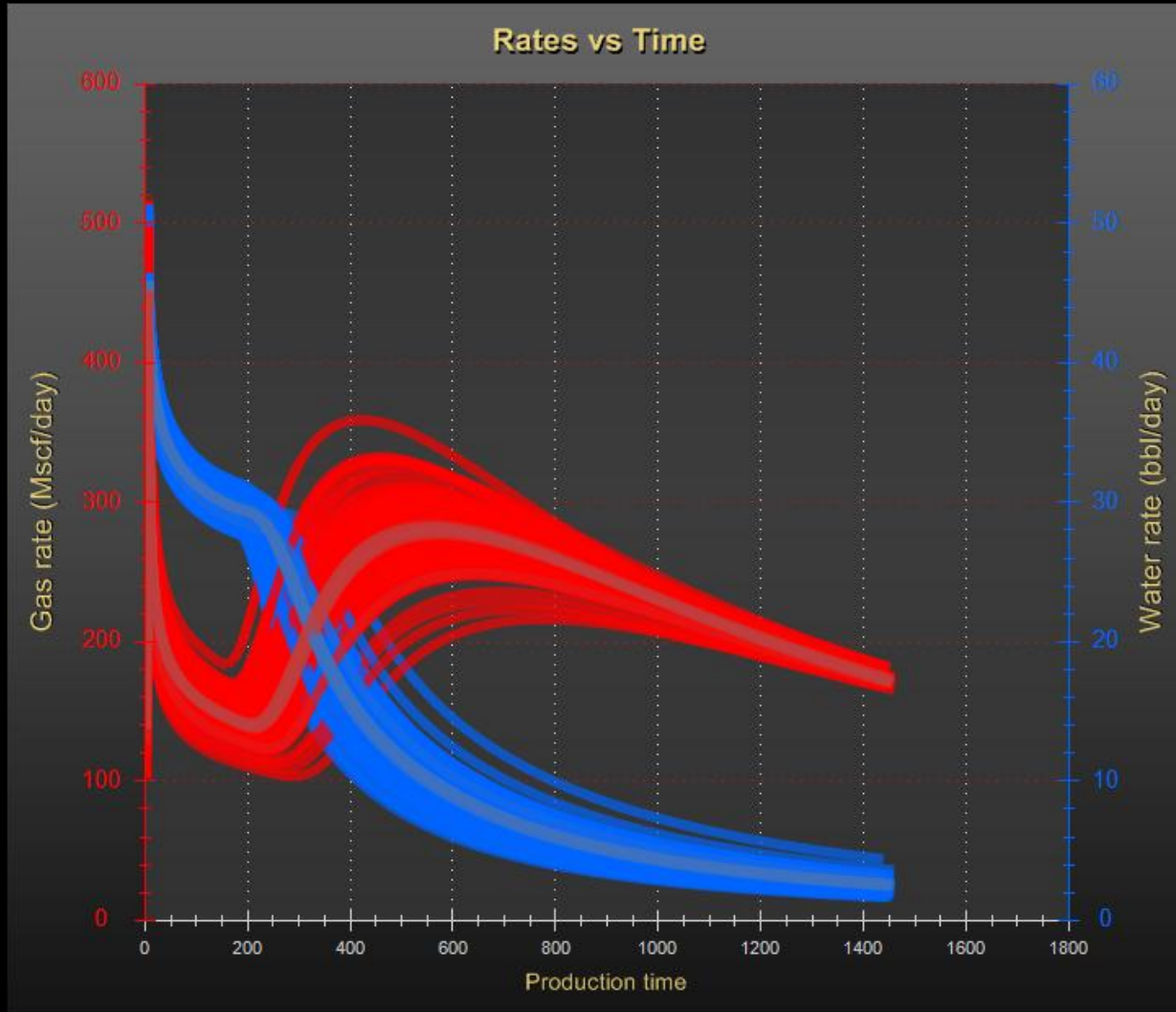
Example of multi-parameter matching



- A few selected additional matches
- Evidence of a range of possible future performance given an acceptable historical match

Pilot production matching

Example of multi-parameter matching



Now plotting the top 150 solutions

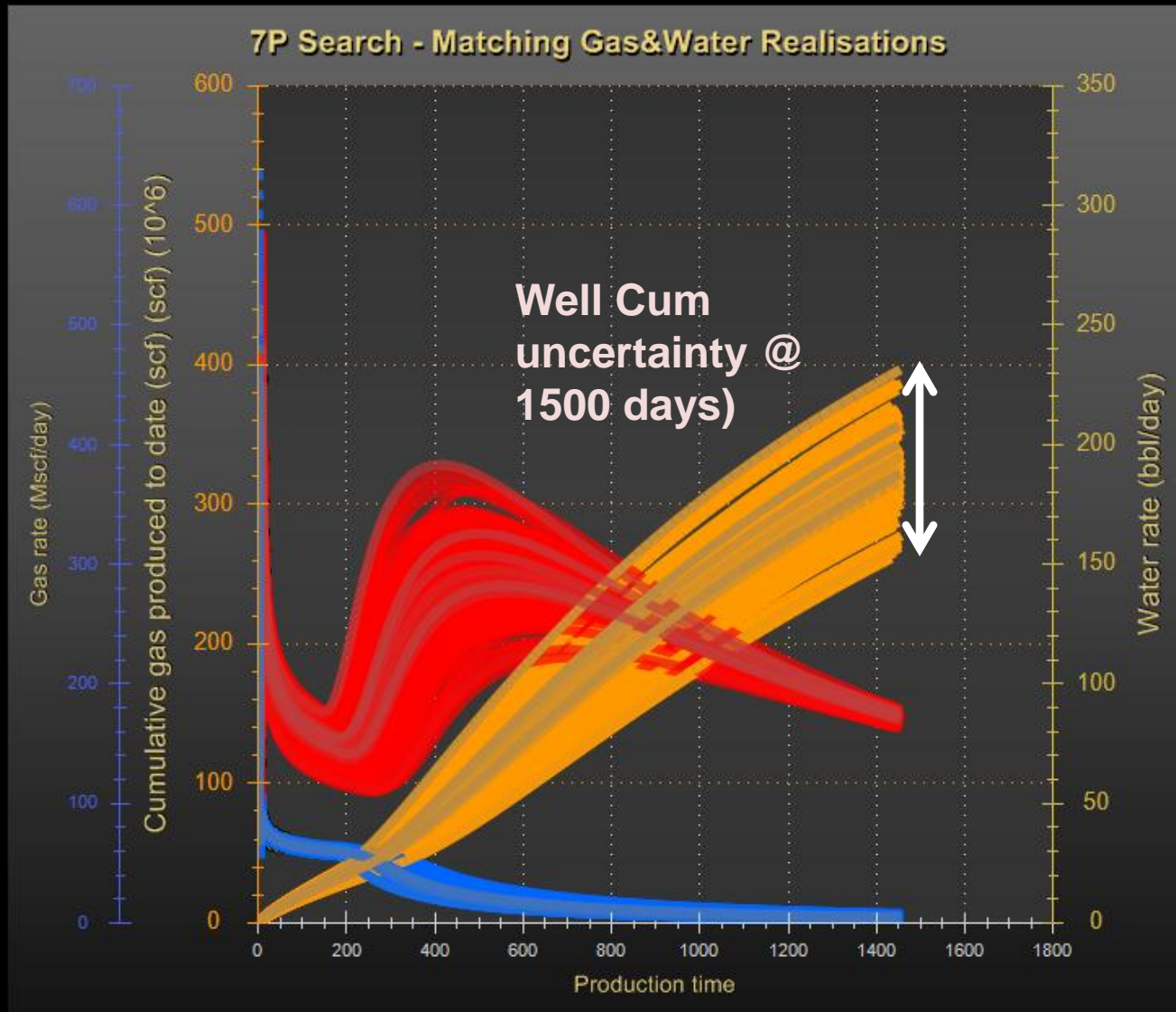
Selected as acceptable match

Provides a greater understanding of

- Future well performance
- Underlying reservoir parameters

Pilot production matching

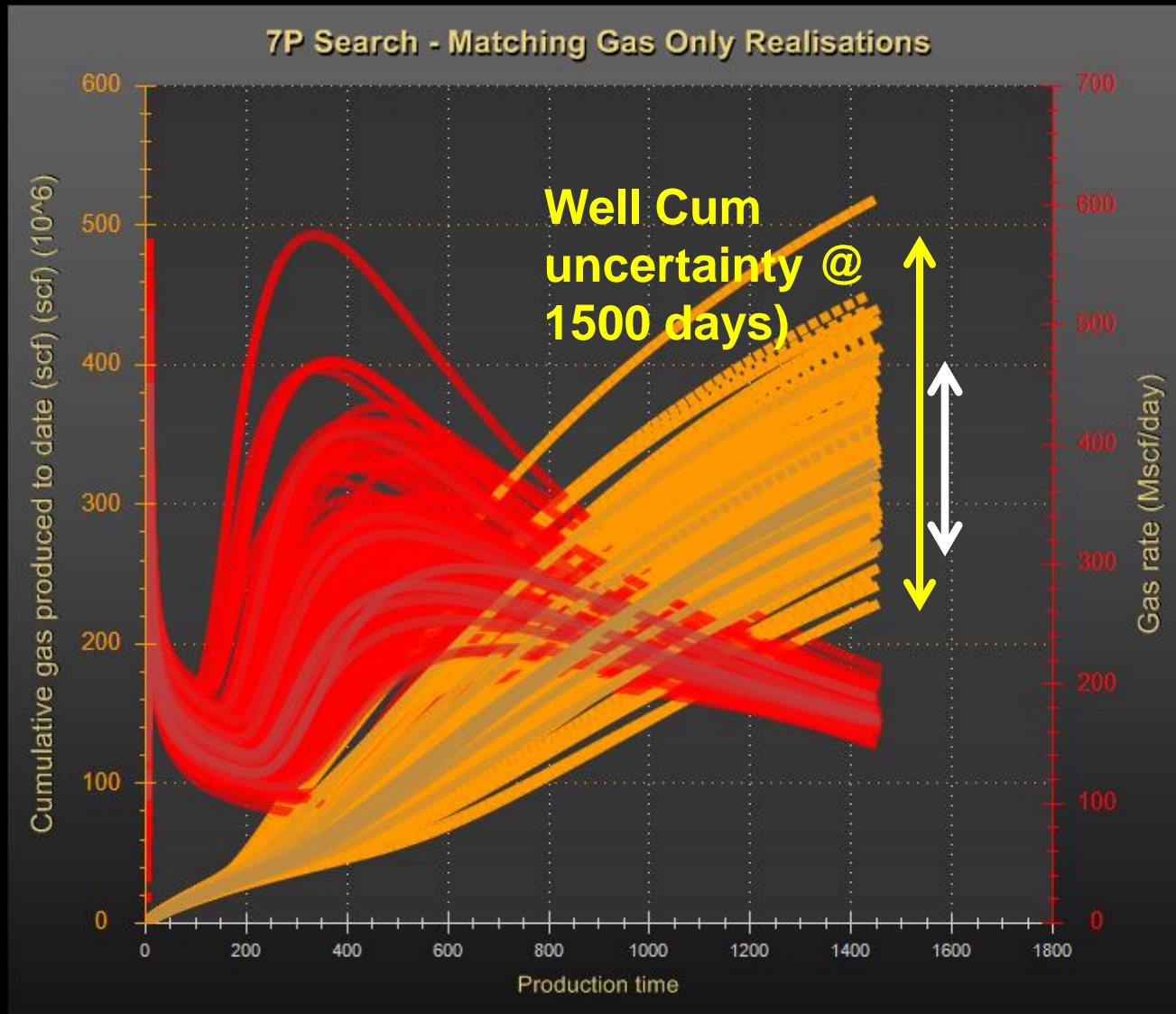
Value of Information for Water Measurement at well level



- Remaining uncertainty can be quantified
- Useful for reserves assessment

Pilot production matching

Value of Information for Water Measurement at well level



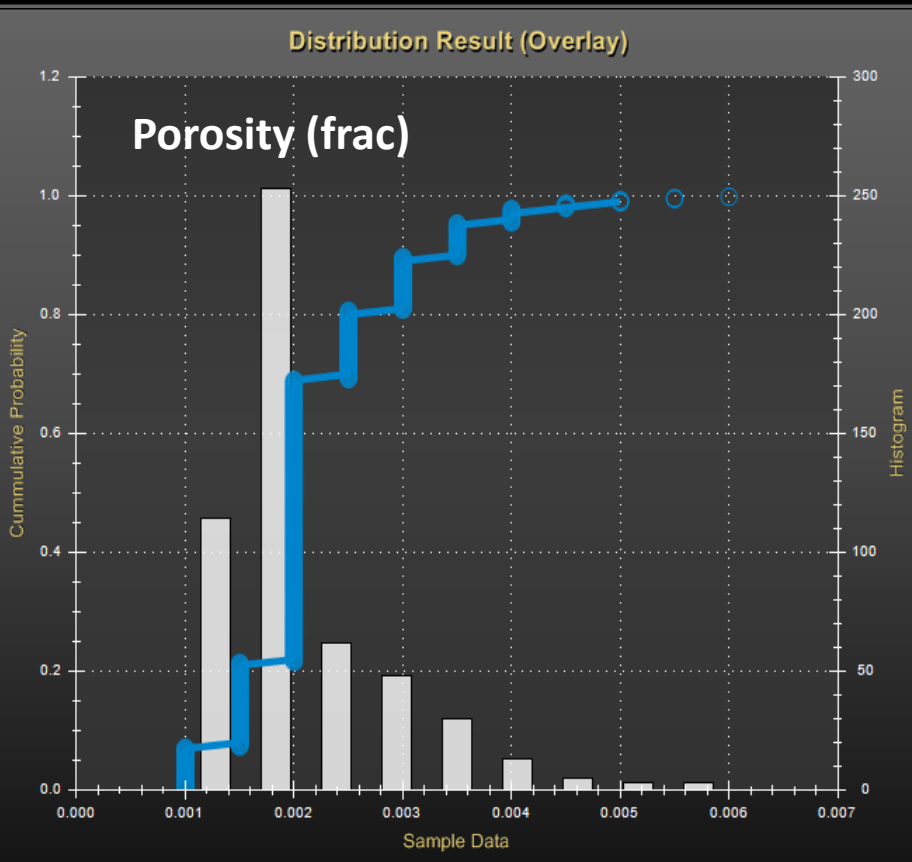
- Considerable Value of Information associated to measuring individual well water production
- The stochastic workflow allows to quantify the information

Pilot production matching

Utilising the matched cases to extract statistics: MATCHING PARAMETERS

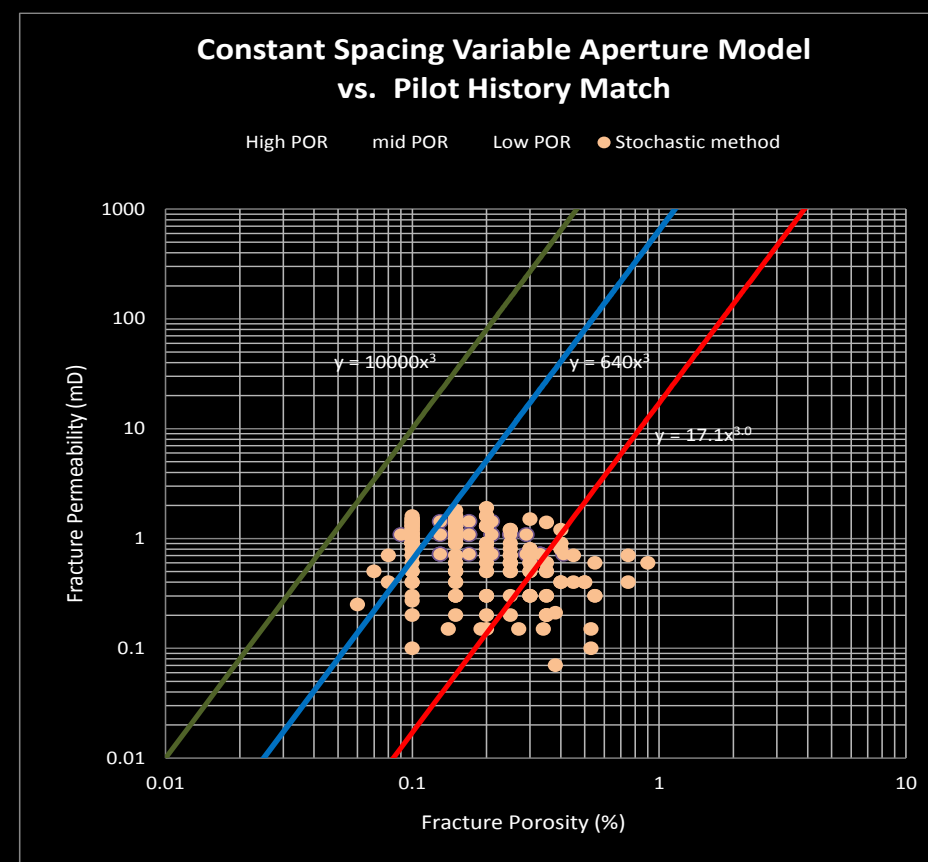
Reservoir characteristics

Assess uncertainty range in match given data quality and production time



Cross-plot results

Verification of reservoir characterisation models vs. Solutions from HM

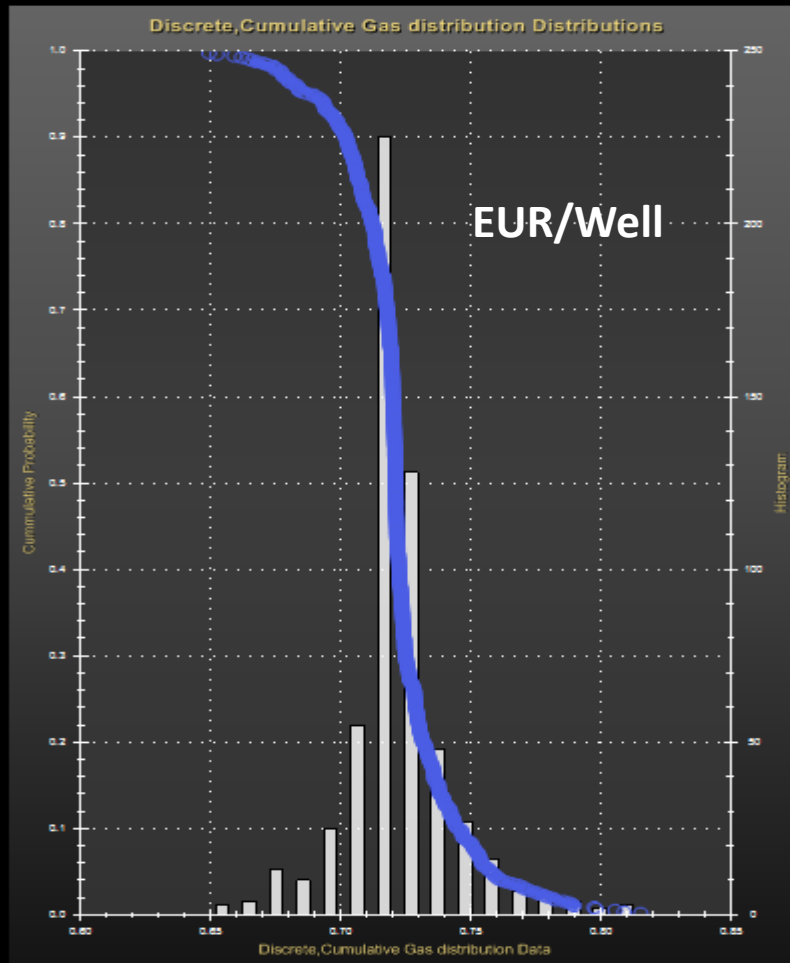


Pilot production matching

Utilising the matched cases to extract statistics: FORECAST RESULTS

Statistics on matches

Again we use the DOT.CBM data analysis capability

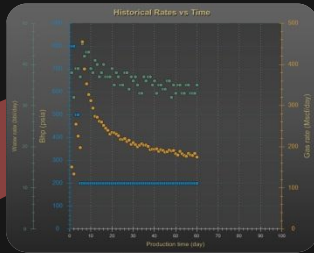


Multi-Well History Matching

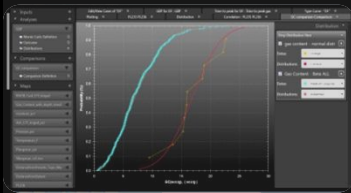
Matches Filtering & Average Maps Generation

Well Level

Production Data



Reservoir Characterization



Single Well History Matches

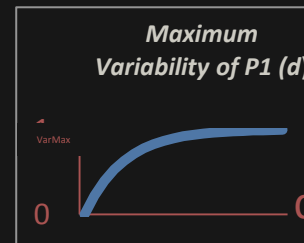


Field Level

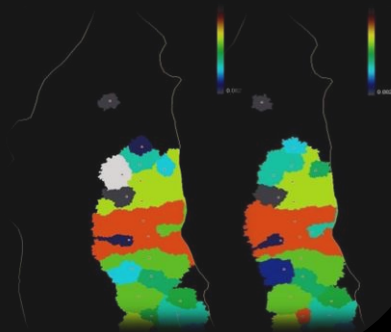
Field Matches Filtering

#	Perm	Area	Porosity	Gci	VI	#	Perm	Area	Porosity	Gci	VI
1	0.1739	338	0.0251	353	649	1	0.1739	338	0.0251	353	649
2	0.2599	123	0.0033	542	934	2	0.2599	123	0.0033	542	934
3	0.2437	2	0.042	230	778	3	0.2437	2	0.042	230	778
4	0.0668	142	0.0043	339	651	4	0.0668	142	0.0043	339	651
5	0.2409	18	0.0495	549	789	5	0.2409	18	0.0495	549	789
6	0.1141	31	0.0058	216	648	6	0.1141	31	0.0058	216	648
7	0.1225	380	0.0012	180	729	7	0.1225	380	0.0012	180	729
8	0.043	296	0.001	280	751	8	0.043	296	0.001	280	751
9	0.1389	50	0.0005	235	662	9	0.1389	50	0.0005	235	662

Geo-statistical Constraints



Average Properties Maps



Field Matches Filtering

Using Geo-Statistical Constraints

Possible Matches for Well 1

#	Perm	Area	Porosity	Gci	VI
1	0.1739	338	0.0251	353	649
2	0.2599	123	0.0033	542	934
3	0.2437	2	0.042	230	778
4	0.0668	142	0.0043	339	651
5	0.2409	18	0.0495	549	789
6	0.1141	31	0.0058	216	648
7	0.1225	380	0.0012	180	729
8	0.043	296	0.001	280	751
9	0.1389	50	0.0005	235	662

...

Possible Matches for Well i

#	Perm	Area	Porosity	Gci	VI
1	0.1739	338	0.0251	353	649
2	0.2599	123	0.0033	542	934
3	0.2437	2	0.042	230	778
4	0.0668	142	0.0043	339	651
5	0.2409	18	0.0495	549	789
6	0.1141	31	0.0058	216	648
7	0.1225	380	0.0012	180	729
8	0.043	296	0.001	280	751
9	0.1389	50	0.0005	235	662

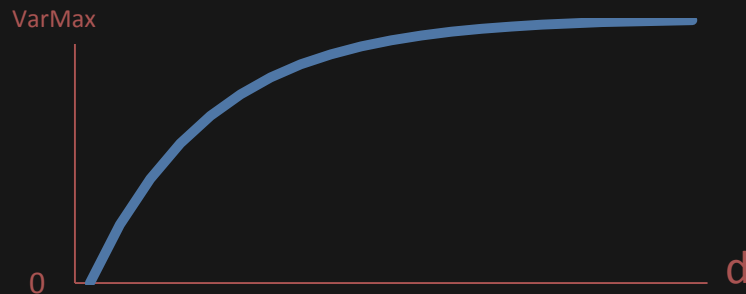
...

Possible Matches for Well n

#	Perm	Area	Porosity	Gci	VI
1	0.1739	338	0.0251	353	649
2	0.2599	123	0.0033	542	934
3	0.2437	2	0.042	230	778
4	0.0668	142	0.0043	339	651
5	0.2409	18	0.0495	549	789
6	0.1141	31	0.0058	216	648
7	0.1225	380	0.0012	180	729
8	0.043	296	0.001	280	751
9	0.1389	50	0.0005	235	662

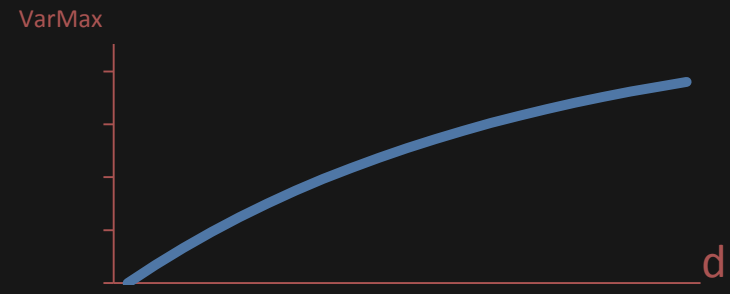
Geo-statistical Constraints

Maximum Variability of P1 (d)



...

Maximum Variability of Pn (d)

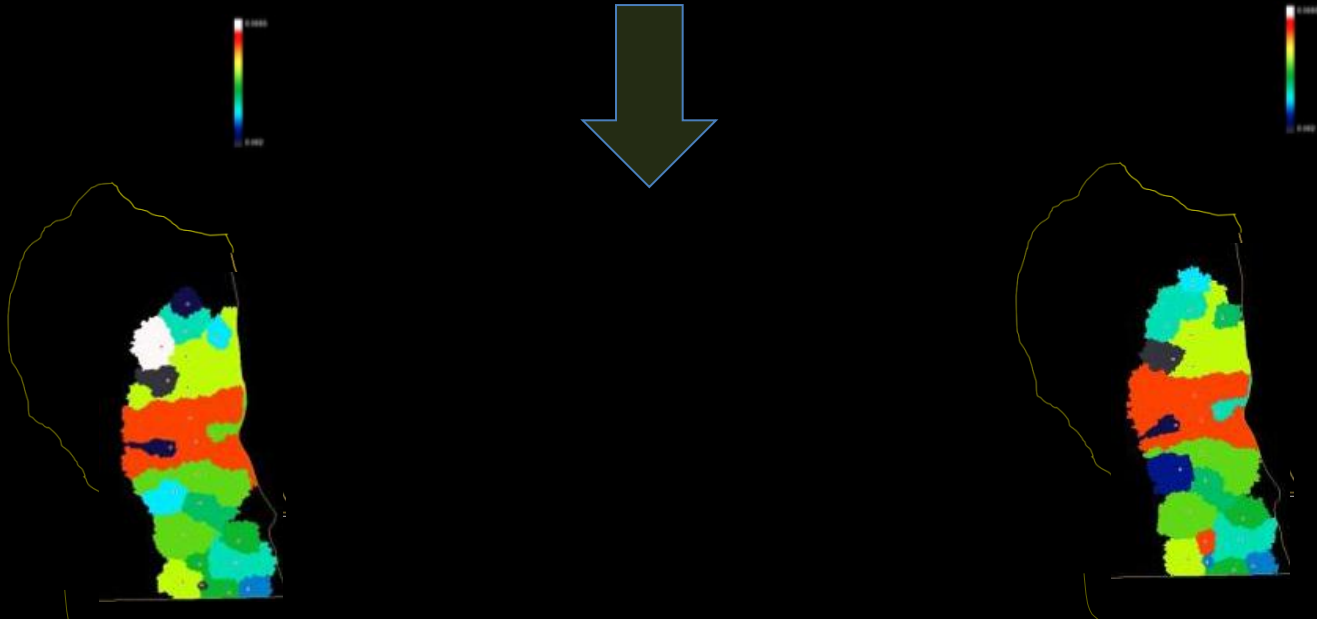


Average Maps Generation

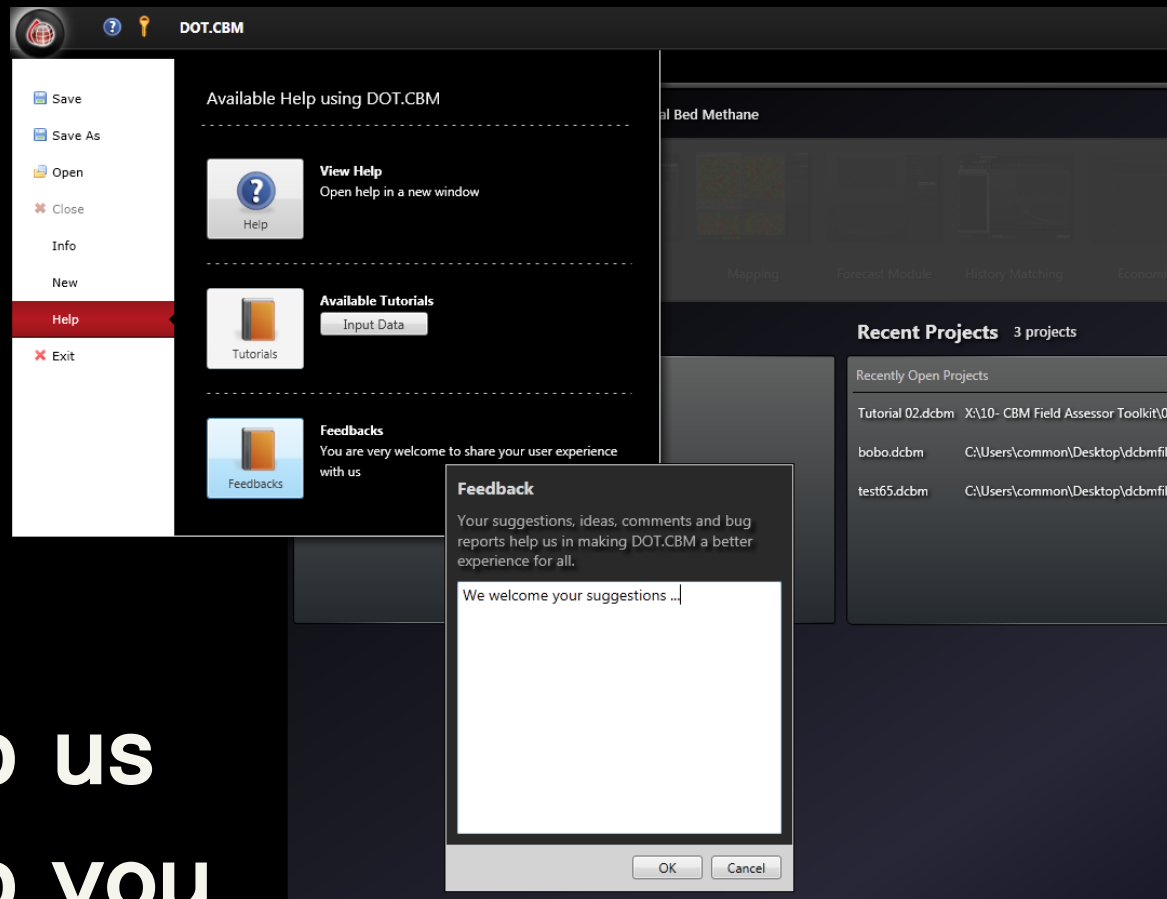
Using Matched Drainage Areas

<i>Field Match 1</i>					
	Well1	Well2	Well3	.	.
Area	100	120	300		
Porosity	0.0008	0.0014	0.002		
Perm	1	2	4		

<i>Field Match 2</i>					
	Well1	Well2	Well3	.	.
Area	150	120	280		
Porosity	0.0007	0.0004	0.0018		
Perm	1	2	4		



Thank you for your attention



Help us
Help you

Share with us your experience, suggestions and ideas with the DOT.CBM feedback tool.