Production Forecasting in the Age of Big Data in Oil & Gas industry

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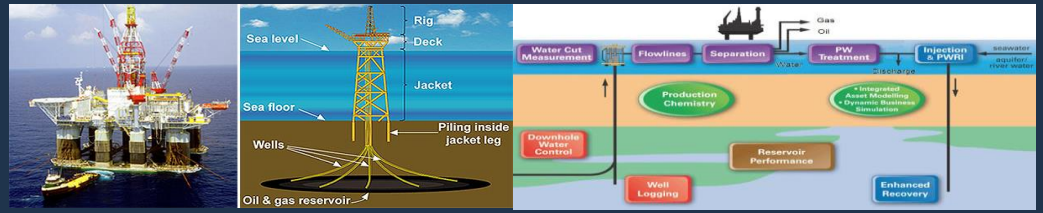
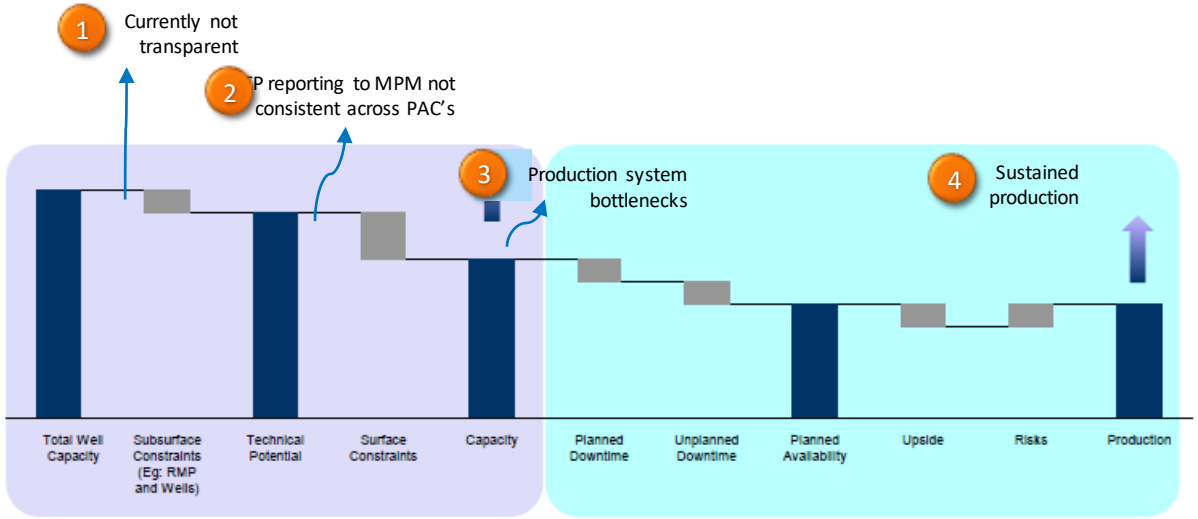


Technical Potential Forecasting

National Production Portfolio Management and why is TP important?



Ensuring standardization on TP definition allows systematic & focused review of existing key constraints

- Ideally, this is the rate at which we should be producing.
- However the production at sale point is significantly lower.
- This gap is created by efficiency of various processes through which the crude passes from wellhead to sale point and uptime of the system.
- The balance between maintaining peak efficiency of production system and uptime is directly proportional to delivery of technical potential.

Technical Potential Forecasting

Value of improving the TP forecasting accuracy

Existing Thinking

- Oil Forecast are still done using Decline Curve Analysis, A theory proposed by JJ Arps (1944).
- Forecasting adopted was Complex, dependent upon interaction of multiple variables
- Normal interpolation techniques applied did not plug gaps in Well Test data
- Measurement of Forecasting accuracy not a practice
- Forecasting Process was not automated

Opportunities

- Understanding the overall technical characteristics / patterns of Fields/Well with the Application of Analytics
- Adopt a system that shall automate the process of Short Term, Medium Term and Long Term Forecasting
- Forecasts & its Upside/Downside with Accuracy measurement an integral part of forecasting process
- Integration of structured and unstructured data from PD/UPD to enhance forecasts

Business Outcome

- Major Oil & Gas Operators, especially NOCs face decision that involve billions of dollars and thousands of lives essentially based on the production profiles.
- When it comes to short term (1-2 years) the accuracy of forecast is paramount since it could mean saving on a huge unnecessary investment.
- Downtimes can be preempted or delayed based on the overall production requirement

Technical Potential Forecasting

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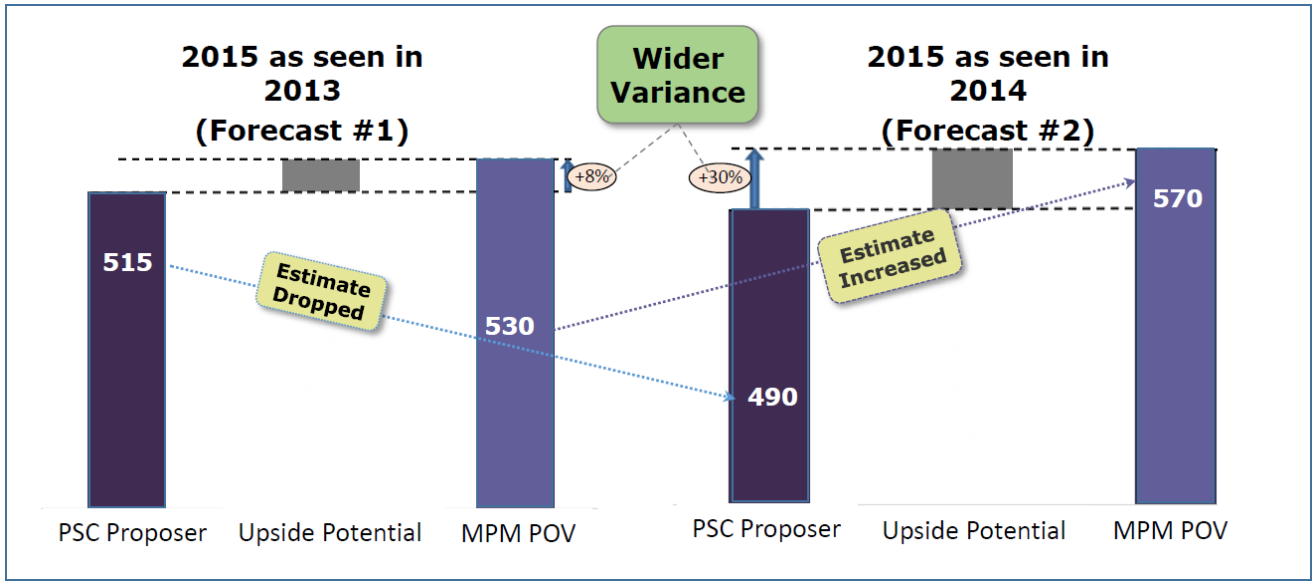
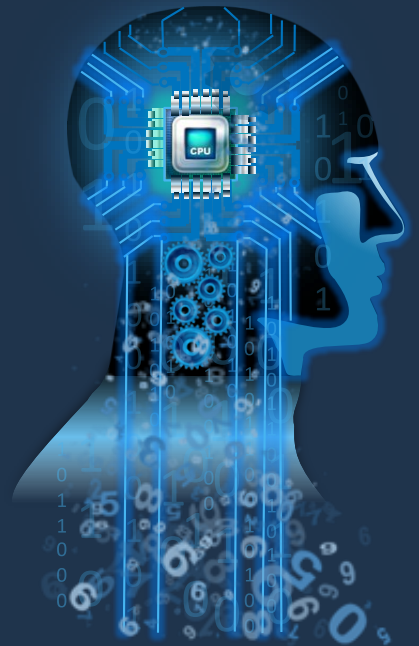
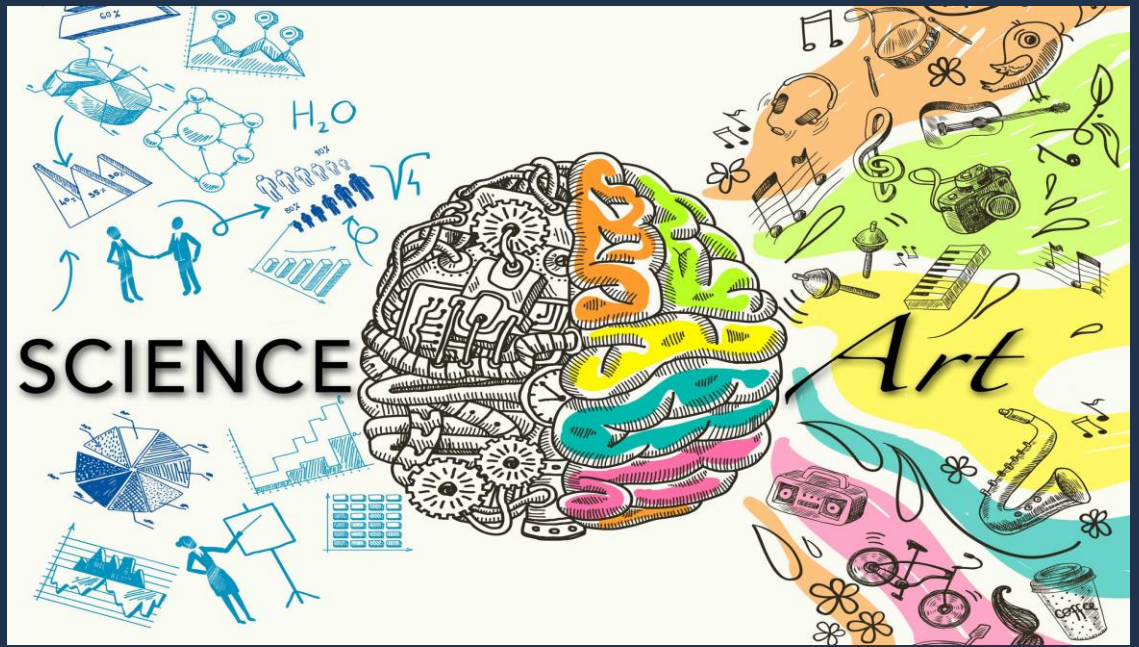


Note: Numbers are indicative only and do not reflect the actual/forecast figures

Forecasting

Science and Art





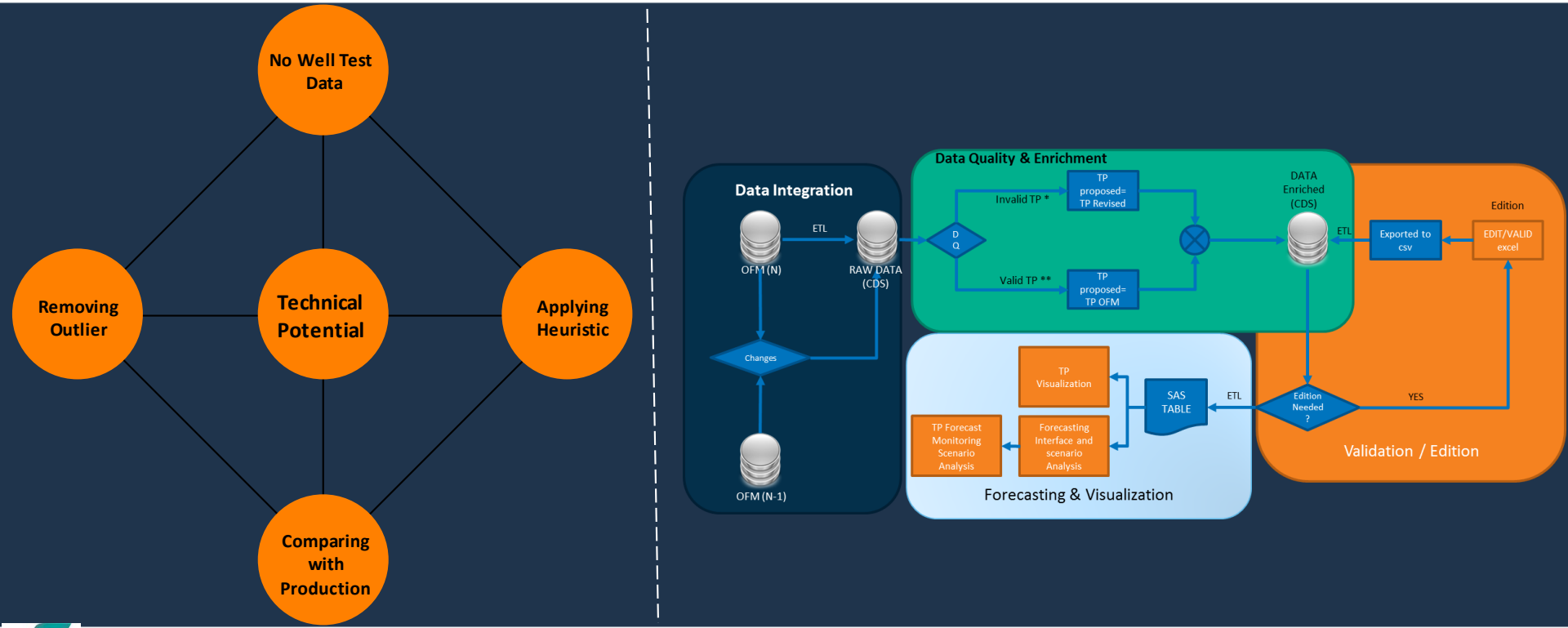
Technical Potential Forecasting

Considerations

- What is technical potential data?
- How do we build the time-series data?
- Understanding the time-series patterns?
- What do we want out of a production forecast? Long-term or short-term?
- Do we want to measure effect of X on Y? (scenario forecasting)
- What methods are out there to forecast/analyze them?
- How do we decide which method is best?
- How can we use SAS for all this?

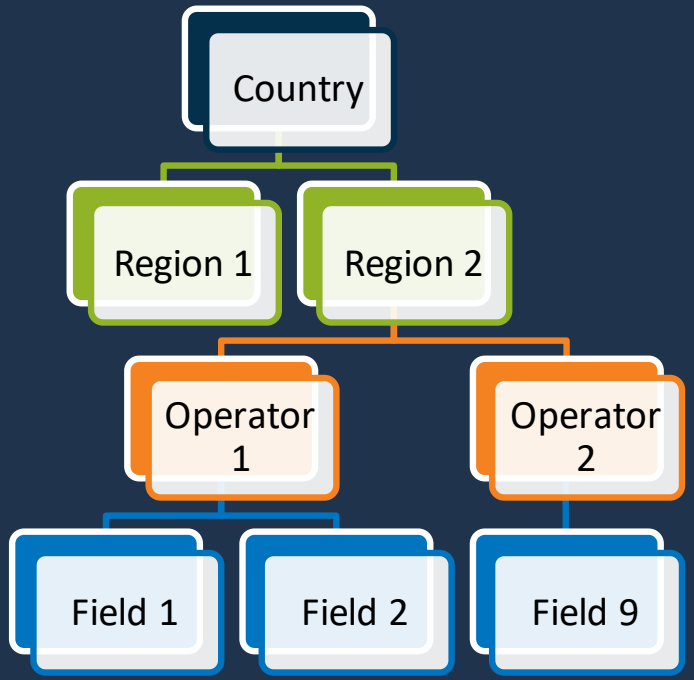
Forecasting

Building the Technical Potential

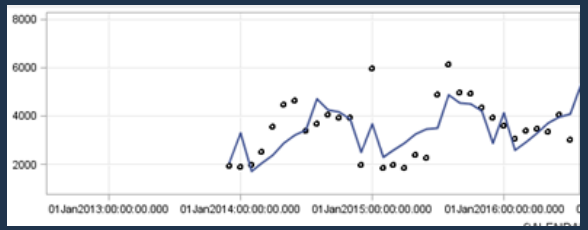


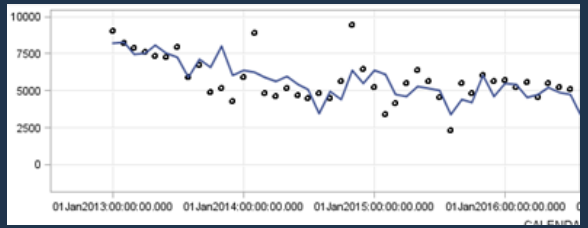
Forecasting

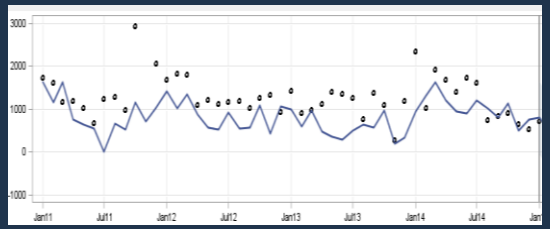
Building the Technical Potential



Technical Potential @ various Field Levels





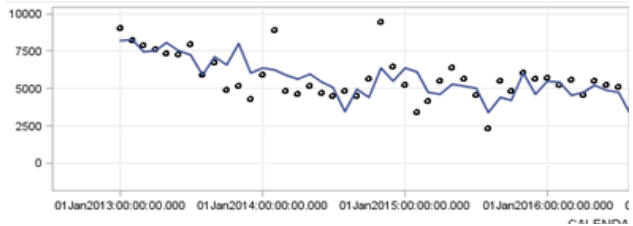


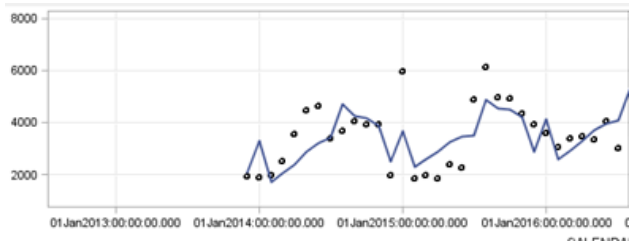
Technical Potential Forecasting

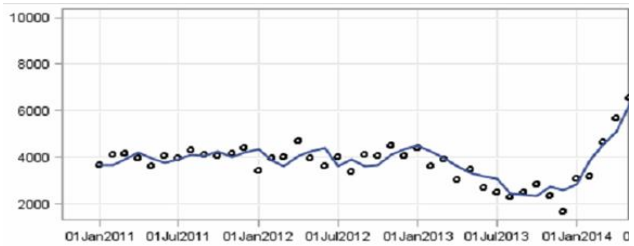
Time Series Patterns

Time series

Pattern







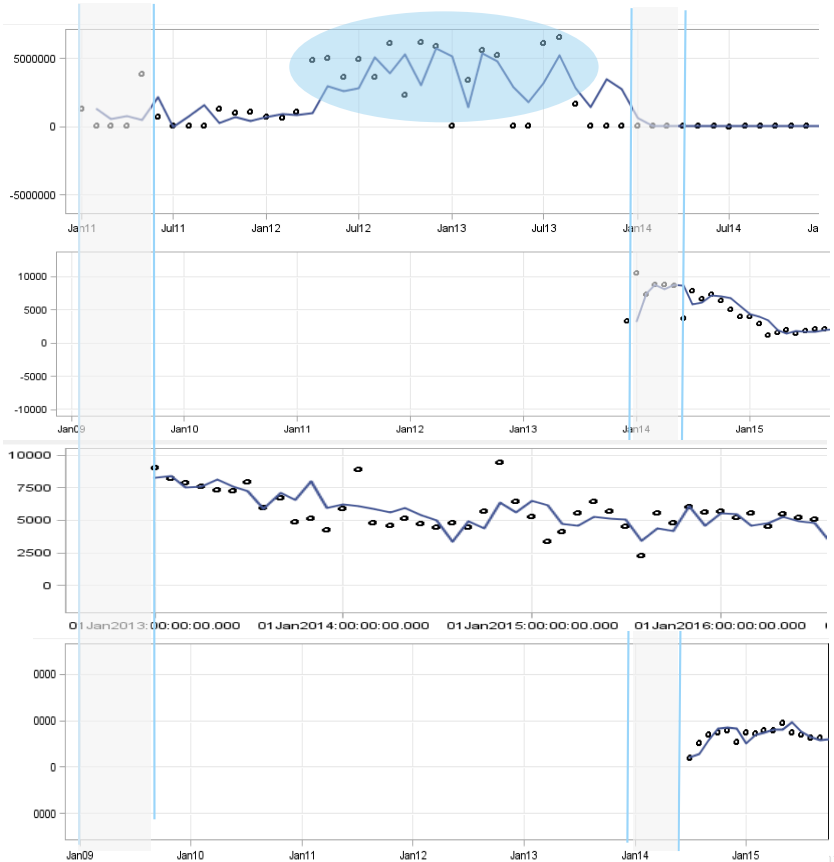
Trends + Outliers

Trend + Cyclic

Trend + Ramp Up

Technical Potential Forecasting

Time series Patterns



Data Quality

Very Short History

Long history +
Different Start Dates

Short History +
Different Start Dates

Technical Potential Forecasting

Time series modelling

ARIMA

- Analyzes and forecasts equally spaced univariate time series data, transfer function data and intervention data
- Using the Autoregressive integrated moving average or autoregressive moving average model
- Predicts a value in a response time series as a linear combination of its own past values, past errors (shocks or innovations) and current and past values of the other time series (ARIMAX Model)
- Divided into three stages – *identification, estimation & diagnostic checking and forecasting stage*

UCM

- Model decomposes into trends, cycles, and the regression effects of explanatory variables
- Provides variety of diagnostic tools to asses the fitted model and to suggest possible extensions or modifications
- Components of UCM provide the a succinct description of the underlying mechanism governing the timeseries
- Similar to the Dynamic Models, popular in Bayesian time series, captures the versatility of ARIMA and interpretability of Smoothing Models

Technical Potential Forecasting

Challenges and Integrating DCA

- Very Short History Modelling
- Benchmarking the results of ARIMA, UCM
- Time series with Large errors in ARIMA, UCM
- Lifecycle behaviour of fields

Loss Ratio:

$$D = -\frac{dq/dt}{q} \quad (1)$$

Derivative of the Loss Ratio:

$$b = \frac{d}{dt}\left(-\frac{1}{D}\right) \quad (2)$$

Arps equation:

$$q(t) = \frac{qi}{(1+bDit)^{1/b}}$$

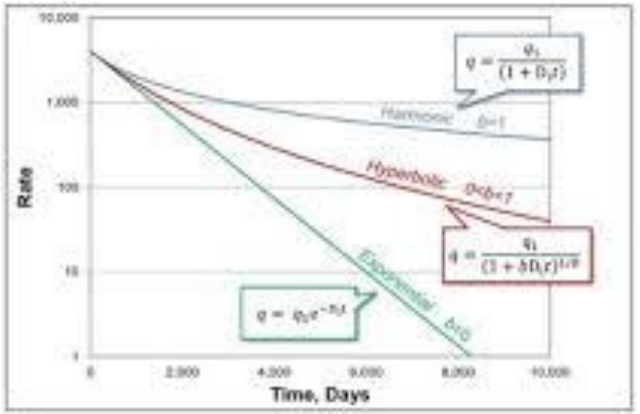
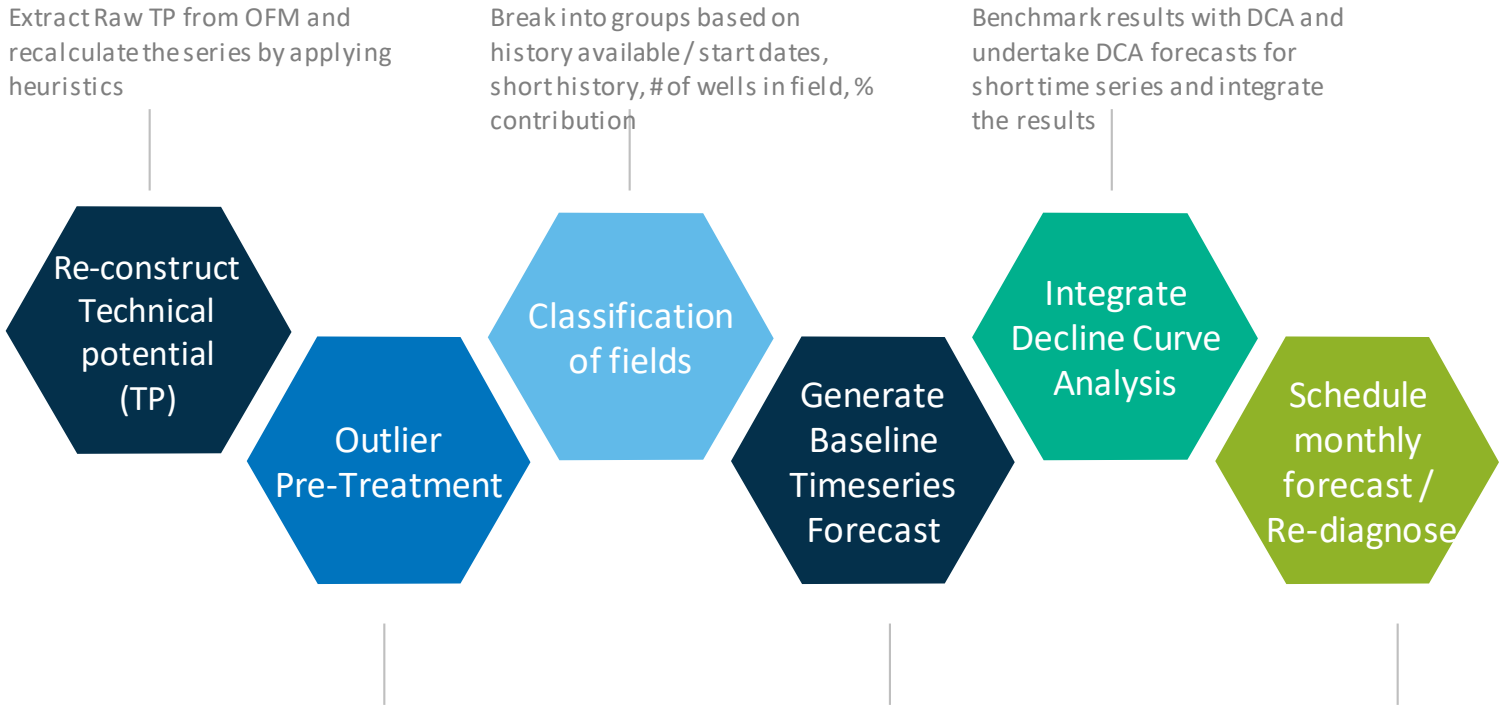


Figure. Arps' three types of decline and their formulas on a semi-log plot after Arps (1965).

Decline Curve Analysis

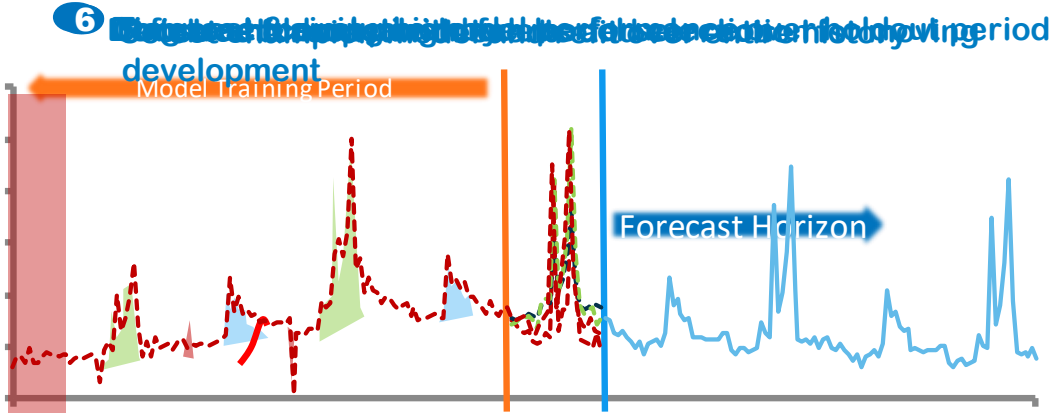
Technical Potential Forecasting

Overall Framework



Technical Potential Forecasting

Forecast Evaluation Method and Observed Accuracy



Error	
13.64%	Model1: *ARIMA*, f (History, Outliers, etc…)
11.05%	Model2: *ARIMAX*, f (History, Trends, Outliers, Predicting variables)
8.58%	Model3: *UCM*, f (History, Outliers, Trends, Cyclicity, Events, etc…)

Trend
Cyclicity
Seasonality
Causal Events
Outliers

$$M = \frac{100}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|,$$

where A_t is the actual value and F_t is the forecast value.

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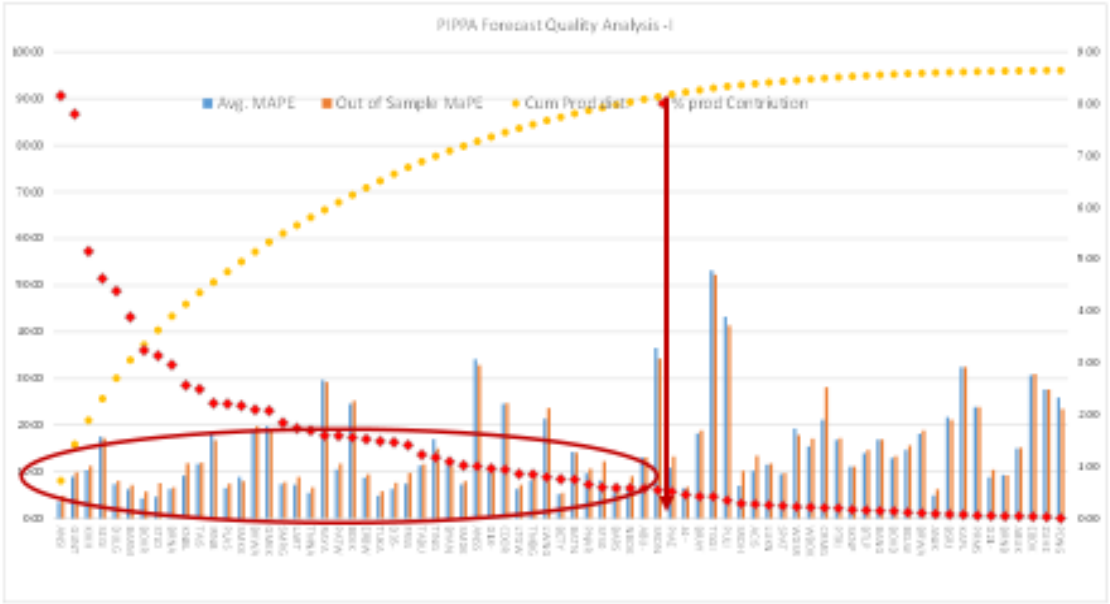

80% of the fields we achieved < 20% error in MAPE

Top 30 fields contributing 80% of production we achieved average < 10% error in MAPE

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