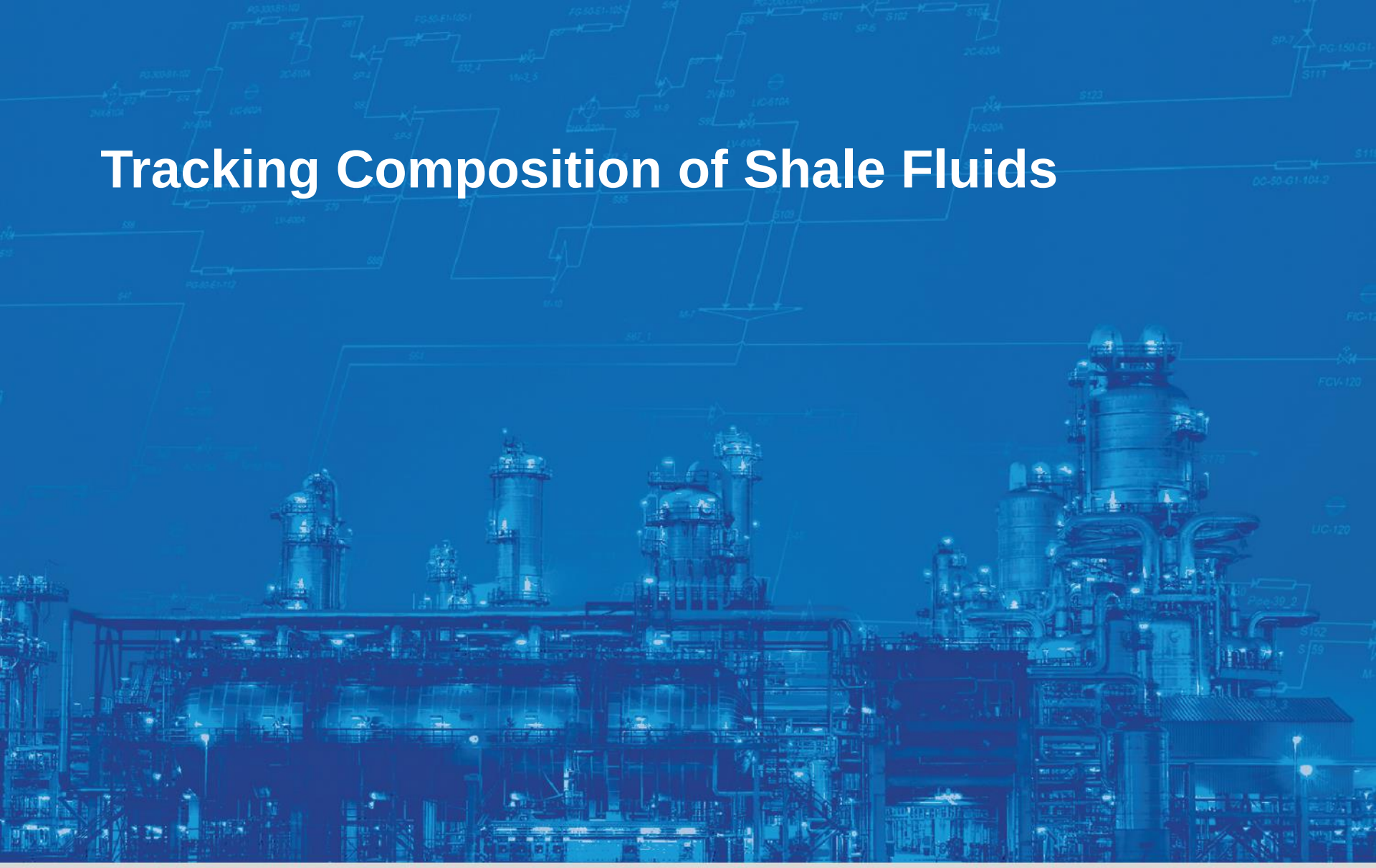
Tracking Composition of Shale Fluids

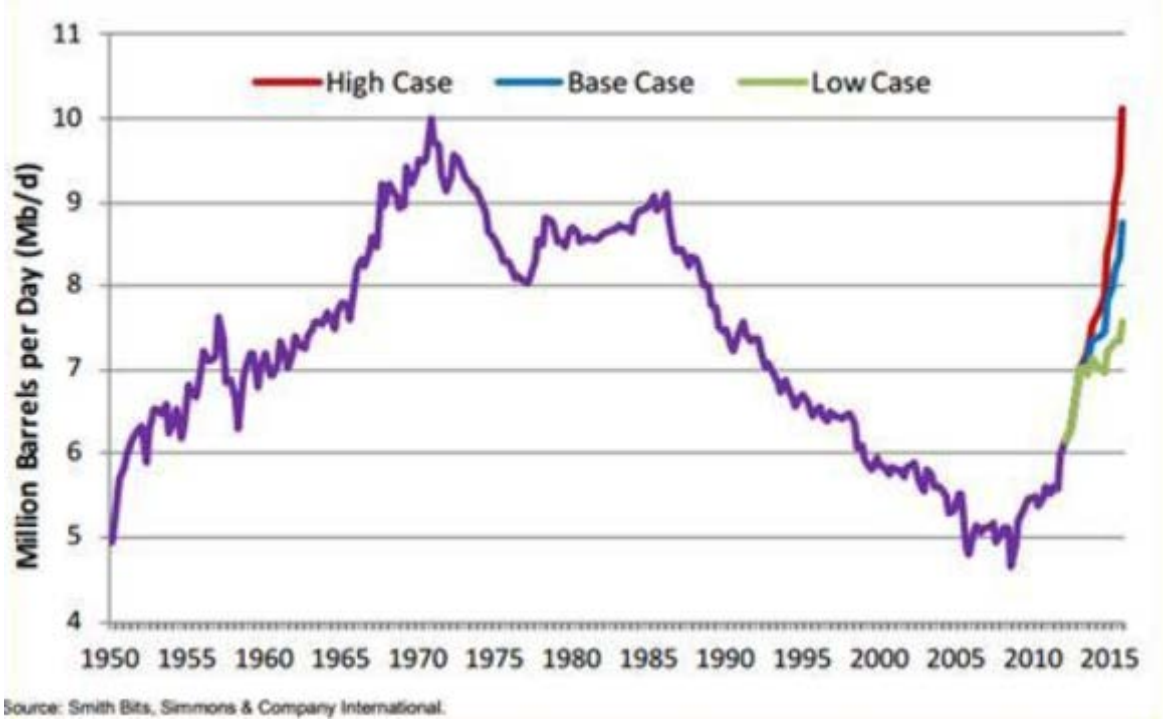


VMG
EMPOWERING PROCESS SIMULATION

Outline

- Shale Characteristics
- Shale Fluid Characteristics
- Field Development / Operations
- Limitations of Conventional Characterisation
- Tracking Shale Composition
- Field Composition Tracking

Shale Characteristics



Shale Characteristics

- Lower permeability
  - Composition is highly variable
  - Wells are expensive
- Multi-stage fractured wells typically have steep decline curves.
  - Changing production rates
  - Changing GOR
  - Changing reservoir conditions
- Unconventional composition
  - Conventional facilities may not be adequate
  - Opportunity for high value products
  - Changing market conditions

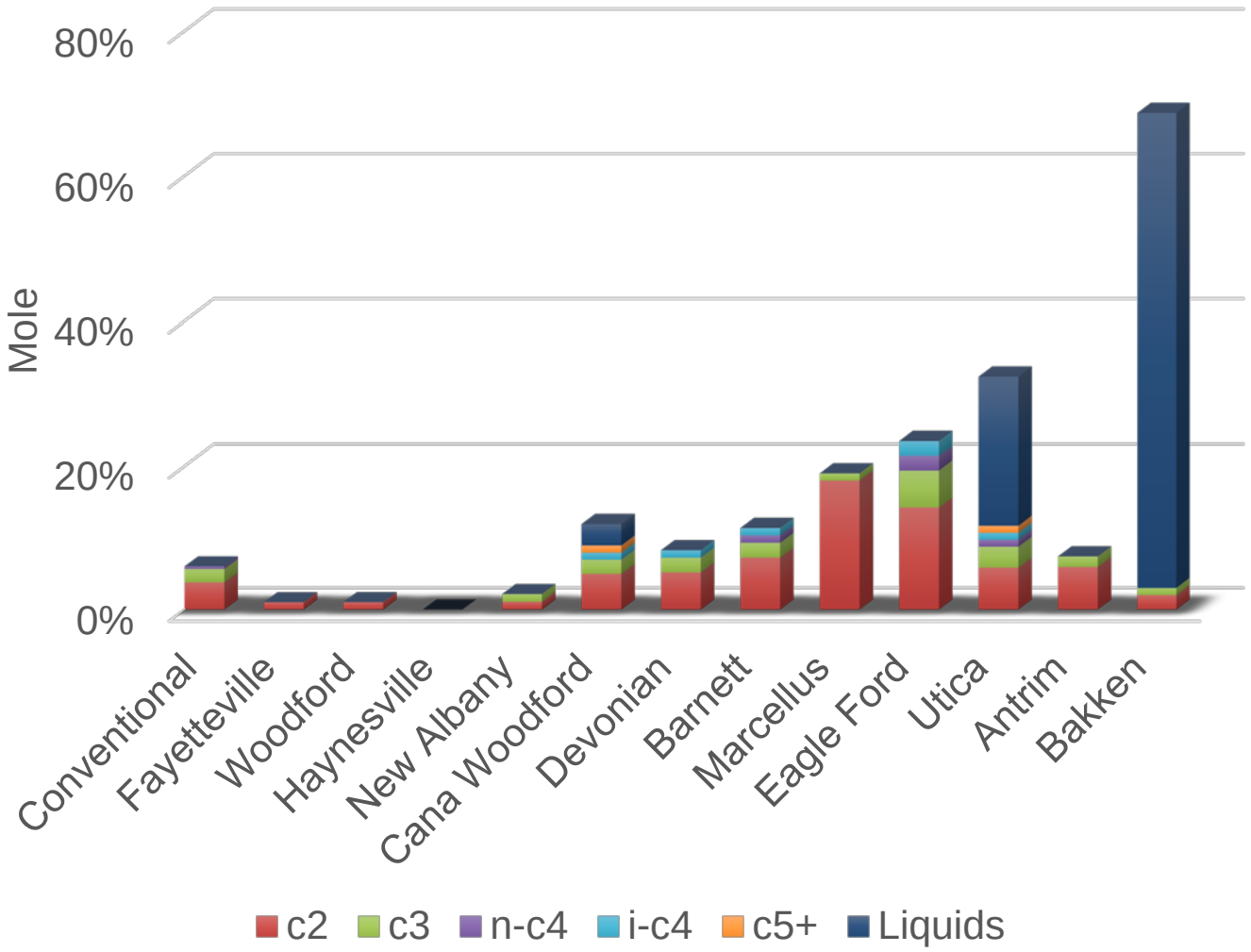
Shale Fluid Characteristics

General Characteristics

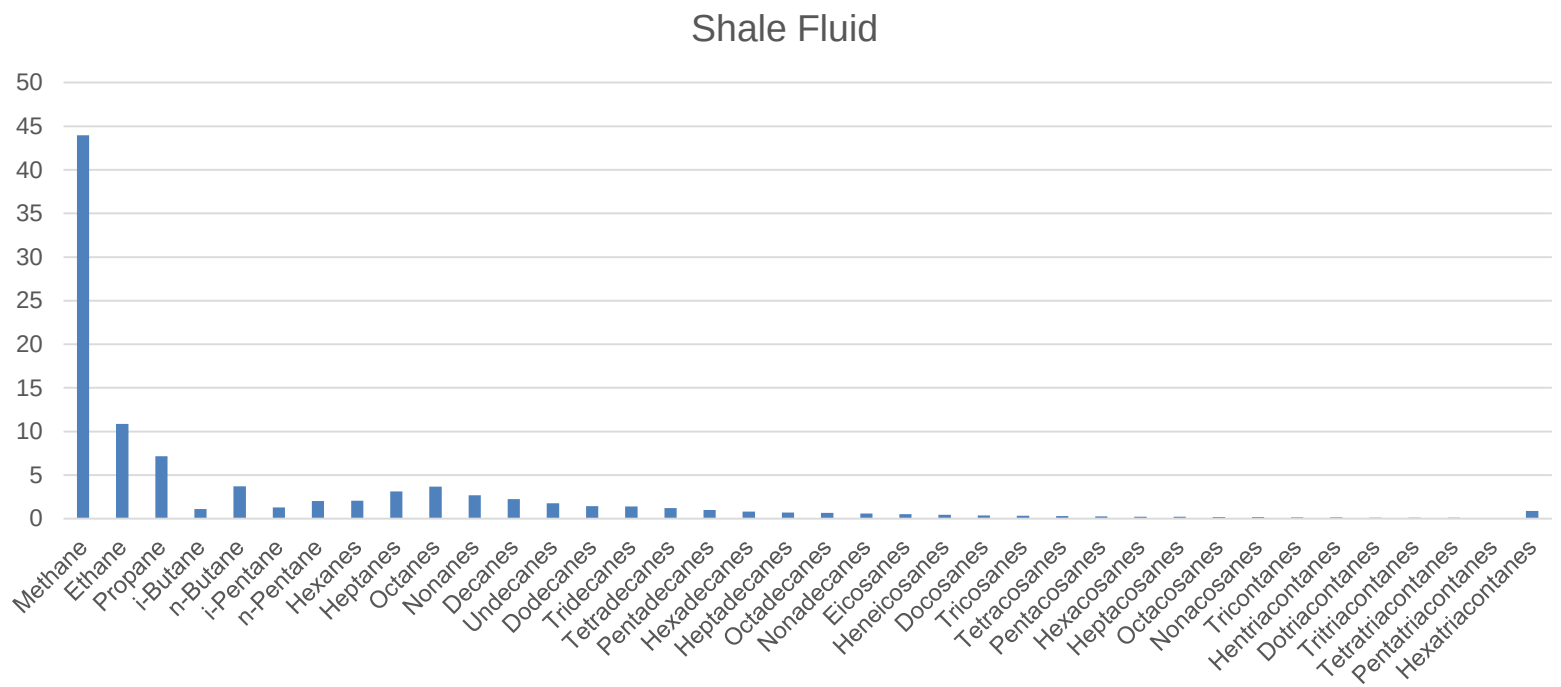
- Low permeability – variable composition
- Potentially:
  - Low GOR – Montney up to 200bbl per MMSCF
  - Rich Gas – < 80% Methane
  - Heavy Ends – Natural gasoline or heavier

Analysis companies looking to change techniques to capture C6+ components

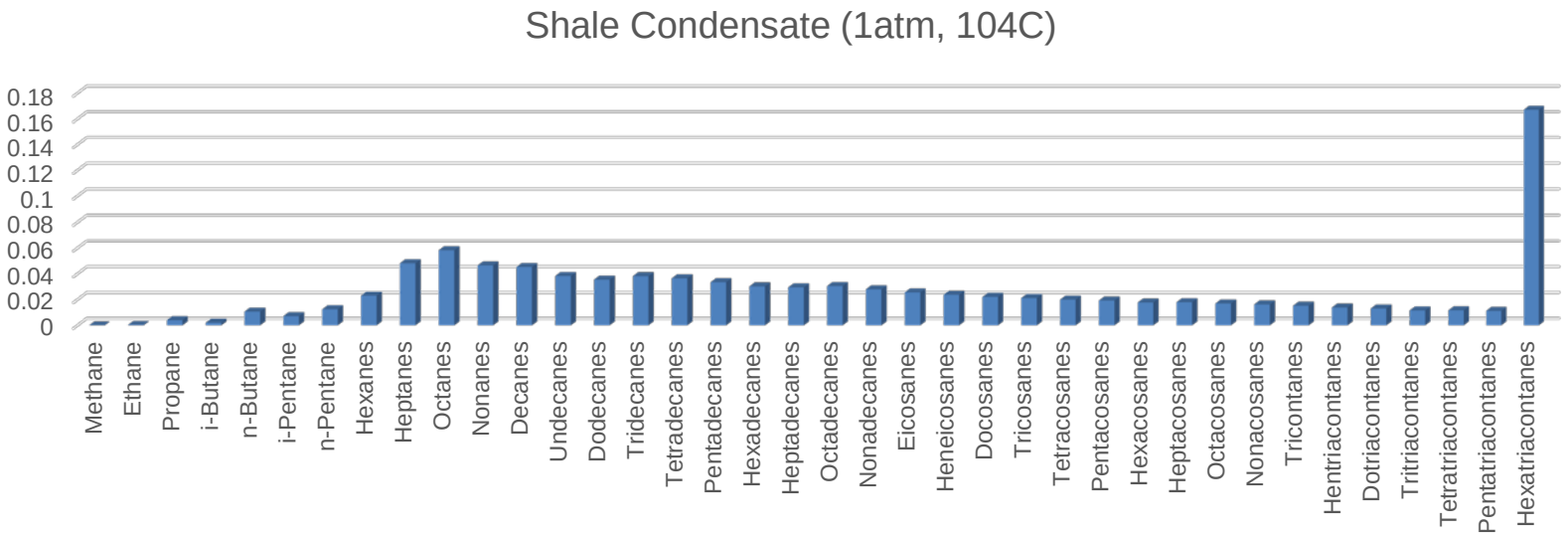
Shale Fluid Characteristics



Shale Fluid Characteristics

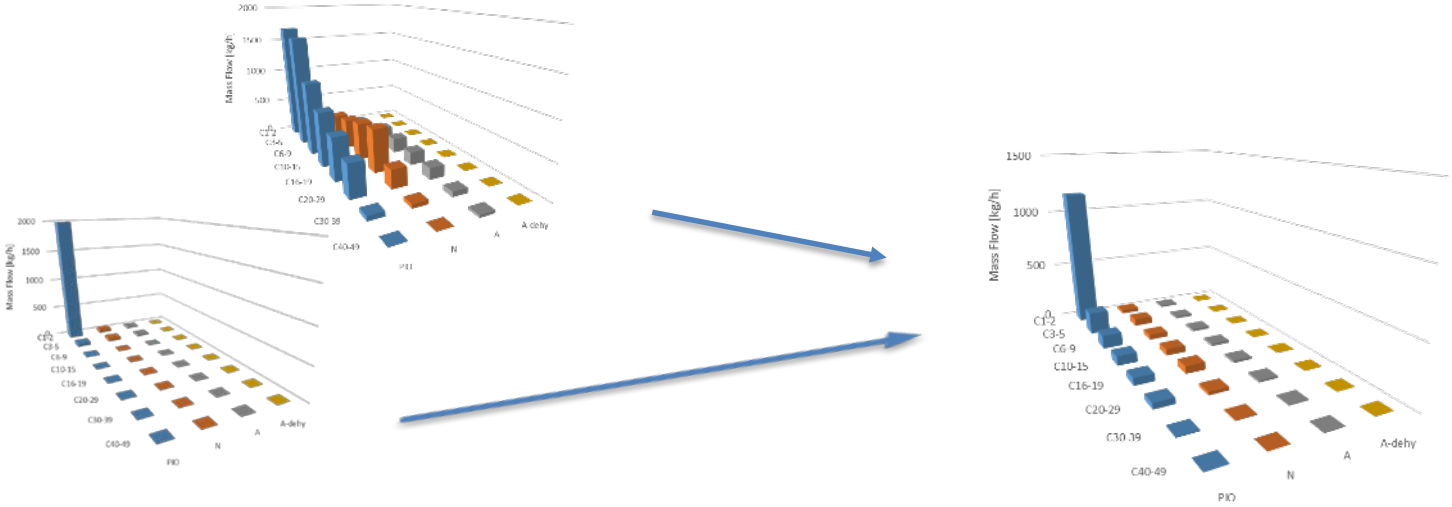


Shale Fluid Characteristics



Field Development / Operations

- Different wells may produce different fluids
- Adaptability of facilities
- Compression for fluids at a range of densities



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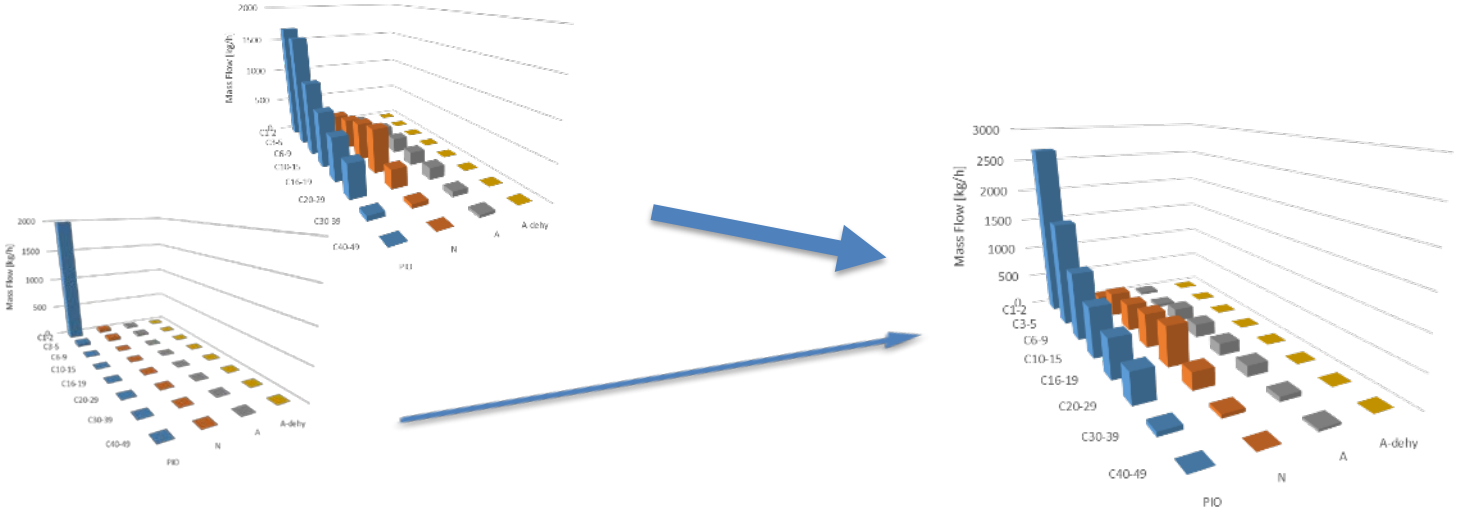


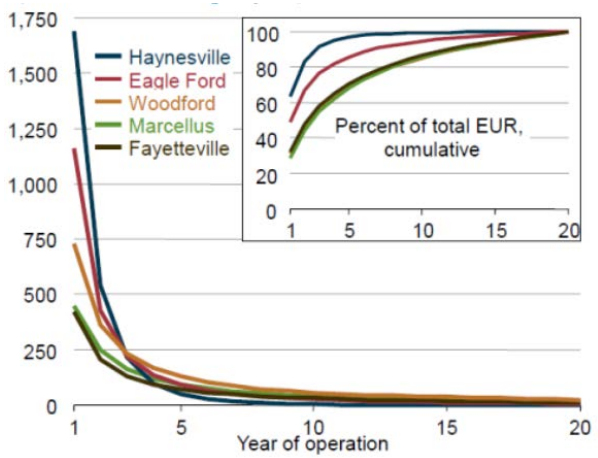
Completions

- Rapid change in composition after completions
  - Methane
  - Propane

- Effect on fuel gas
- Vapour recovery
- Sales composition

Decline

- Rapid decline
- Change in production rates
- GOR as a function of pressure
- Enhanced recovery



Graph from US Energy Information Administration

Transient Effects

- Impact of transient effects on whole field
- Adapting operating parameters to meet specification
- Tracking of composition

Potential Markets

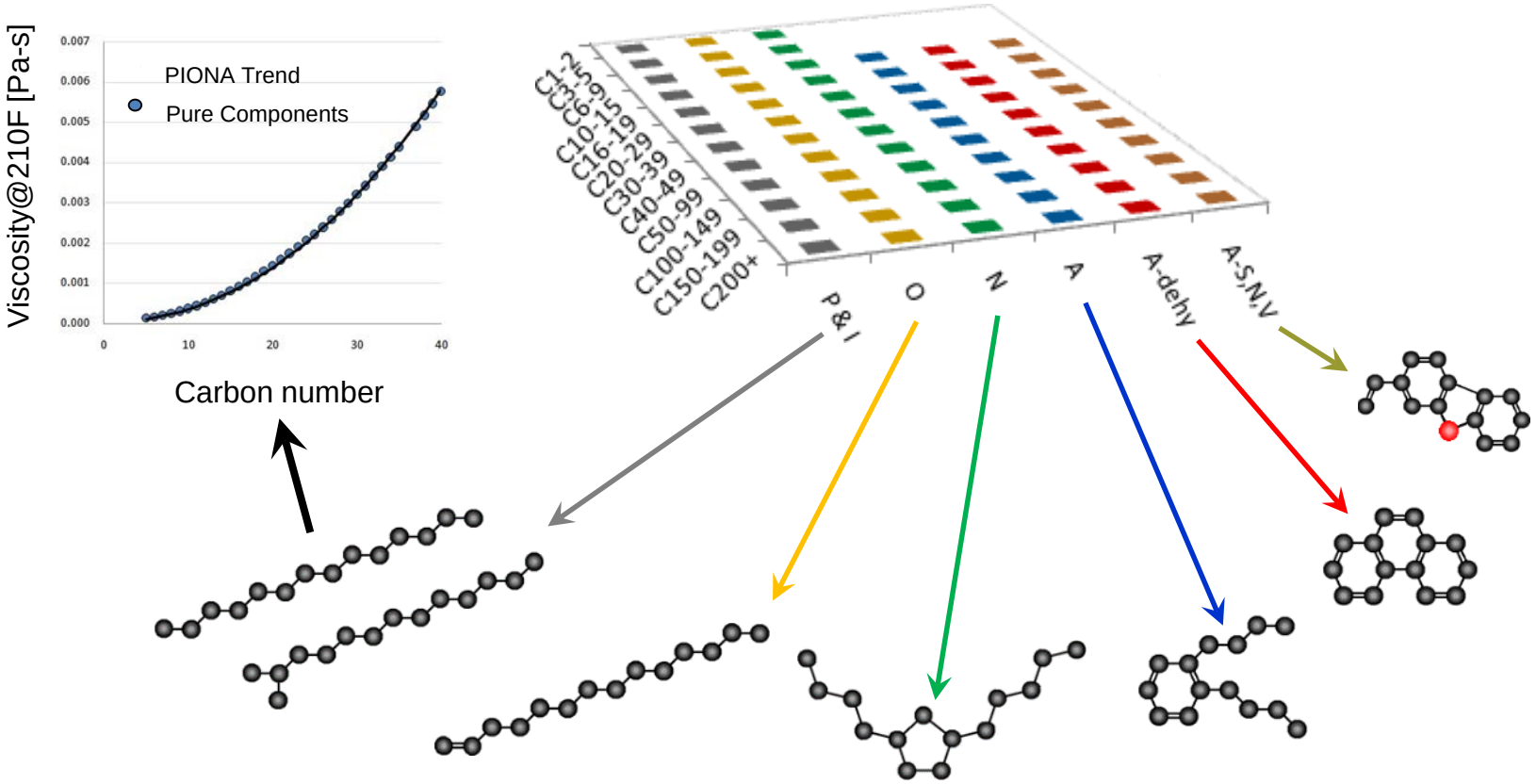
- Options in Alberta:
  - Gas to pipelines
  - Diluent for bitumen
  - Fractionate NGL for local market
  - Light oil
- Composition tracking allows decisions to be made based on current and relevant data

Limitations of Conventional Characterization

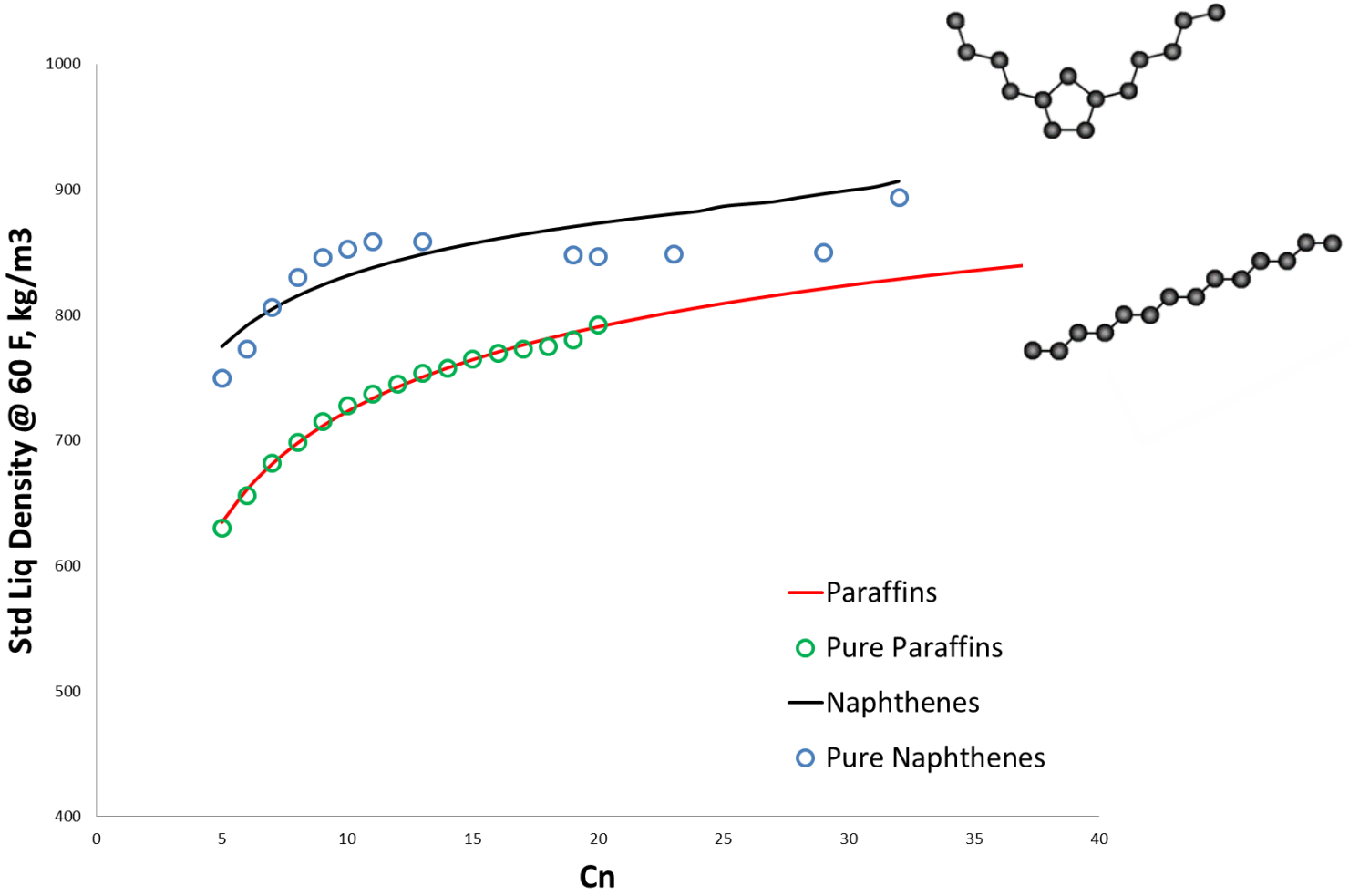
- Hypothetical components are not scalable
- Hypothetical components cannot be fractionated
- Chemical families have very different bulk properties
- Composition and production changes with time and location
- Large quantity of data

Tracking shale composition

- Matrix created based on carbon number and molecular structure



Tracking Shale Composition



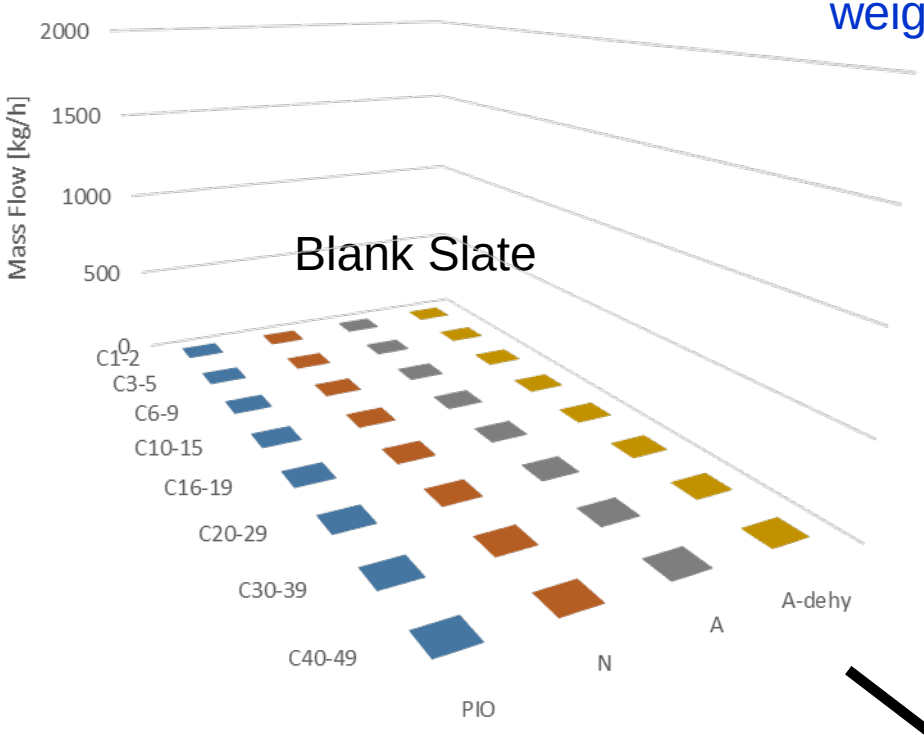
Tracking Shale Composition

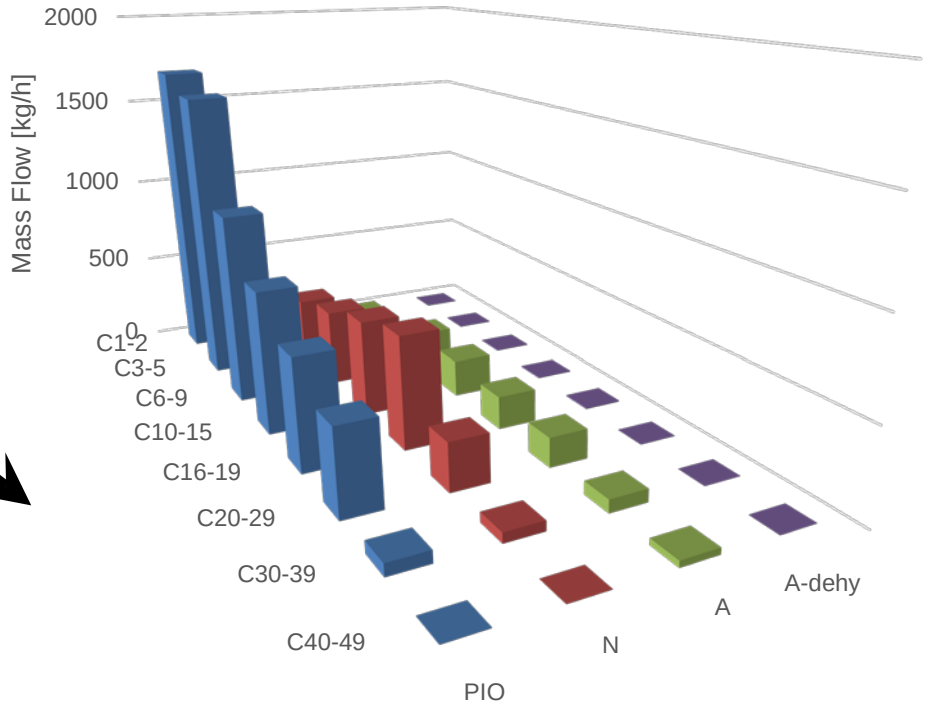
Extended analysis

Cn	Mole Fraction	Molecular Weight	Mass Density	P_{sat}
C7	0.1473			
C8	0.1229	151	788	3020
C9	0.1003	[Kmol Kg^{-1}]	[Kg m^{-3}]	[kPaa]
C10	0.0743			
.	.			
.	.			
.	.			
C30+	0.0445			

Tracking Shale Composition

Component mixture that best matches molecular weight, bulk density, vapor pressure etc.



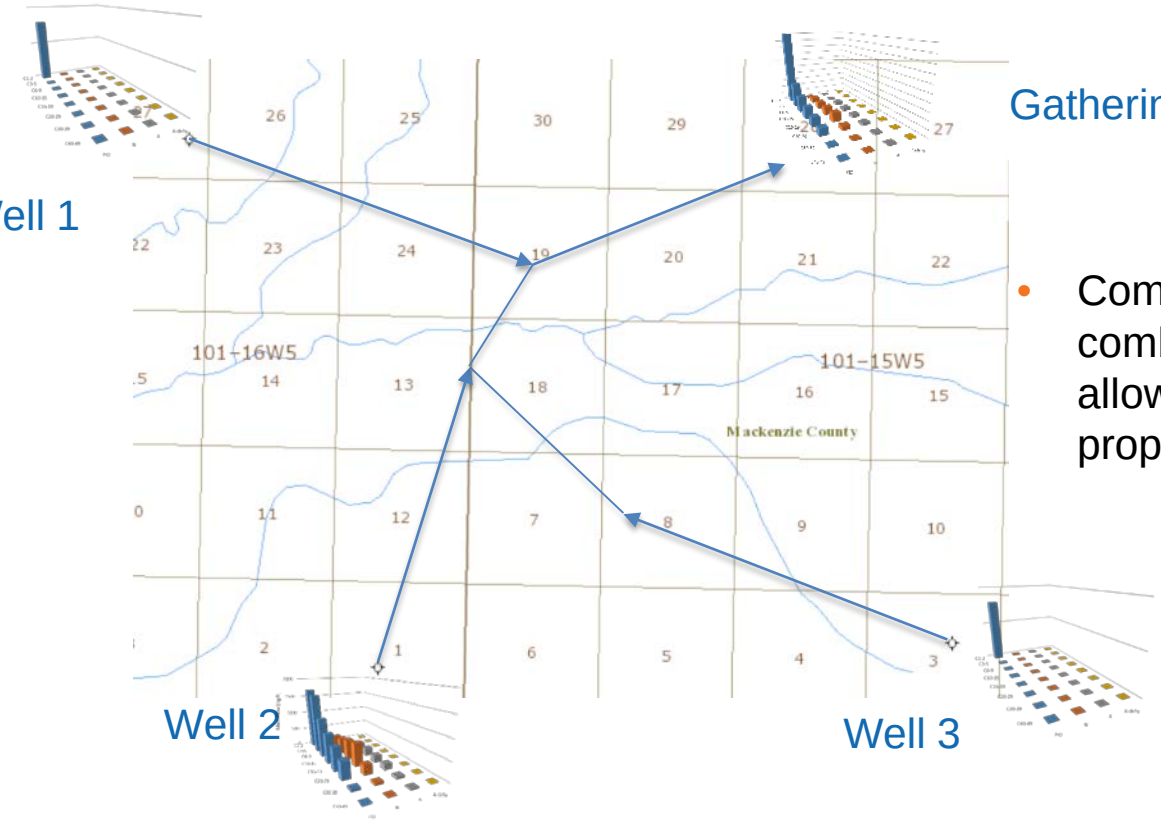


Tracking Shale Composition

Details of extended analysis become important!

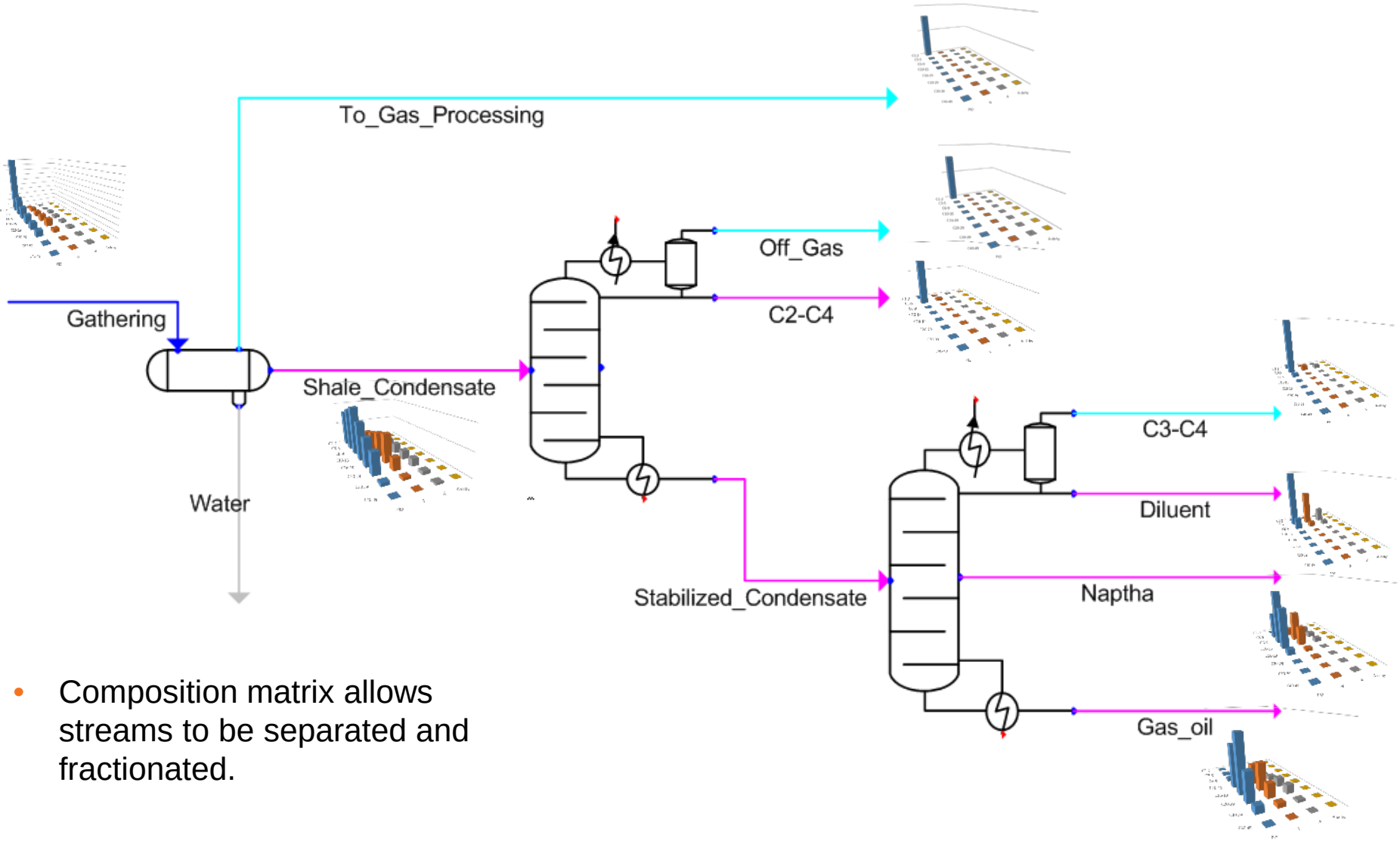
- Separation of light components
- Calculated or measured
- Accuracy of measurement

Tracking Shale Composition



- Composition matrix tracks combinations of streams allowing prediction of key properties.

Tracking Shale Composition



- Composition matrix allows streams to be separated and fractionated.

Tracking Shale Composition

- C30+ analyses can be used to categorise hydrocarbons from each well
- Saturation pressure, molecular weight and density used to divide each carbon number fraction into molecular groups.
- Scalable, streams can be mixed, separated and fractionated.
- Validation has shown promising results

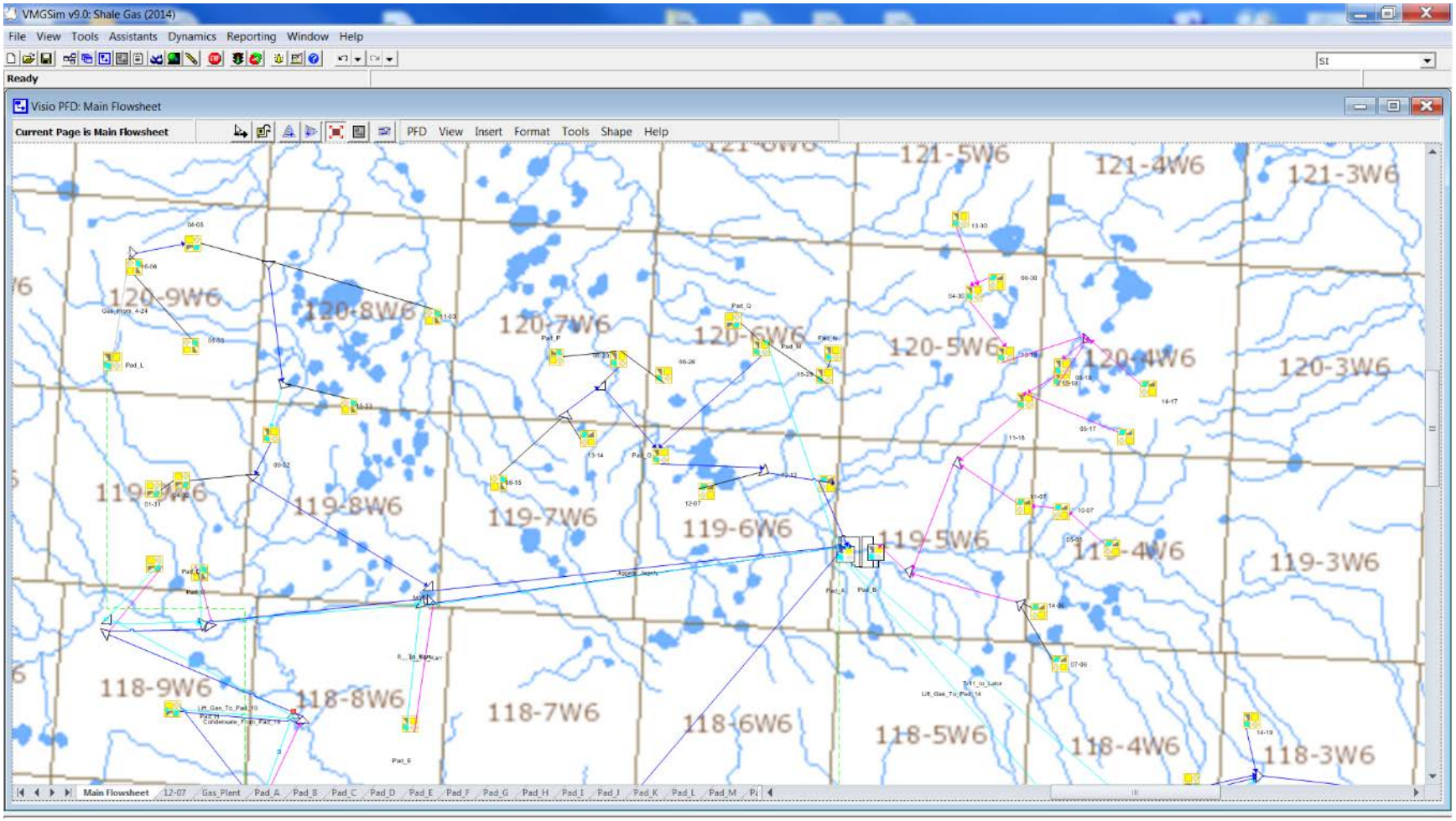
Tracking Shale Composition

	Molecular Weight (error)	Density (error)
Tank Liquid (Measured)	0%	0%
PIONA Regressed	-1.61%	-0.18%
All Paraffin	-2.15%	-4.22%
CN	4.77%	1.98%
Gamma	0.12%	1.13%
C7+ Hypo	-7.14%	0.39%

Field Composition Tracking

Needs to handle large quantities of composition and production data that is updated as conditions change

Field Composition Tracking



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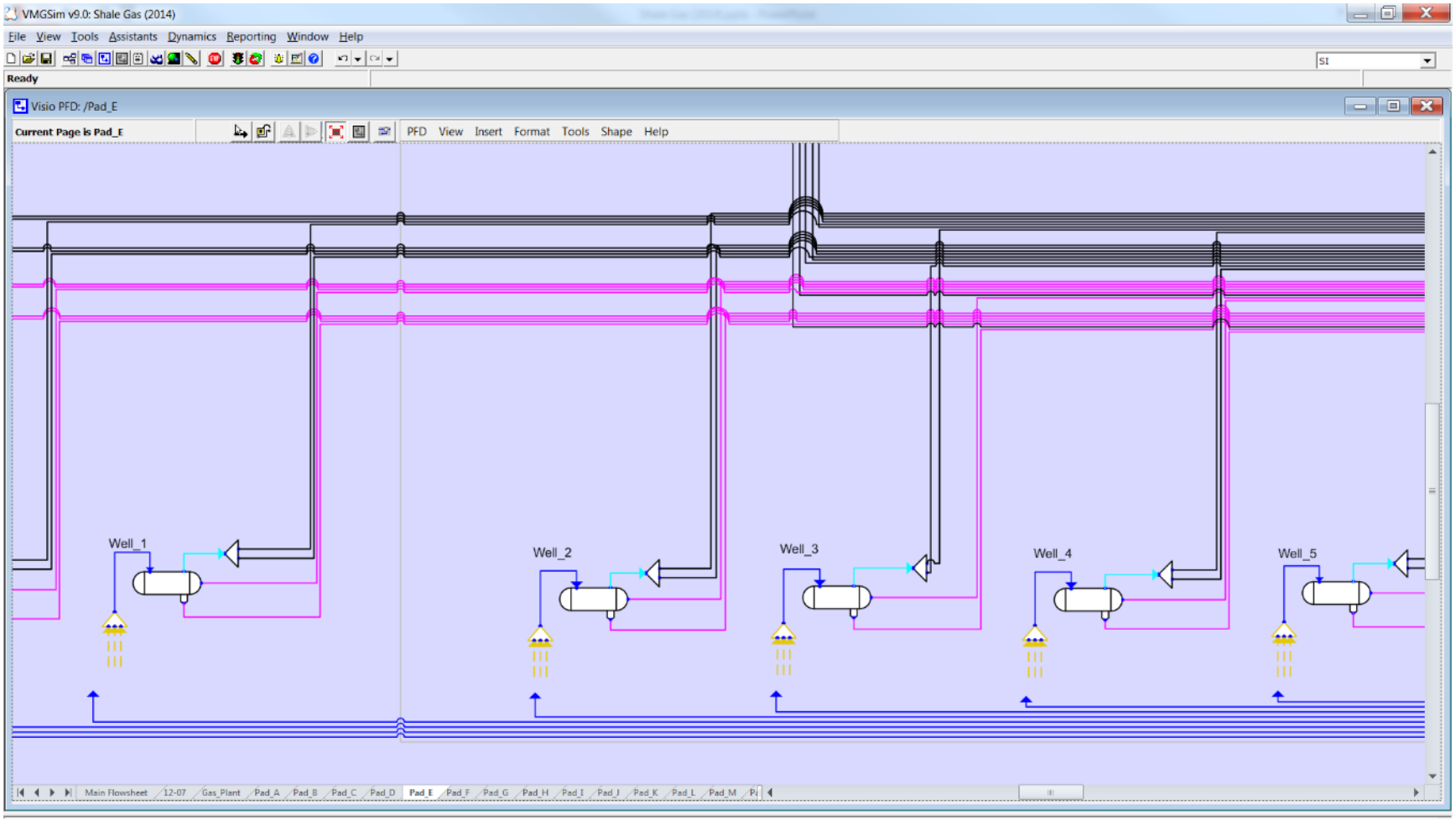
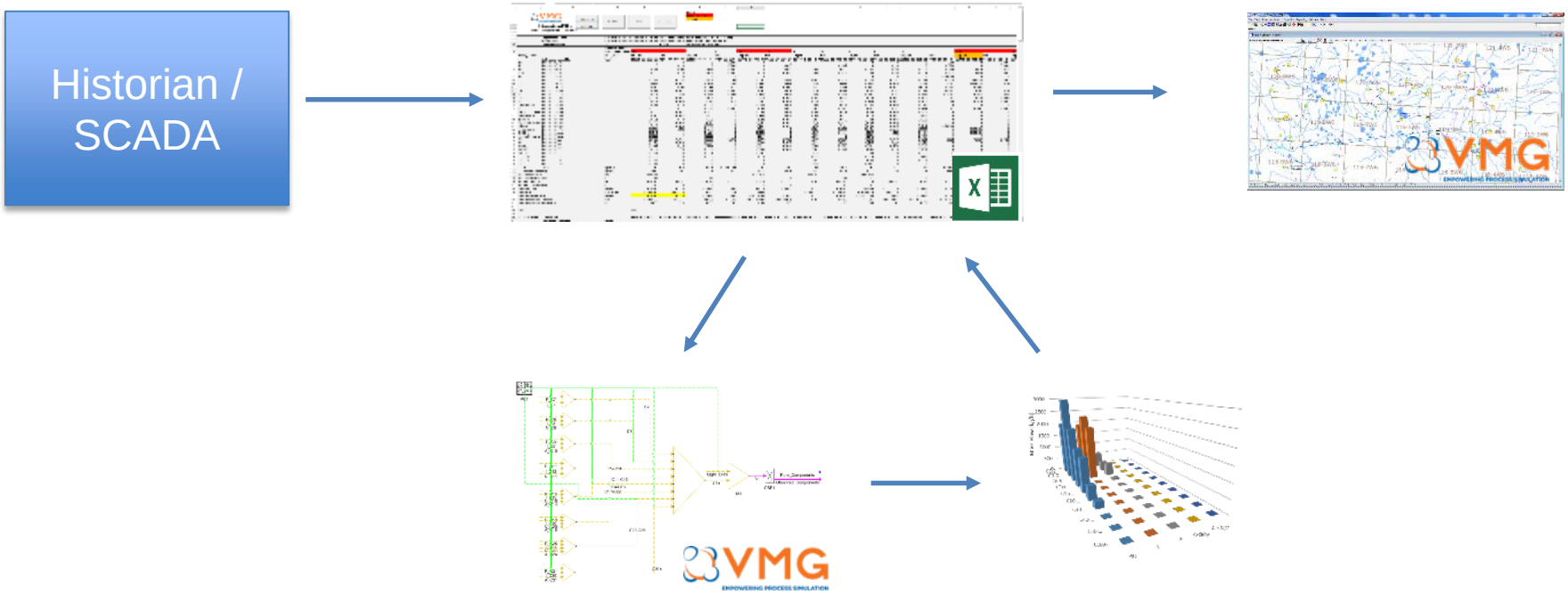


Field Composition Tracking

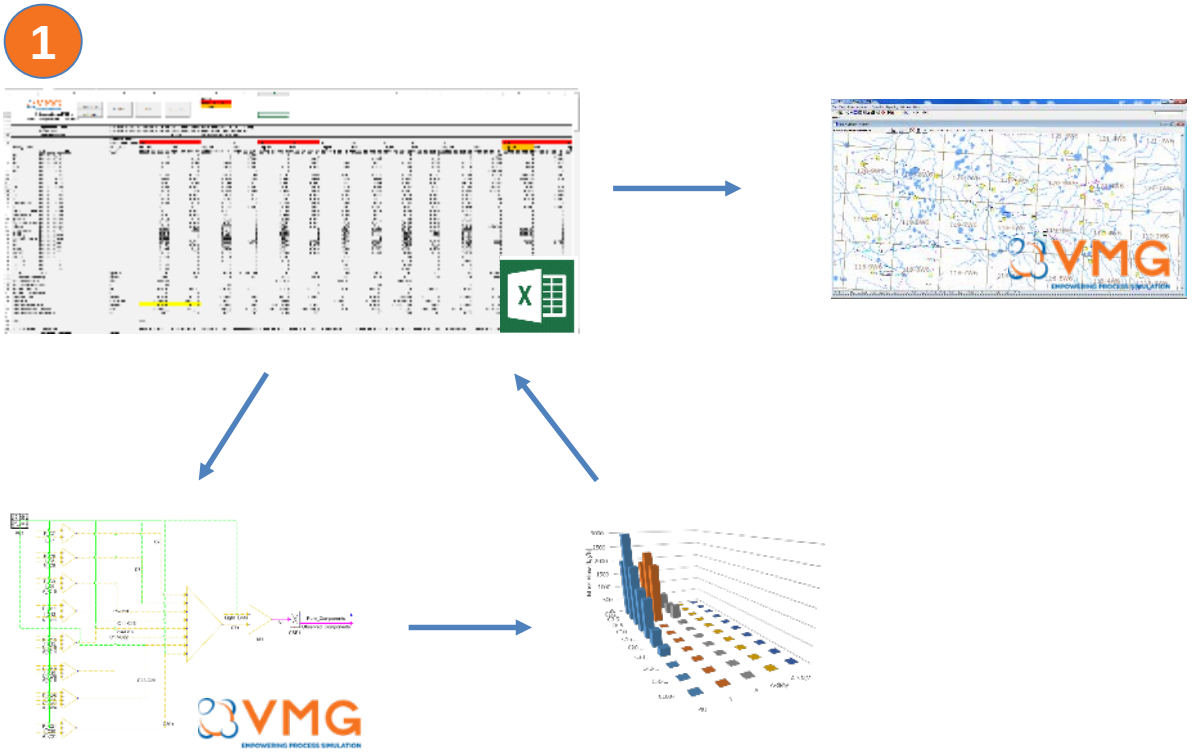
System automated to accommodate 100+ wells and facilities



Field Composition Tracking

System automated to accommodate 100+ wells and facilities

Historian / SCADA



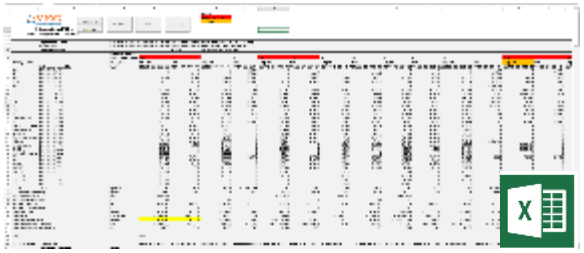
Systems coordinated and automated using central database to eliminate data entry.

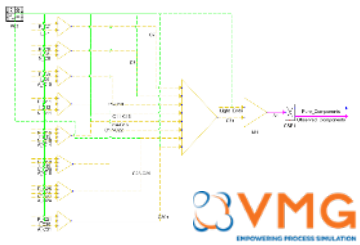
Field Composition Tracking

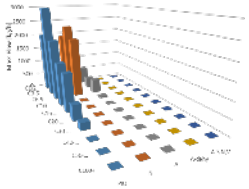
System automated to accommodate 100+ wells and facilities

Historian / SCADA

2





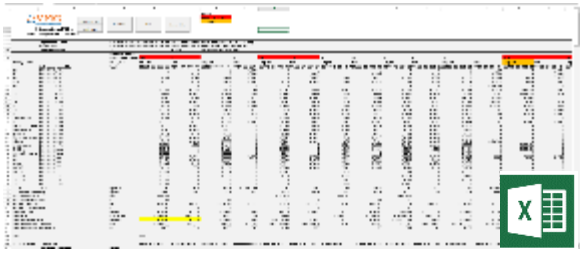


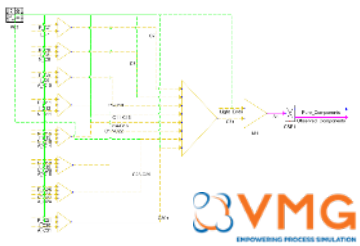
C30+ Analysis and operational data read into database

Field Composition Tracking

System automated to accommodate 100+ wells and facilities

Historian / SCADA





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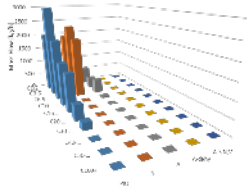

VMGSim used to translate C30+ analyses into common composition matrix

Field Composition Tracking

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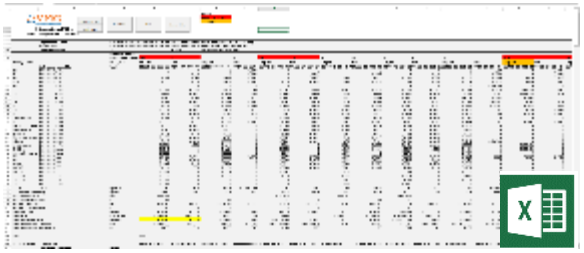

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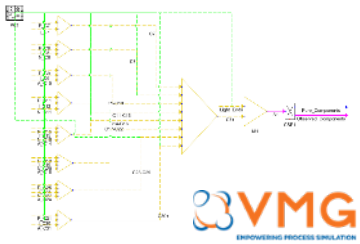
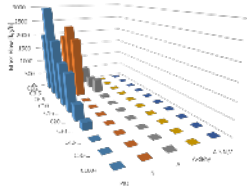
Data exported to simulation of field





Field Composition Tracking

Existing data used to track shale fluids throughout field

Information processed and distributed to business groups:

- Engineering - Design, troubleshooting
- Production - Scheduling, operating conditions, soft sensors
- Production accounting - Allocations, shrinkage
- Management - Field planning, product summary

Conclusion

- Shale fluids can be different to conventional fluids and can change with time.
- A system is needed that can categorise shale fluids and track the composition throughout the field to maximise the value of composition and production data
- Tracking composition and production data allows better decisions to be made based on, often, existing information.