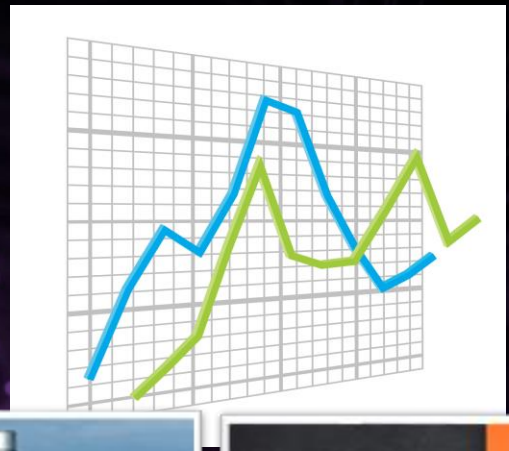
# LP accuracy – Best Practices




Presented By : Anwar Tatariya

AVEVA

# About IZZI Business Services LLP

- IZZIBS is a proficient business consulting and implementation service provider.
- Providing solutions & services to Energy Industry clients since January 2016.
- Stands firm on pillars of moral values and ethical business practices.
- Founded and lead by qualified professional with 22+ years multi disciplinary Refinery and Petrochem experience.
- All sales and services staff are qualified and experienced Chemical Engineers.
- Registered as LLP with Government of India.

# IZZIBS – Petroleum Business Domain Expertise


- Planning and Optimization using LP
- Refinery and Petrochemical Scheduling
- Blending Optimization
- Jetty / Dock Scheduling
- Process Simulation and Modelling
- Energy Management and Optimization
- MES Solution – Dashboards, KPI, Report Automation, Notifications
- Profit Improvement studies / Consulting Assignments

# IZZIBS – Our Partners & Clients

## Implementation Partners

- AVEVA
- Shell Global Solutions
- Accenture
- Tech Mahindra
- Wipro
- Jaaji Technologies
- Trust Technical Services

## End Clients Served

- Marathon Petroleum Corp., USA
- ADNOC Refining, UAE
- Petronas, Malaysia
- Petro Rabigh, Saudi Arabia
- OQ, Oman
- IOCL, India
- ZPC, China
- Bangchak Refinery, Thailand
- Astron Energy, South Africa
- YASREF, Saudi Arabia
- Nayara Energy, India

# Outline

Current Problems with LP Accuracy

Why LP Accuracy Matters

Current Industry Practices

Recommended new Best Practice

Conclusion and Summary

# Current Problems with LP Accuracy

# The Problem Definition

A good LP structure does not mean that the LP matches the plant actual performance.

| | | | | | |
|---|---|---|---|---|---|
| | | | | ☑ | ☑ |
| | | | Name | Feed Carbon Residu... | Feed UOPK (none) |
| | | | Property | Carbon Residue (MC... | UOPK |
| | | | Stream | | |
| | | | UoM | % | none |
| | | | Type | Property | Property |
| | | | Base | 0.0000 | 0.0000 |
| | | | Step | 1.0000 | 1.0000 |
| Active | Name | Base | Offset | | |
| ☑ | RFCC H2S Yield (wgt) | 0.1100 | 0.0000 | 0.0020 | 0.0080 |
| ☑ | RFCC Off-gas Yield (... | 3.7900 | 0.0000 | 0.0010 | 0.0090 |
| ☑ | RFCC C3S Yield (wgt) | 1.0800 | 0.0000 | 0.0150 | -0.0050 |
| ☑ | RFCC Propylene Yield... | 10.7100 | 0.0000 | 0.0012 | 0.0088 |
| ☑ | RFCC C4 Yield (wgt) | 14.1000 | 0.0000 | 0.0013 | 0.0087 |
| ☑ | LFG Yield (wgt) | 17.2900 | 0.0000 | -0.0120 | 0.0220 |
| ☑ | HFG Yield (wgt) | 22.3300 | 0.0000 | -0.0025 | -0.0125 |
| ☑ | LCO Yield (wgt) | 17.5100 | 0.0000 | 0.0026 | -0.0075 |
| ☑ | CLO Yield (wgt) | 5.7700 | 0.0000 | -0.0024 | -0.0124 |
| ☑ | Coke-on-Catalyst Yiel... | 7.3100 | 0.0000 | -0.0062 | -0.0192 |

**RFCC Yields - LP vs Actual (Wt%)**

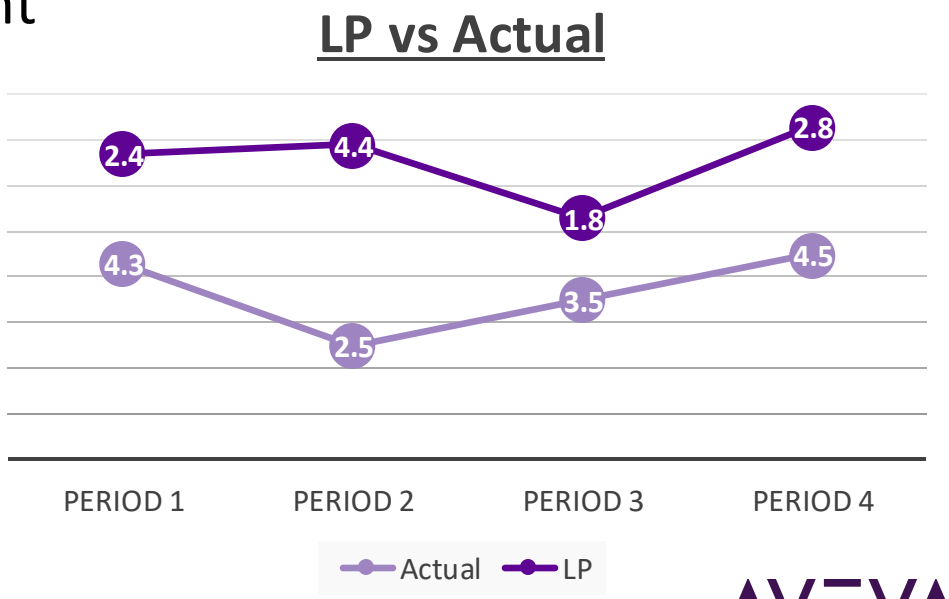
| Stream | Actual | LP | Delta | Delta % |
|---|---|---|---|---|
| RFCC H2S | 0.53 | 0.11 | 0.42 | 79.64% |
| RFCC Off-gas | 5.79 | 3.79 | 2.00 | 34.51% |
| RFCC C3S | 1.17 | 1.08 | 0.09 | 7.80% |
| RFCC Propylene | 10.65 | 10.71 | -0.06 | -0.57% |
| RFCC C4 | 14.87 | 14.10 | 0.77 | 5.18% |
| LFG | 18.15 | 17.29 | 0.86 | 4.74% |
| HFG | 18.58 | 22.33 | -3.75 | -20.19% |
| LCO | 14.21 | 17.51 | -3.30 | -23.22% |
| CLO | 7.59 | 5.77 | 1.82 | 23.93% |
| Coke-on-Catalyst | 8.46 | 7.31 | 1.15 | 13.62% |



AVEVA

# The reasons behind LP Prediction v/s Actual Differences

- Catalyst Activity changes over time
- Change in operational modes
- Technical problems in the units imposing operational constraints
- Structural modification / revamp in the plant
- Seasonal / Upgraded Product specifications
- Stringent Environmental Regulations



# Why are the differences not Fixed regularly?

In over-constrained work environment, LP accuracy does not get the attention it deserves.

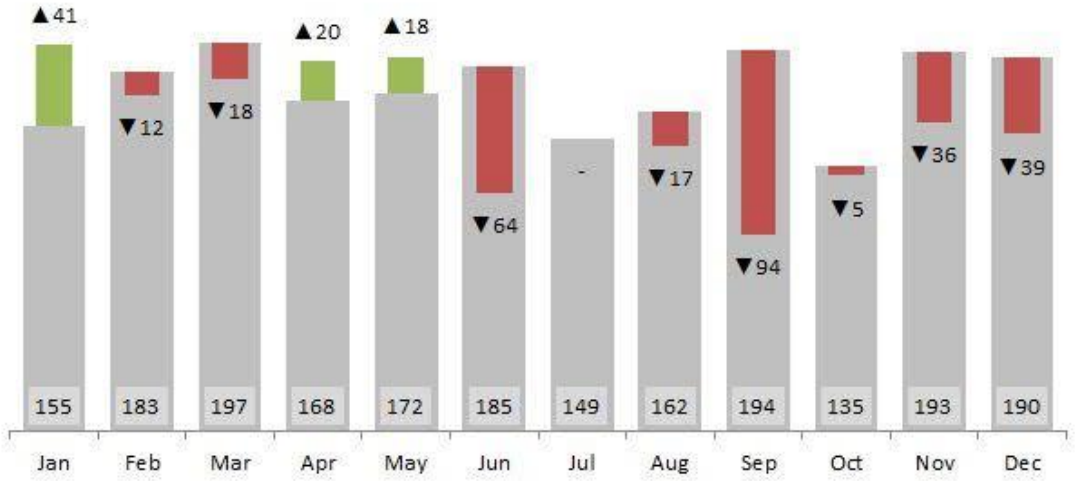
- Planners always busy:
  - Monthly operations planning.
  - Strategic and Commercial planning.
  - Special projects and investment runs.
- Process engineers are also very busy.
- Staff rotations and Retirement resulting in loss of expertise.

Everyone is very busy, and nobody has **time**!

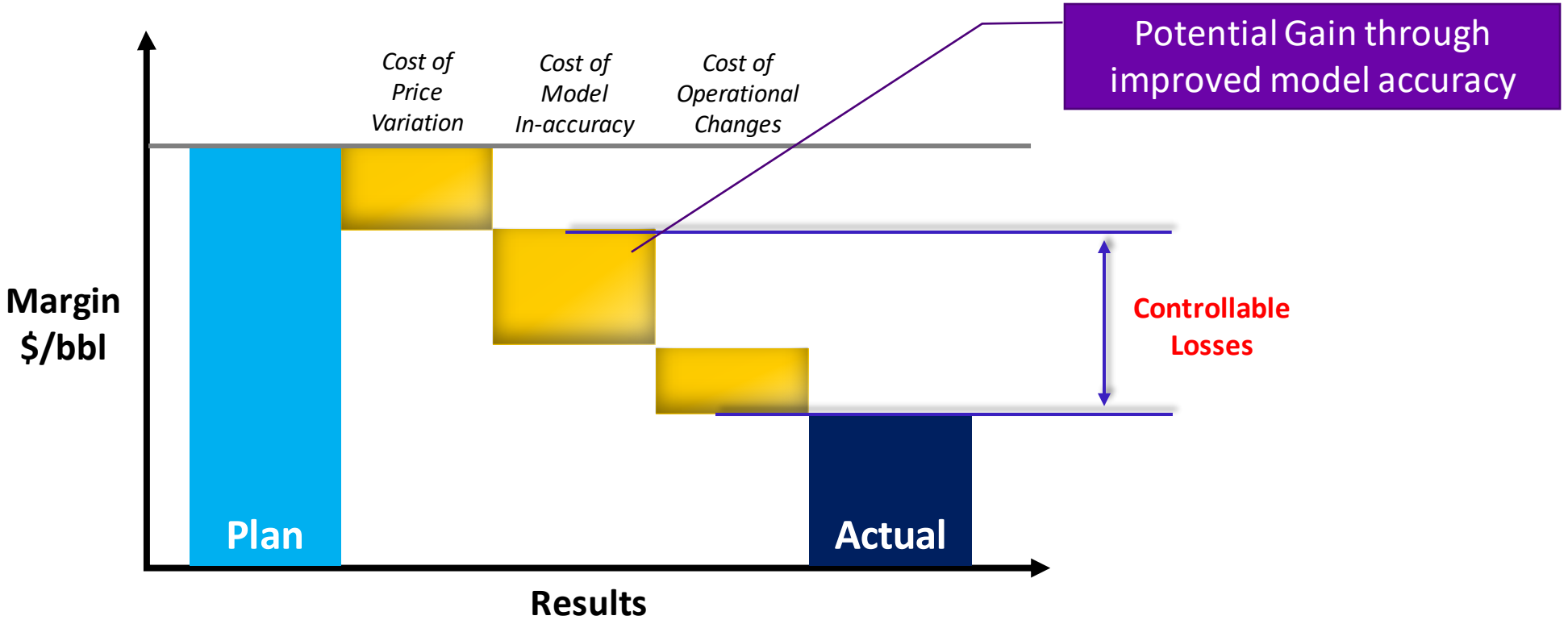
# Why LP Accuracy Matters

# Consequences of Inaccurate LP Models

- Errors in LP model leads to incorrect economic decisions:
  - Incorrect Crude feed selection
  - Under or over utilization of available unit capacities
  - Incorrect product make decisions
  - Incorrect Intermediate feeds optimization
- **Result is sub-optimal planning decisions**



# The Cost of Model In-accuracy




**Accurately** captured economic drivers results in right business decisions

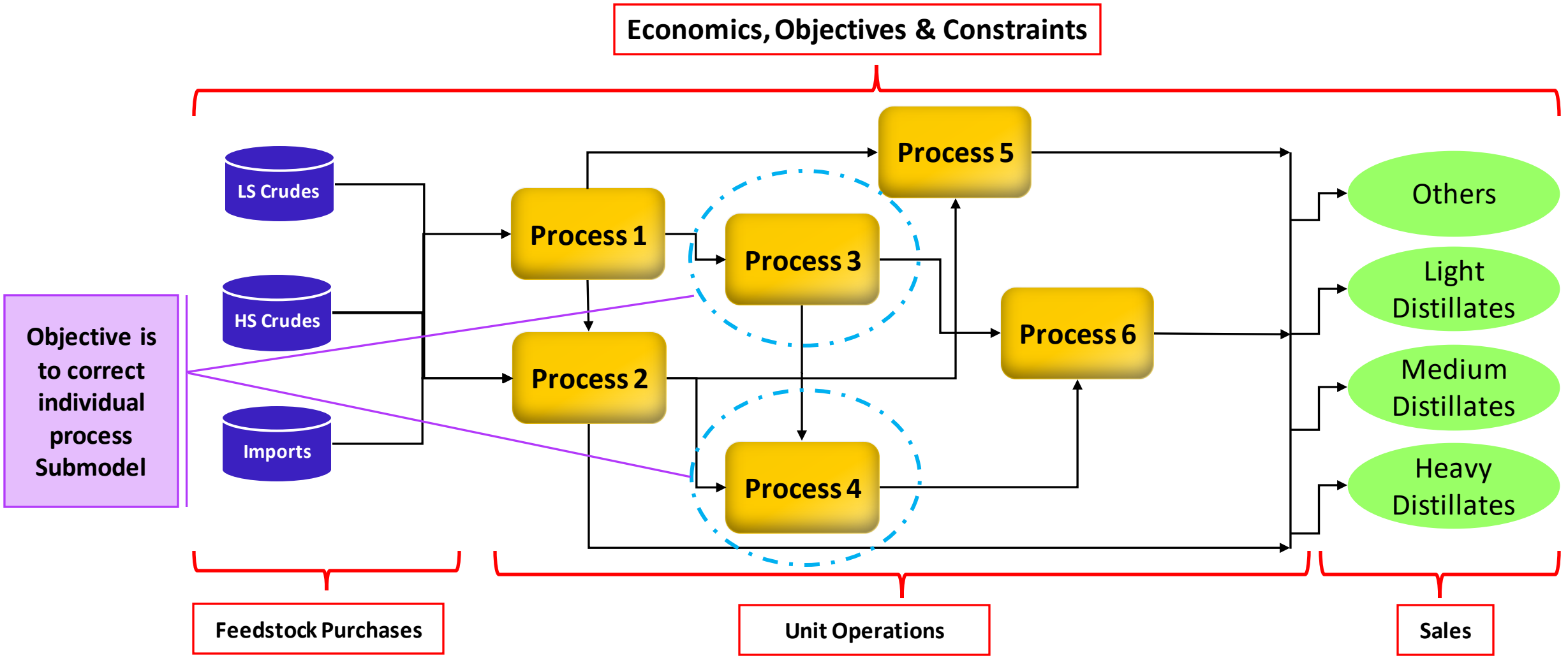
# Cost of Inaccurate LP Models

- The value of planning model accuracy can be quite significant:
  - A midrange value of 0.50 US$/BBL for a 300 thousand bpd refinery results in a savings of over 50 million dollars a year.
  - This figure is large because that can be due to incorrect feedstock selection during monthly operating plans with shutdown / slowdowns

| Accuracy | US$/BBL |
|---|---|
| Similar crudes | 0.10 - 0.25 |
| Different types of crude | 0.25 - 0.50 |
| Major shift in operations | 0.50 - 1.00 |

# Current Industry Practices

# Submodel-based Approach



# Current Industry Practices

## Back-Casting using LP / Retro Analysis

- Time consuming work process
- Based on aggregated data (say monthly average)
- Entire refinery optimization – so hard to pinpoint causes of mismatches

| HDS | Actual | | LP | | diff | |
|---|---|---|---|---|---|---|
| | t/d | %wof | t/d | %wof | t/d | %wof |
| HDS Feed | 7270 | | 7128 | | -142 | |
| H2 Consumption | 34 | 0.5 | 48 | 0.7 | 14 | 0.20 |
| Total Feed | 7303 | | 7175 | | | |
| Off gas | 85 | 1.2 | 33 | 0.5 | -52 | -0.71 |
| Naphtha | 270 | 3.7 | 112 | 1.6 | -158 | -2.13 |
| Kero | 882 | 12.1 | 1027 | 14.6 | 145 | 2.54 |
| LGO | 612 | 8.4 | 612 | 8.5 | 0 | 0.15 |
| HGO | 5455 | 74.7 | 5370 | 74.8 | -85 | 0.15 |
| Total Product | 7303 | | 7154 | | | |

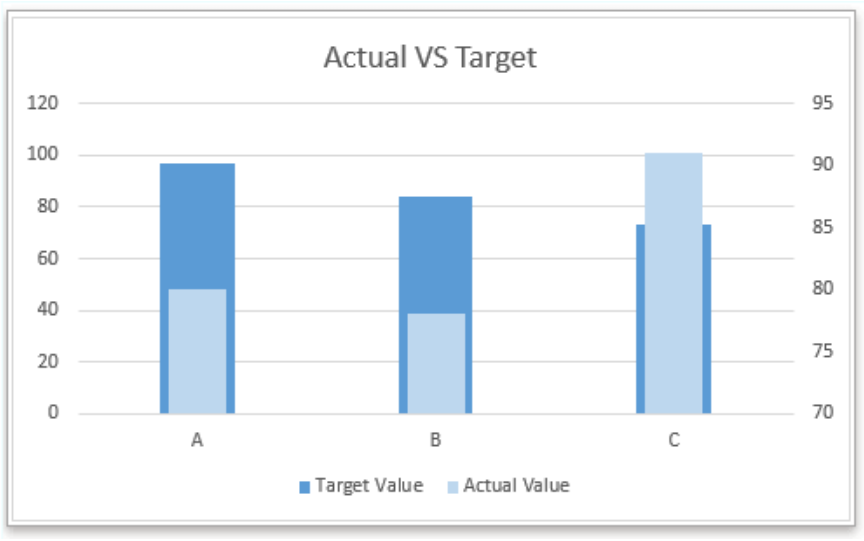


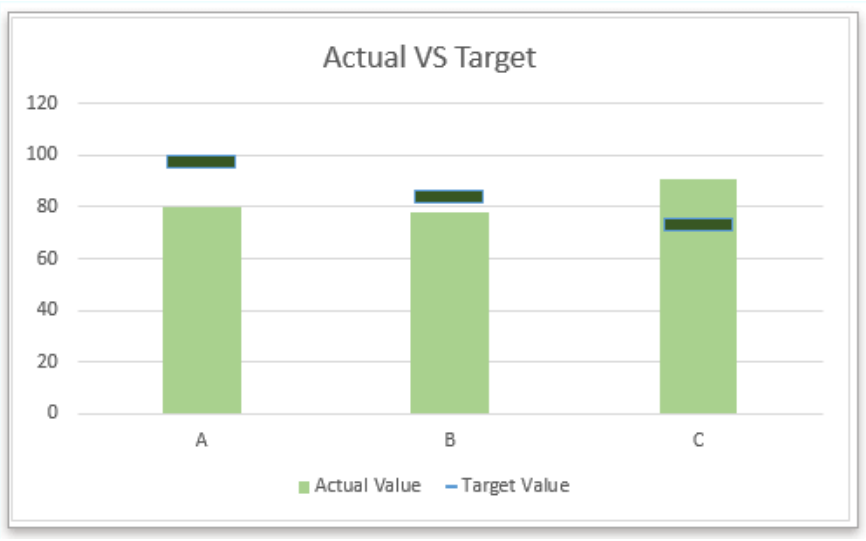
AVEVA

# Current Industry Practices

## Process Engineer's monitoring

- Periodically monitor plant yields and compare the aggregated values against monthly plan yields.
- Use of monthly / period average Production Accounting yields
- Dependent on usage of Production Accounting models for yield reconciliation
- Effect of unit feed quality change on product yields and quality cannot be captured.
- Excel based and person dependent process - Different process engineers for different units

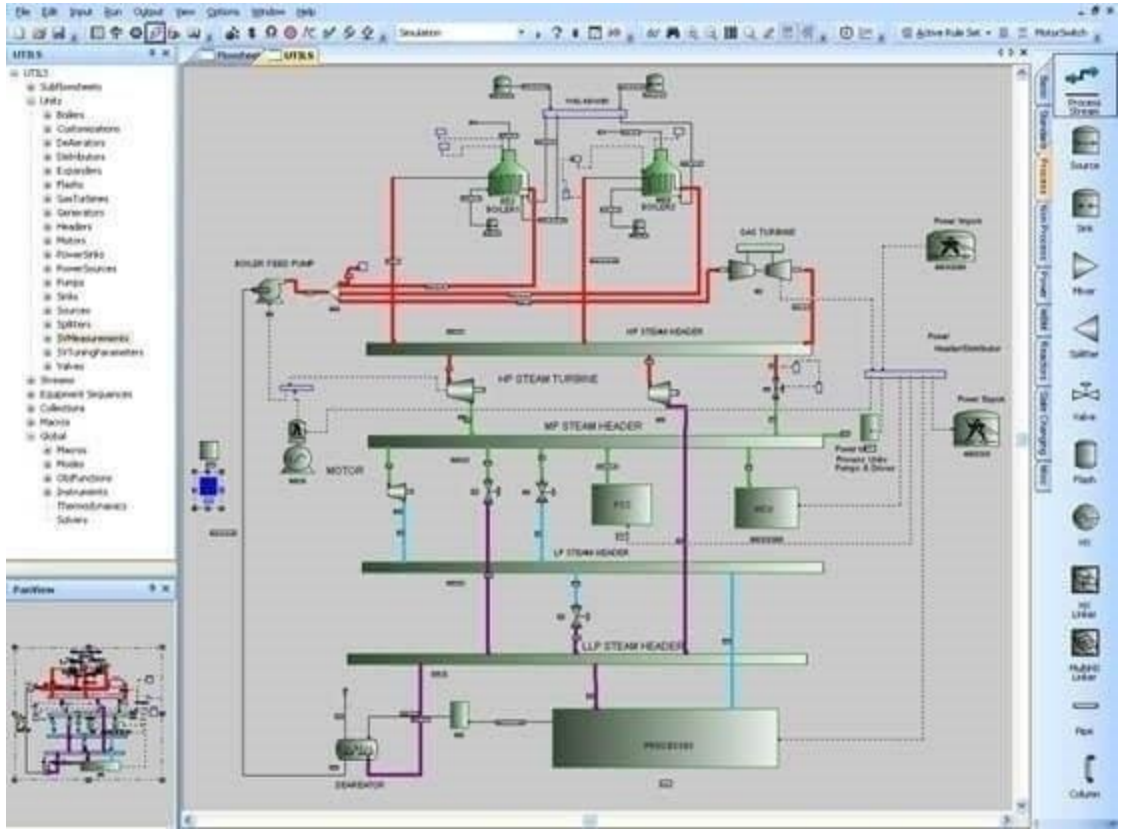


# Current Industry Best Practice

## Use of Process simulation Tool

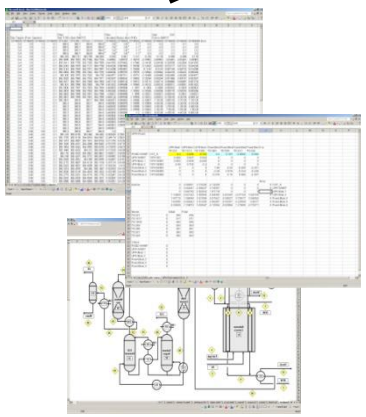
- Use of Rigorous Simulation tools to generate LP vectors
- Require plant test runs and process model recalibration
- Generate base and delta vector from recalibrated models
- Normal Update frequency is once in a year or few years
- Highly time consuming & person dependent process



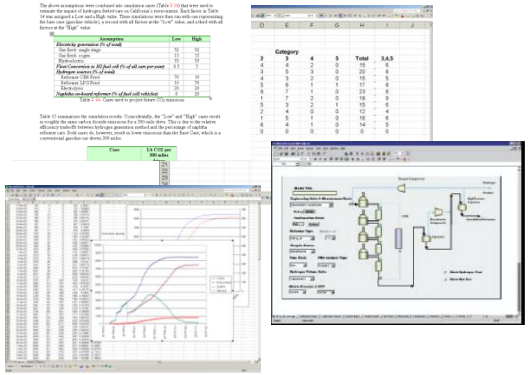
# Current Non-Sustainable Approach

- Many different work processes
- Many different Excel sheets
- Difficult for LP modeler to update

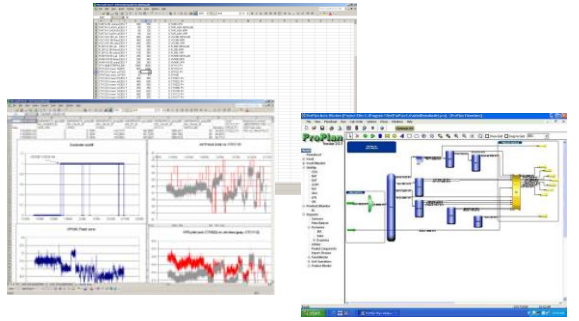
**PLANNER**



Vector update for FCC submodel



Vector update for Catalytic Reformer submodel



Vector update for Hydrotreater submodel



AVEVA

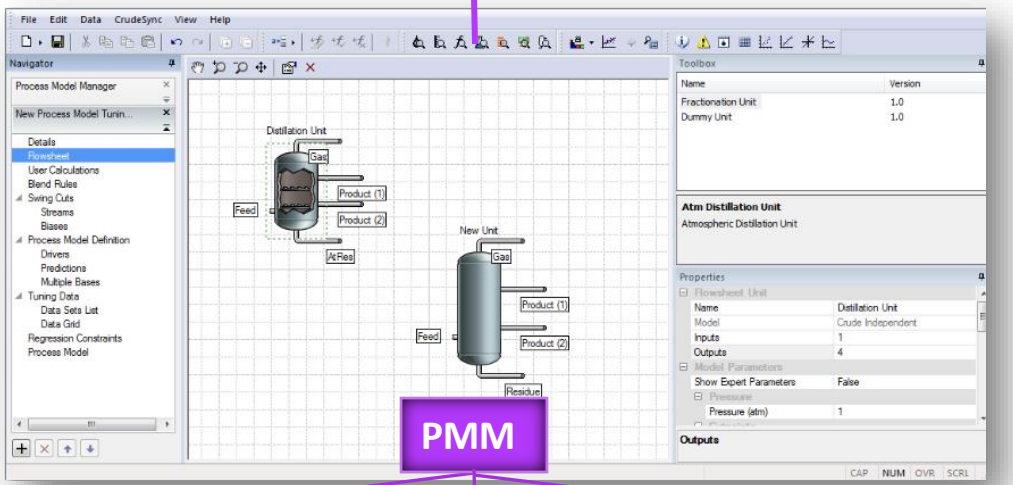
# Recommended new Best Practice

# Sustainable New Approach

**PLANNER/SCHEDULER**

- Single work process
- Off The Shelf application
- System dependency

Derived vectors for base-delta structure can be used in Planning & Scheduling models




Input data set representing actual plant condition

Add required drivers & predictions for base-delta structure

Regress the data and analyze the results

# A New Best Practice

## Process Model Manager (PMM)

- PMM can be used to create and update Base-delta process submodels.
- Actual measurements of the properties and utilities from plants are entered using Data Sets.
- A single PMM case generally contain many Data Sets reflecting different operational conditions.
- After regression, we can export Base-delta models to use in other software like LP optimizer.
- Part of AVEVA Unified Supply Chain (AUSC) Suite:
  - Easy to share model, maintain traceability and version control;
  - standard modeling in planning and scheduling ensures consistent decision making
  - easier maintenance and reduces plan vs. schedule differences

Make it system dependent and not person dependent

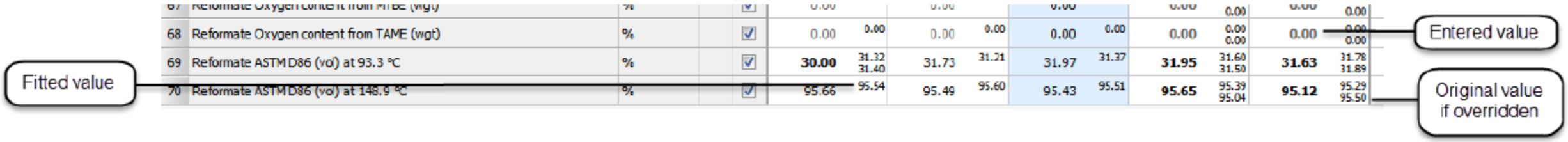


AVEVA

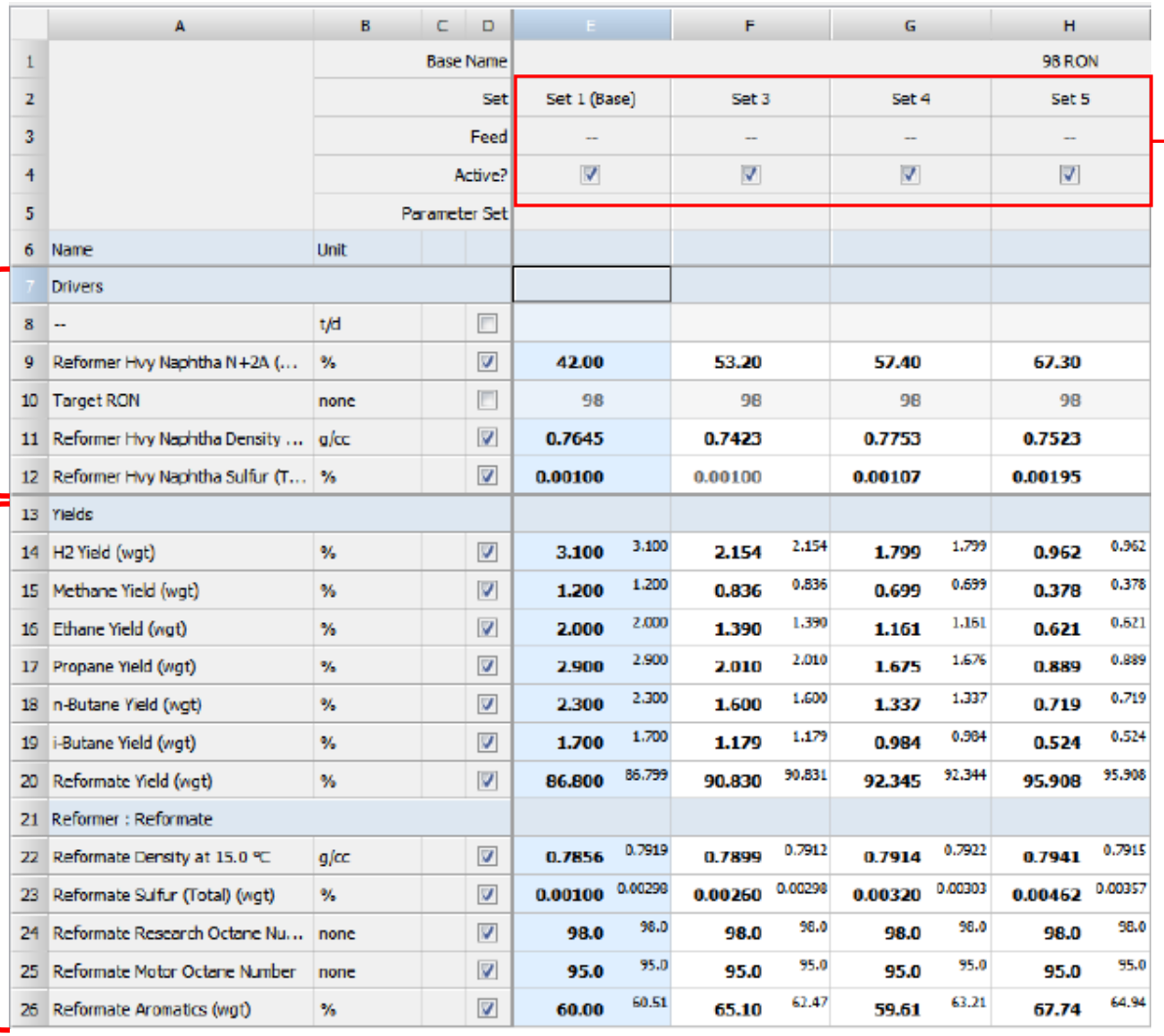
# Process Model Manager (PMM)

## Key features :

- Allow users to easily work with large data sets collected across time and under multiple conditions from plant data
- Ability to regress in various UOMs or blend indices, which helps in building more accurate models
- Supports multi-base models which increases accuracy for non-linear processes
- Easy to use and user-friendly UI for accurate base delta vector generation
- Powerful visualization helps in highlighting problem data by considering input data sets and output model results after regression



# Process Model Manager (PMM) – Input Data Grid



| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | | Base Name | | | | | | 98 RON |
| 2 | | Set | | | Set 1 (Base) | Set 3 | Set 4 | Set 5 |
| 3 | | Feed | | | -- | -- | -- | -- |
| 4 | | Active? | | | ☑ | ☑ | ☑ | ☑ |
| 5 | | Parameter Set | | | | | | |
| 6 | Name | Unit | | | | | | |
| 7 | Drivers | | | | | | | |
| 8 | -- | t/d | | ☐ | | | | |
| 9 | Reformer Hvy Naphtha N+2A (... | % | | ☑ | 42.00 | 53.20 | 57.40 | 67.30 |
| 10 | Target RON | none | | ☐ | 98 | 98 | 98 | 98 |
| 11 | Reformer Hvy Naphtha Density ... | g/cc | | ☑ | 0.7645 | 0.7423 | 0.7753 | 0.7523 |
| 12 | Reformer Hvy Naphtha Sulfur (T... | % | | ☑ | 0.00100 | 0.00100 | 0.00107 | 0.00195 |
| 13 | Yields | | | | | | | |
| 14 | H2 Yield (wgt) | % | | ☑ | 3.100 3.100 | 2.154 2.154 | 1.799 1.799 | 0.962 0.962 |
| 15 | Methane Yield (wgt) | % | | ☑ | 1.200 1.200 | 0.836 0.836 | 0.699 0.699 | 0.378 0.378 |
| 16 | Ethane Yield (wgt) | % | | ☑ | 2.000 2.000 | 1.390 1.390 | 1.161 1.161 | 0.621 0.621 |
| 17 | Propane Yield (wgt) | % | | ☑ | 2.900 2.900 | 2.010 2.010 | 1.675 1.676 | 0.889 0.889 |
| 18 | n-Butane Yield (wgt) | % | | ☑ | 2.300 2.300 | 1.600 1.600 | 1.337 1.337 | 0.719 0.719 |
| 19 | i-Butane Yield (wgt) | % | | ☑ | 1.700 1.700 | 1.179 1.179 | 0.984 0.984 | 0.524 0.524 |
| 20 | Reformate Yield (wgt) | % | | ☑ | 86.800 86.799 | 90.830 90.831 | 92.345 92.344 | 95.908 95.908 |
| 21 | Reformer : Reformate | | | | | | | |
| 22 | Reformate Density at 15.0 °C | g/cc | | ☑ | 0.7856 0.7919 | 0.7899 0.7912 | 0.7914 0.7922 | 0.7941 0.7915 |
| 23 | Reformate Sulfur (Total) (wgt) | % | | ☑ | 0.00100 0.00298 | 0.00260 0.00298 | 0.00320 0.00303 | 0.00462 0.00357 |
| 24 | Reformate Research Octane Nu... | none | | ☑ | 98.0 98.0 | 98.0 98.0 | 98.0 98.0 | 98.0 98.0 |
| 25 | Reformate Motor Octane Number | none | | ☑ | 95.0 95.0 | 95.0 95.0 | 95.0 95.0 | 95.0 95.0 |
| 26 | Reformate Aromatics (wgt) | % | | ☑ | 60.00 60.51 | 65.10 62.47 | 59.61 63.21 | 67.74 64.94 |

Multiple Data sets

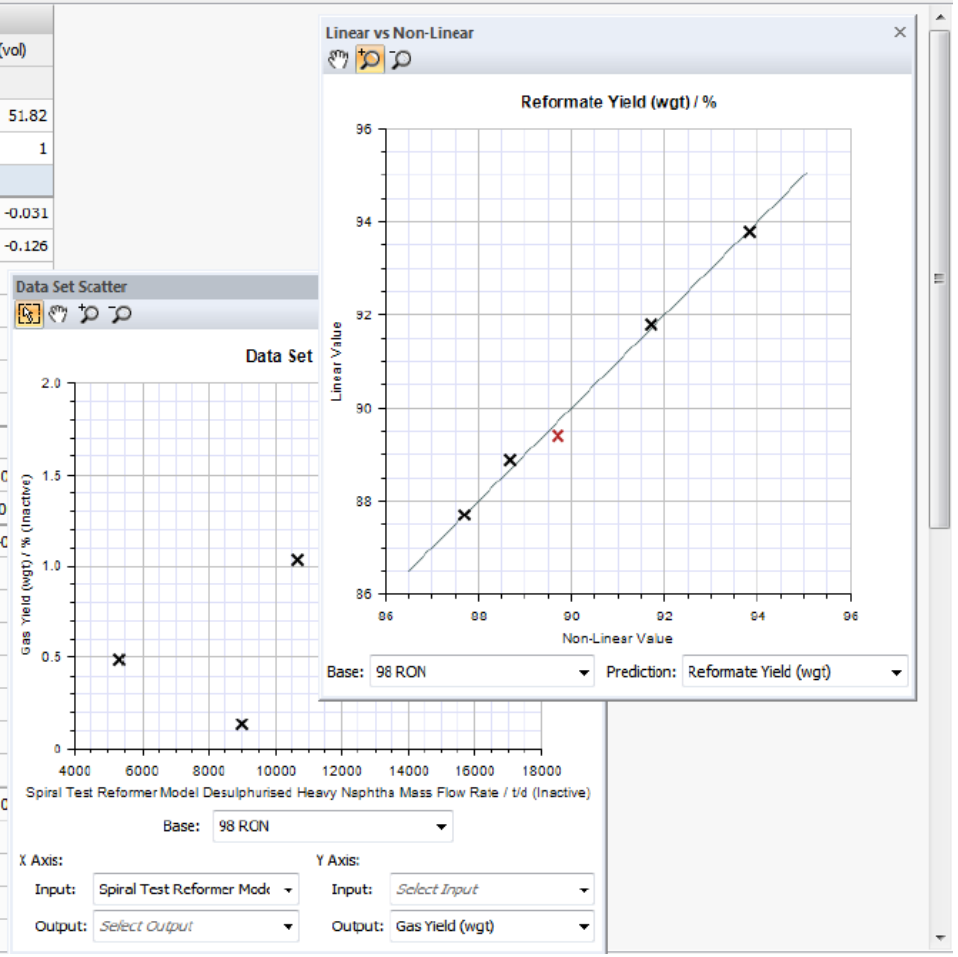
Drivers

Yields & Property Predictions

# Process Model Manager (PMM) – Regressed data analysis

98 RON | 100 RON | 102 RON

| | A | B | C | D | E | I |
|---|---|---|---|---|---|---|
| 1 | | | | | Driver Name | N+2A (vol) |
| 2 | | | | | Driver Unit | % |
| 3 | | | | | Base Value | 51.82 |
| 4 | | | | | Step Size | 1 |
| 5 | | Unit | Base | Offset | R² | |
| 13 | H2 Rich Gas Yield (wgt) | % | 3.701 | | 0.9603 | -0.031 |
| 14 | LPG Yield (wgt) | % | 6.885 | | 0.9867 | -0.126 |
| 15 | Reformate Yield (wgt) | % | 89.414 | | 0.99417 | |
| 16 | Gas RON (Leaded) | none | 98.96 | | 0.96434 | |
| 17 | Spiral Test Reformer Mod... | kWh | 4.8082 | | 1 | |
| 18 | Spiral Test Reformer Mod... | GJ | 1.0045 | | 1 | |
| 19 | Spiral Test Reformer Mod... | tonne | 0.0745 | | 1 | |
| 20 | H2 Rich Gas Hydrogen (... | % | 100.00 | | 1 | |
| 21 | H2 Rich Gas Density at 1... | g/cc | 0.0700 | | 1 | 0 |
| 22 | H2 Rich Gas Calorific Value | kJ/kg | 120000 | | 1 | 0.0000000 |
| 23 | LPG Density at 15.0 °C | g/cc | 0.4817 | | 0.99384 | -0 |
| 24 | LPG Calorific Value | kJ/kg | 46300 | | 0.99118 | |
| 25 | LPG C01P : methane (wgt) | % | 11.61 | | 0.98364 | |
| 26 | LPG C02P : ethane (wgt) | % | 16.08 | | 0.96271 | |
| 27 | LPG C03P : propane (wgt) | % | 26.60 | | 0.99148 | |
| 28 | LPG C04P : i-butane (wgt) | % | 12.08 | | 0.98968 | |
| 29 | LPG C04P : n-butane (wgt) | % | 32.65 | | 0.99873 | |
| 30 | LPG Hydrogen Sulphide (... | % | 0.00 | | 1 | |
| 31 | Reformate Density at 15... | g/cc | 0.8162 | | 0.99559 | 0 |
| 32 | Reformate Aromatics (wgt) | % | 69.81 | | 0.99101 | |
| 33 | Reformate Aromatics (vol) | % | 59.71 | | 0.99101 | |
| 34 | Reformate C06A : benze... | % | 0.68 | | 0.23674 | |
| 35 | Reformate C06A : benze... | % | 0.59 | | 0.23674 | |




98 RON | 100 RON | 102 RON

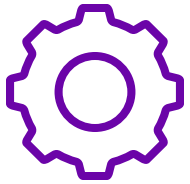
| | A | B | C | D | E | I |
|---|---|---|---|---|---|---|
| 1 | | | | | Driver Name | N+2A (vol) |
| 2 | | | | | Driver Unit | % |
| 3 | | | | | Base Value | 51.82 |
| 4 | | | | | Step Size | 1 |
| 5 | | Unit | Base | Offset | R² | |
| 13 | H2 Rich Gas Yield (wgt) | % | 3.701 | | 0.9603 | -0.031 |
| 14 | LPG Yield (wgt) | % | 6.885 | | 0.9867 | -0.126 |
| 15 | Reformate Yield (wgt) | % | 89.414 | | 0.99417 | 0.156 |
| 16 | Gas RON (Leaded) | none | 98.96 | | 0.96434 | 0.02 |
| 17 | Spiral Test Reformer Mod... | kWh | 4.8082 | | 1 | 0 |
| 18 | Spiral Test Reformer Mod... | GJ | 1.0045 | | 1 | 0 |
| 19 | Spiral Test Reformer Mod... | tonne | 0.0745 | | 1 | 0 |
| 20 | H2 Rich Gas Hydrogen (... | % | 100.00 | | 1 | 0.00 |
| 21 | H2 Rich Gas Density at 1... | g/cc | 0.0700 | | 1 | 0.0000 |
| 22 | H2 Rich Gas Calorific Value | kJ/kg | 120000 | | 1 | 0.0000000000... |
| 23 | LPG Density at 15.0 °C | g/cc | 0.4817 | | 0.99384 | -0.0004 |
| 24 | LPG Calorific Value | kJ/kg | 46300 | | 0.99118 | 4.60 |
| 25 | LPG C01P : methane (wgt) | % | 11.61 | | 0.98364 | 0.08 |
| 26 | LPG C02P : ethane (wgt) | % | 16.08 | | 0.96271 | 0.04 |
| 27 | LPG C03P : propane (wgt) | % | 26.60 | | 0.99148 | 0.09 |
| 28 | LPG C04P : i-butane (wgt) | % | 12.08 | | 0.98968 | 0.07 |
| 29 | LPG C04P : n-butane (wgt) | % | 32.65 | | 0.99873 | -0.28 |
| 30 | LPG Hydrogen Sulphide (... | % | 0.00 | | 1 | 0.00 |
| 31 | Reformate Density at 15... | g/cc | 0.8162 | | 0.99559 | 0.0014 |
| 32 | Reformate Aromatics (wgt) | % | 69.81 | | 0.99101 | 0.10 |
| 33 | Reformate Aromatics (vol) | % | 59.71 | | 0.99101 | 0.09 |
| 34 | Reformate C06A : benze... | % | 0.68 | | 0.23674 | 0.01 |
| 35 | Reformate C06A : benze... | % | 0.59 | | 0.23674 | 0.00 |

# More about Process Model Manager (PMM)

- Easily work with large data sets collected across time with multiple conditions from plant data
- Powerful regression engine to ensure models are statistically valid and robust for optimization
- Regression tries to minimize the error across all the data sets and shows the recalculated (fitted) value against the entered value
- Simple to understand statistics and visualizations help to choose appropriate structure and assess the quality of the resultant models based different input data sets.
- Publish models directly from PMM across the enterprise for fast and confident usage through the advanced synchronization infrastructure of AVEVA Unified Supply Chain Management

# Conclusion and Summary

# Conclusion and Summary



## Challenge

- For known reasons, LP process models become less accurate over time.
- In typical hectic work environment, significant LP errors can persist for months or even years.
- As a result, Margins are lower than they should be.
- Planners and Process Engineers need an easy-to-use and single approach system to check and fix LP errors.

## Solution

- To periodically check that the LP more closely matches actual operation and update planning model and ensure
- Update LP models' accuracy without the need for complex process simulators and/or plant test runs.
- Even Process Engineers can easily understand and update LP process models for their unit without knowledge of the entire LP model.

## Benefits

- Effective and Reliable Planning Decisions
- Typical refiner with multi-crude processing should expect to see approximately 0.50 $/BBL improvement in margin.



AVEVA

# Anwar Tatariya

## Partner


- IZZI Business Services LLP
- anwar.tatariya@izzibs.com

# About the Speaker – Anwar Tatariya

## AREAS OF EXPERTISE

**Functional / Technical**

- Petroleum Supply Chain Mgmt.
- Planning and Optimization
- Scheduling & Blending
- Process Modelling / Simulation
- Energy Management

## Profile

- Anwar is an expert of Petroleum Supply Chain Management with 22 years of experience, mainly in Refinery Economics, Planning Scheduling & Blending, Supply & Trading, Process Modeling and Simulation, Energy Management and Technical Consulting Services.
- He has perfect blended experience, 10 years of industry and 12 years of consulting services.

## EDUCATION AND CERTIFICATES

- **Chemical Engineer (with throughout Distinctions)**
- Advance diploma in Network Centered Computers **NIIT**, India
- Certified **Petroleum Trader** by Reliance with 6 months inhouse course

## EXPERIENCE

- **2019 onwards: McKinsey & Company - Expert Senior Consultant - Planning & Optimization**
  - Working with McKinsey & Company as Subject Matter Expert / Senior Consultant for Refinery Planning and Optimization, on profit improvements and optimization studies in India, America, Middle East and Far East.
- **2022: OQ Oman - Scheduling Subject Matter Expert (SME)**
  - Project Management Consultant / SME for Scheduling and Blending of IMS (Integrated Management System) project
- **2021-22: IOCL Scheduling project - Subject Matter Expert (SME)**
  - Senior technical Consultant / SME for Scheduling and Blending for IOCL RPS project of IOCL, India
- **2021: Bangchak Refinery, Bangkok, Thailand - Planning and Scheduling Model Development**
  - Refinery Planning Model Development project using AVEVA Unified Supply Chain.
- **2020: Astron Energy Refinery, South Africa - Planning (LP) Model Development using AVEVA Spiral Suite**
  - Refinery Planning Model project for Astron Energy Refinery, Cape Town, South Africa.
- **2018-19: Nayara Energy Ltd., India - Reports Automation, Dashboards and KPI Project,**
  - Full Project Implementation partnered with Jaajitech for Reports Automation, Dashboards and KPI Management.
- **2018: Petronas Malaysia - Subject Matter Expert (SME) - Scheduling & Blending**
  - Subject Matter Expert for Scheduling and Blend Optimization domains of RAPID project for Petronas Refinery. The Services include high end technical support to Accenture team for various project activities
- **2017: Petro Rabigh, KSA - Scheduling Model using Aspen Petroleum Scheduler**
  - Partnered with Accenture as Project Technical Lead for Design Developments, Testing and Final Delivery of Liquid Scheduling Model for Petro Rabigh complex, Saudi Arabia.
- **2016-2018: ADNOC Refining - Project Management Consultant-**
  - Scope of Services - Planning, Scheduling & Pricing and Performance Management
- **2016-2017: BAPCO, Bahrain - Real Time Energy Management using Visual Mesa**
  - Technical Project Lead for ERTO Models development project for BAPCO refinery, Bahrain.
- **2015-2016: YASREF, KSA - Process Modelling using KBC Petro-SIM and VMG-SIM**
  - Technical Project Lead and Delivery head for Steady State Process Simulation Models development project.
- **2014: REPSOL, Spain - Scheduling & Blending Models using Aspen APS + MBO**
  - Hired by Accenture as Senior Domain Consultant (Scheduling & Blending SME) for Design and development of five refineries' Integrated Supply Chain Project for REPSOL, Spain
- **2011-13: KNPC MOG – Onsite Technical Support Consultant for Planning & Scheduling**
  - Functional and Technical Support Consultant for KNPC, Kuwait, responsible for Go-Live Support for three KNPC refineries Planning and Scheduling Models and Business processes.
- **2010-11: BAPCO, Bahrain - Scheduling & Blending Models using Aspen APS + MBO**
  - Lead BAPCO (Bahrain) Scheduling & Blending Model Development Project single handed
- **2006-10: Lead Product Scheduling and Unit Scheduling Desks at Essar Oil, India**
- **2000-06: Process Engineer & Scheduling Engineer at Reliance Industries, India**



AVEVA

# Questions?

Please wait for the microphone.

State your name and company.

# Please remember to…

Navigate to this session in the mobile app to complete the survey.

# Thank you!



AVEVA