ppPLUS Flyers Overview

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Margin Variance Analysis

How to Improve Your Business Results Significantly Using Margin Variance Analysis (MVA)?

Is your refinery, petrochemicals or any other production plant making less actual financial margin than originally planned or aimed for?

Then execute a Margin Variance Analysis (MVA) which describes in detail WHERE exactly the deviation is caused. Is it a price effect, deviations in supply and/or demand, or the capacity of the process units, or … all of the above?

See the first picture below how such a detailed analysis could look like. This example is for a typical refinery where the Gross Refinery Margin (GRM) is expressed in dollars per barrel crude oil intake. We used an existing local linear programming (LP) optimisation program to execute the calculations. The 0.40 $/bbl margin gap between Actual and Plan can be explained by several contributors (in this example being Prices, Inventory, Logistics, Refinery Capability, Feeds Selection, Products Selection) whereof some (but not all) are controllable.

The remaining gap between Plan and Actual after accounting for the first six optimisation activities mentioned above is called 'Others / Unexplained' and accounts for planning tool inaccuracy and other not identified factors. The analysis also includes consideration of the results obtained and historic trend analysis (see the second picture below).

Identification, quantification, and historical trending of the value of each gap will help prioritise and guide improvement efforts. It will also provide input and direction to management. Moreover, it will highlight where efforts might be targeted to provide higher robustness in premise accuracy, utilization, planning tool accuracy, trigger running sensitivities for future plans, etc.

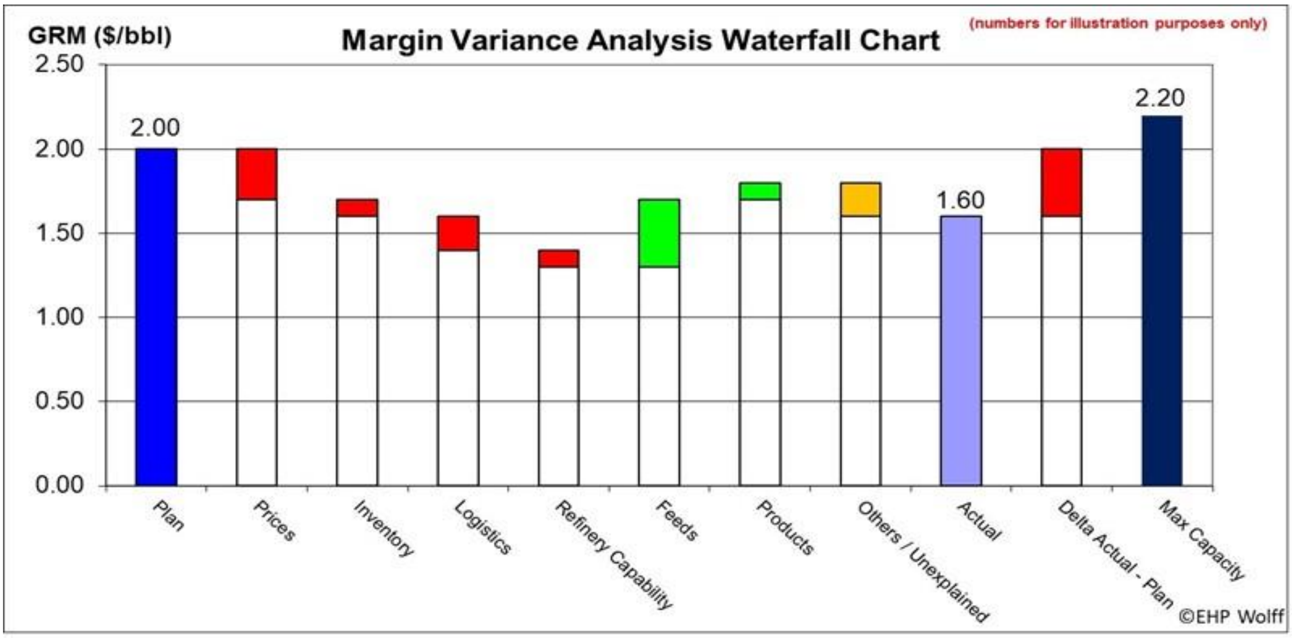
With an MVA executed you are in a much better position to take focussed corrective action, improve the planning process and consequently realise (much) more margin. For medium-size refineries up to several millions of dollars per year. The MVA report is an appropriate tool to inform higher management efficiently at the same time.

Margin Variance Analysis is often performed in conjunction with F&PYA (see separate dedicated flyer).

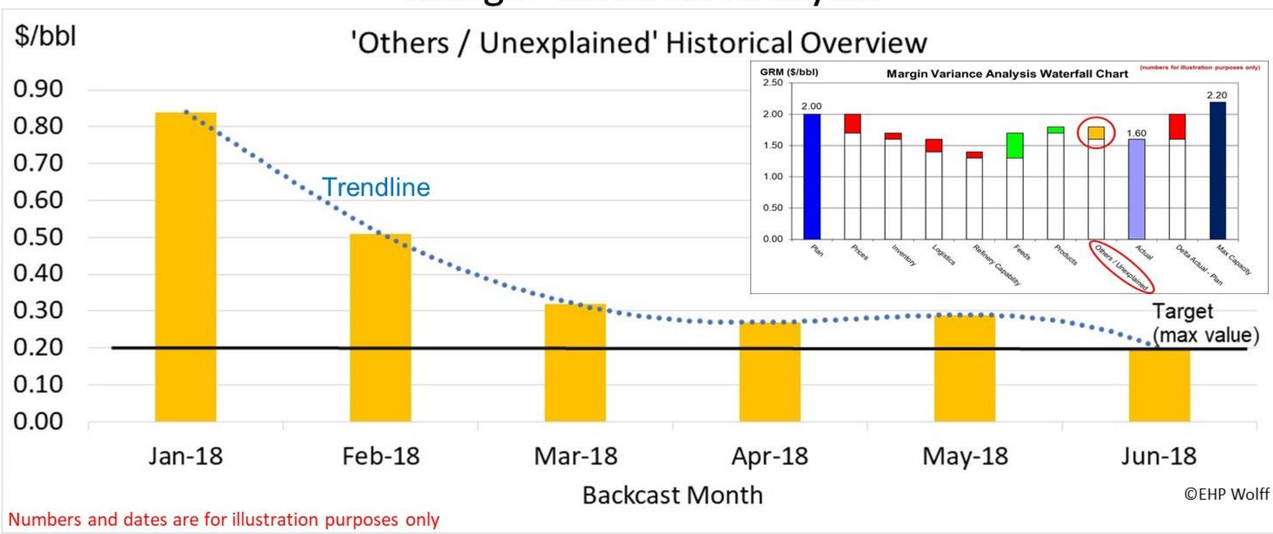
Note that MVA may also be applicable to other branches such as chemicals, utilities, pharmaceuticals and food & beverages. Especially where there are several types of feed with different price/quality ratios, such as crude oil & condensates (to a refinery), naphtha & gasoil (to a steam cracker), coal (to a power plant or gasifier), biomass (to a power plant or gasifier), milk to a cheese plant,… etcetera.

MVA is best performed as a joint consultant – client team operation.

The author of this article has personally executed approximately 25 MVA studies and has over 30 years of experience in technical consultancy and operational auditing.



Margin Variance Analysis



Enhanced Operational Audits

How to Improve Your Business Results Significantly Using Enhanced Operational Audits?

Are you running a refinery, a petrochemicals-, a utilities-, a pharmaceuticals-, a food & beverages or any other production plant?

And do you want to check your status on compliance while increasing financial margin at the very same time? Then execute ‘Enhanced Operational Audits’.

What is an Enhanced Operational Audit?

An operational audit is a method to verify independently that in production locations risks are identified and adequate controls are in place to manage these very risks. Examples of production locations are refineries, petrochemicals, chemicals, utilities, pharmaceuticals and food & beverages.

Where a ‘traditional’ audit stops at reporting the gaps between desired- and actual situation, an ‘ENHANCED’ operational audit can deliver much more. This by combining the auditing at the same time with technical consultancy on (1) identification of opportunities for improvement and (2) implementation support. It adds significant value for the company beyond a traditional audit often without (much) CAPEX.

Why doing an independent Enhanced Operational Audit?

Several reasons:

(1) Preparation for a ‘higher-level’ (Business Unit) intra-company audit;
(2) Preparation for an external (governmental) audit (legal requirement);
(3) Identifying improvement opportunities (margin gain, cost reduction, organizational);
(4) Identifying areas for continuous improvement and sustainability; and
(5) Executing benchmarking.

An Audit Terms of Reference (ToR) should be written as it defines the purpose and structures of an audit to accomplish a shared goal. A ToR shows how the audit in question will be defined, developed, and verified. It should also provide a documented basis for making future decisions and for confirming or developing a common understanding of the scope among stakeholders. A high-quality ToR serves as the backbone for a successful Enhanced Operational Audit.

Enhanced Operational Audits are best performed as a joint consultant – client team operation.

The author of this article has over 30 years of experience in operational auditing and technical consultancy.

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Enhanced Failure Mode & Effect Analysis (FMEA)

How to Improve Your Production Processes Significantly Using Enhanced Failure Mode & Effect Analysis (FMEA)?

Are you running a refinery, a petrochemicals-, a utilities-, a pharmaceuticals-, a food & beverages or any other production plant?

And do you want to increase production rates without running the risk of, for example, off-spec material?

Then use the Failure Mode & Effect Analysis (FMEA) technique to identify and evaluate failures of products, processes and services. Not only write an FMEA results report, but ENHANCE by giving dedicated training to train-the-trainer top-down in the organisation at the same time as well.

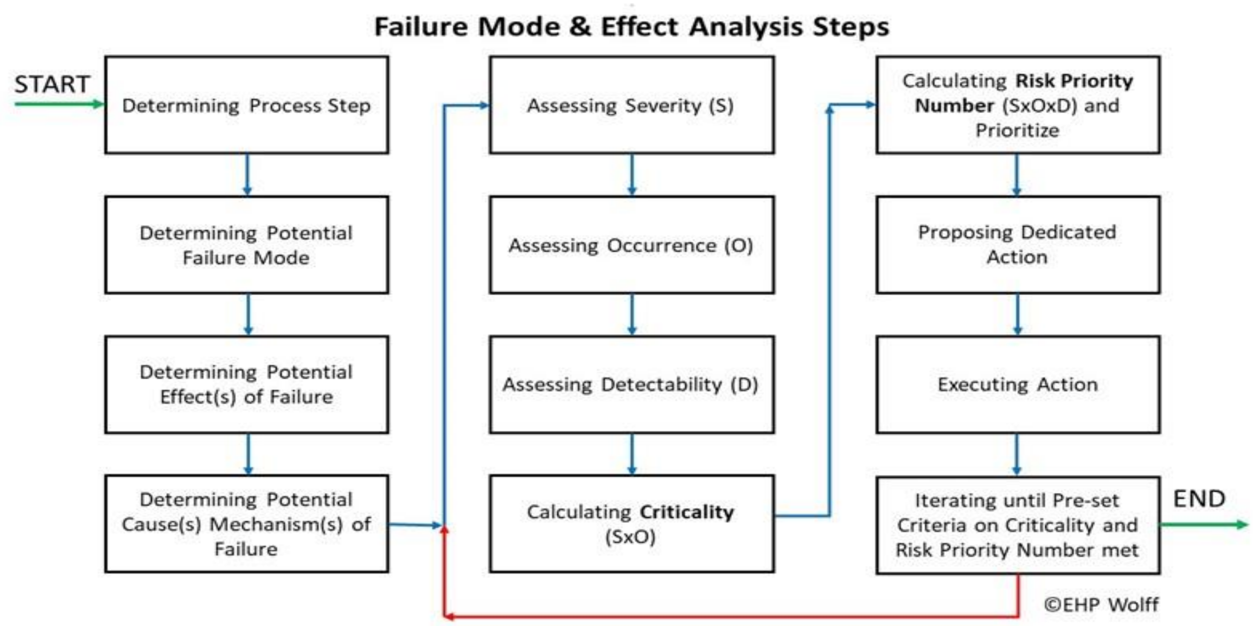
Determine the potential failure modes, their effects and causes within the process. Match current procedures and protocols with these critical points and include external requirements. Assess the gaps and define standards to close the gaps between current and desired situation. Trigger management & operators on awareness and transfer new standard, required knowledge and skills by dedicated training to the core team.

In a recent project a comprehensive 'Medical Grade Plastics Standard' was written by the author of this article to standardise the procedures and processes of Medical Grade Plastics manufacturing in several production locations of a major chemicals company in Europe. The purpose is to minimise the risk of contamination, off-spec material, deviation from agreed recipes and increase production rates.

Several hardware changes have been implemented, without much CAPEX investment, soon after completion of this study. This to improve the production process significantly where millions of dollars extra margin per year is at stake.

FMEA is best performed as a joint consultant – client team operation.

The author of this article has over 30 years of experience in technical consultancy and operational auditing.



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Sales & Operations Planning Process (S&OP)

How to Improve Your Business Results Significantly Using the Sales & Operations Planning Process (S&OP)?

Are you running a refinery, a petrochemicals-, a utilities-, a pharmaceuticals-, a food & beverages or any other production plant?

And do you want to improve on avoiding any business disruptions?

Sales and operations planning (S&OP) is an integrated business management process through which the executive/leadership team continually achieves focus, alignment and synchronization among all functions of the organization.

Organisations do not always have an integrated process for production and supply & distribution. Alignment between feedstock supply, production and sales can often be improved to avoid business disruptions.

Introduction of the Sales & Operations Planning process comprises five steps, being:

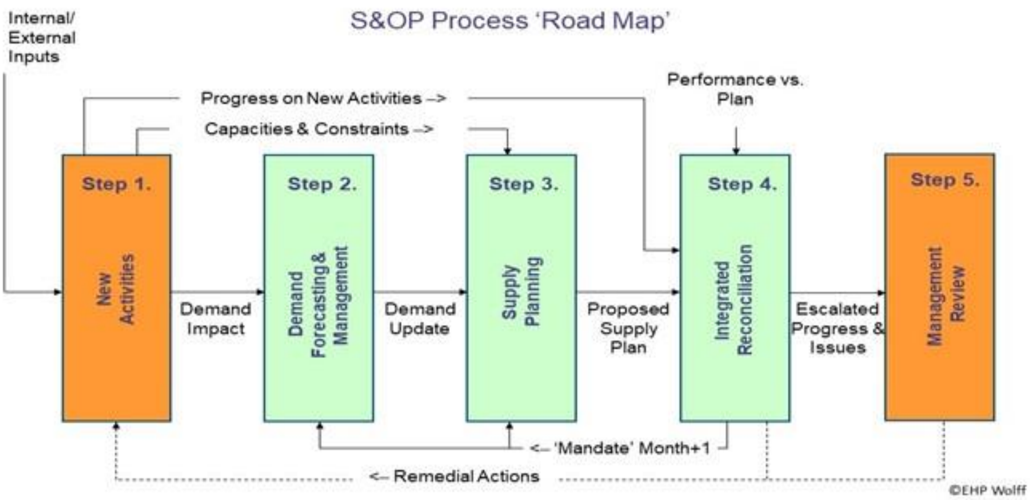
(1) New Activities
(2) Demand Management
(3) Supply Management
(4) Integrated Reconciliation including look-back
(5) Management Review and Sign-Off

Set-up the S&OP process by bringing all stakeholders together and agree on having weekly meetings and a monthly meeting (the latter mainly for the Integrated Reconciliation). A communication format in, for example, Excel for the necessary data to be available at these meetings should be agreed and executed accordingly.

By having an aligned process, the number of disruptions such as miscommunication is brought down significantly. Higher management is informed, amongst others on financial impact, on quarterly basis and will approve (Management Review and Sign-Off). This all without any CAPEX investments.

S&OP is best performed as a joint consultant – client team operation.

The author of this article has set-up the S&OP process for Shell Chemicals in Europe and has over 30 years of experience in technical consultancy and operational auditing.



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Feedstock & Product Yield Analysis (F&PYA)

How to Improve Your Business Results Significantly Using Feedstock & Product Yield Analysis (F&PYA)?

Is your refinery, petrochemicals or any other production plant making less actual financial margin than originally planned or aimed for?

Perhaps your planning tools are performing sub-optimal.

Refineries and petrochemical plants usually have linear programming (LP) margin optimisation models to execute the planning and sometimes backcasting (also called look-back or retro-analysis) as well. The LP models should be able to simulate the refinery's input and output streams within the tolerances set.

A method to verify the deviations between LP predicted and Actual inputs and outputs (according to the Finance accounting books) is the so-called Feedstock & Product Yield Analysis (F&PYA).

See the two pictures below how a part of such a detailed analysis could look like. This example is for a typical refinery where there are 8 input streams (fixed bucket of crude oils, additives, chemical feedstocks, …etcetera) and 21 output streams (mogas, diesel, fuel oil, …etcetera).

The deviation between LP Predicted Actuals and Accounting Actuals is normalised and plotted both in absolute values (metric tons per month) and relative to their Accounting Actuals (mass percentage).

A dedicated study is then executed to explain the more significant gaps often resulting in fine-tuning the used LP models.

With an F&PYA executed you are in a better position to take focussed corrective action, improve the planning process and consequently realise more margin. For medium-size refineries up to several millions of dollars per year (as proven by experience). Mostly without any or much CAPEX investment.

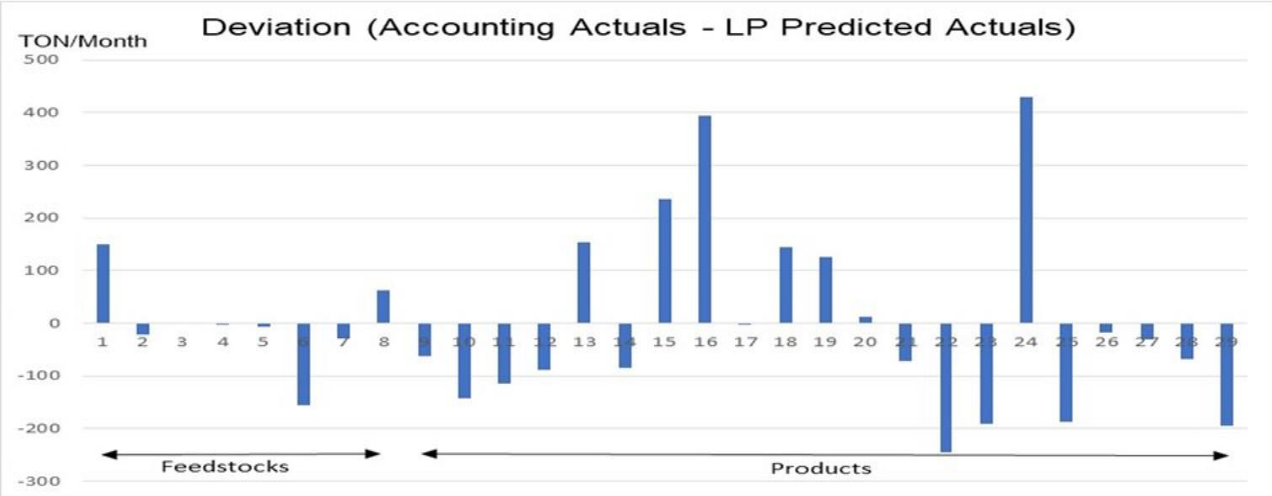
F&PYA is often performed in conjunction with Margin Variance Analysis (see separate dedicated flyer).

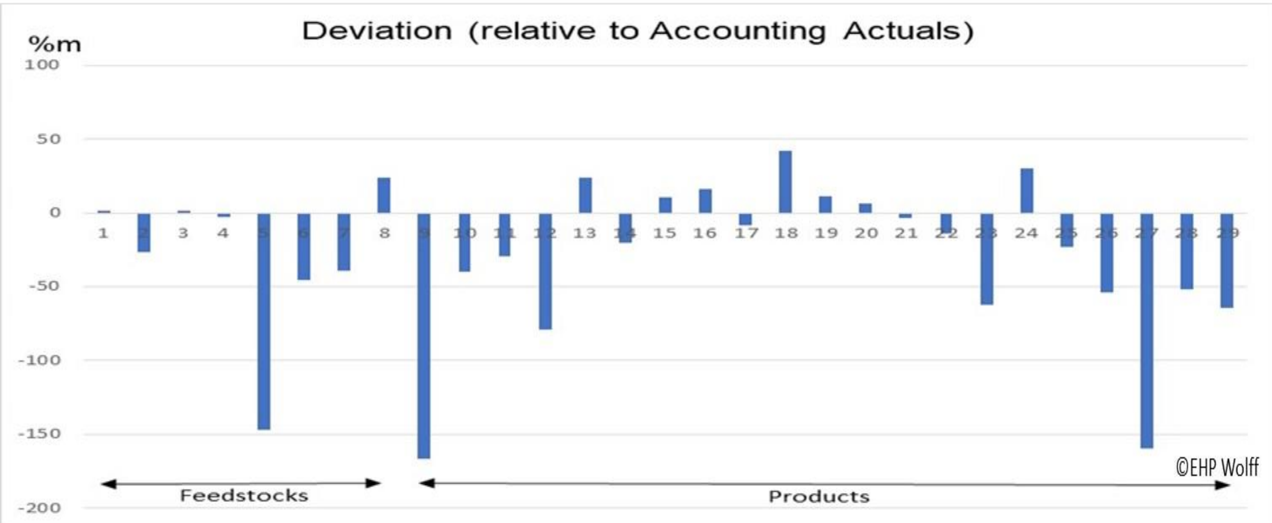
Note that F&PYA may also be applicable to other branches such as (petro)chemicals, utilities, pharmaceuticals and food & beverages. Especially where there are several types of feed with different price/quality ratios, such as crude oil & condensates (to a refinery), naphtha & gasoil (to a steam cracker), coal (to a power plant or gasifier), biomass (to a power plant or gasifier) milk to a cheese plant, … etcetera.

F&PYA is best performed as a joint consultant – client team operation.

The author of this article has personally executed approximately 25 Feedstock & Product Yield studies and has over years of experience in technical consultancy and operational auditing.

Feedstock & Product Yield Analysis





Feedstocks & Products Marginal Margin Analysis (F&PMMA)

How to Improve Your Business Results Significantly Using Feedstocks & Products Marginal Margin Analysis (F&PMMA)?

Is your refinery, petrochemicals or any other production plant making less actual financial margin than originally planned or aimed for?

Then execute a Feedstocks & Products Marginal Margin Analysis (F&PMMA) which describes in detail WHERE exactly on the feedstock and product site there is negative contribution to this deviation.

A refinery or petrochemicals plant usually runs on several feedstock types simultaneously. Refineries run on a mixture of crude oils and/or condensates, while petrochemical plants - such as steam crackers - run on various types of naphtha and/or gasoil. Using Linear Programming (LP) optimisation models the (financial) optimum feedstock intake package is determined.

The LP consists of an objective function and a set of constraints in the form of a system of equations or inequalities, such as limits on the capacities of various refining operations, raw-material & utilities availability, demands for each product, product composition and quality specifications, logistic constraints, and any government-imposed policies on the output of certain products (for example specifications on sulphur content).

The LP is able to calculate for the optimised case for each feedstock its marginal margin (also called marginal value or marginal profit, the added value of the feedstock's 'last drop'). Some may be zero (optimal), others positive or negative. Especially the latter needs a detailed analysis for explanation. What constraints did we hit? Did we buy the right quality crude oil or naphtha type? Did we process too much of one type versus the others in the feedstock mixture?

A similar analysis should also be executed for the products site. Was the 'last drop' of product produced actually profitable?

See the picture attached for an impression of feedstock intake (in metric tonnes per month) impact on margin. This example is for a refinery where the objective function is the Gross Refinery Margin (GRM) expressed in US dollars per month.

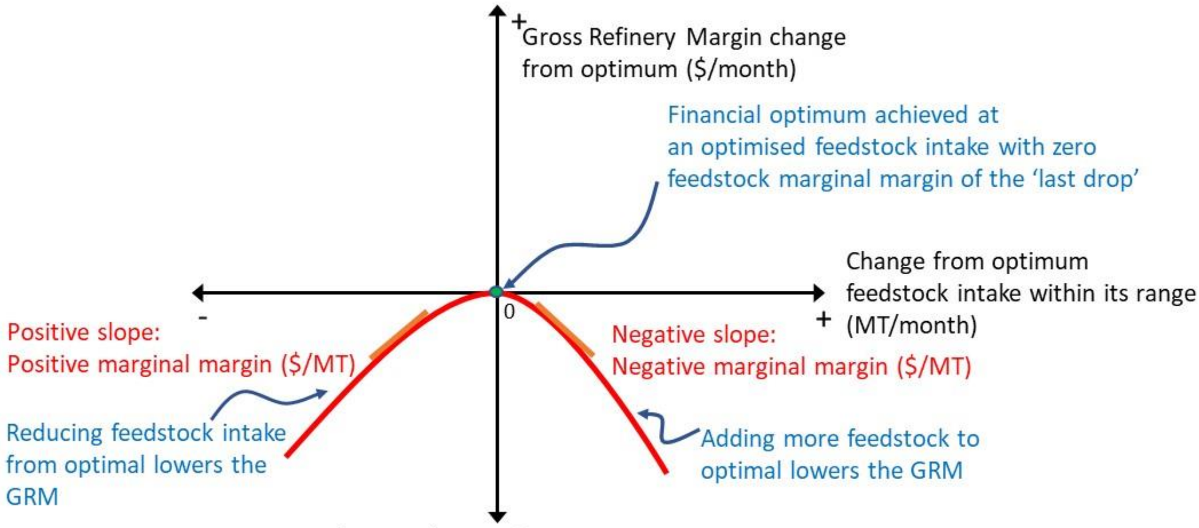
With an F&PMMA executed you are in a better position to take focussed corrective action, improve the planning process and consequently realise more margin. For medium-size refineries up to several millions of dollars per year (as proven by experience). Mostly without any or much CAPEX investment.

Note that F&PMMA may also be applicable to other branches such as chemicals, utilities, pharmaceuticals and food & beverages. Especially where there are several types of feed with different price/quality ratios, such as crude oil & condensates (to a refinery), naphtha & gasoil (to a steam cracker), coal (to a power plant or gasifier), biomass (to a power plant or gasifier) milk to a cheese plant, … etcetera.

F&PMMA is best performed as a joint consultant – client team operation.

The author of this article has personally executed approximately 50 F&PMMA studies for refineries and petrochemicals and has over 30 years of experience in technical consultancy and operational auditing.

Simplified Representation of Feedstock Marginal Margin (Refinery Example)



Typical Refinery LP Output (part of):

1. THROUGHPUTS		T	INTAKE 000S MT	LANDED COST DLRS/MT	LANDED VALUE DLRS/MT	MARG. PROFIT DLRS/MT
			*******	*******	*******	*******
BRUT AMNA	AN00	1	83.97	471.03	509.22	38.19
BRUT IRNH	IH00	1	40.85	410.28	397.94	-12.34
BRUT SAHB	SB00	1	43.25	510.76	525.37	14.61
BRUT SARI	SR00	1	41.94	468.12	502.36	34.24
BRUT SIBL	RL00	1	16.66	465.77	478.92	13.15

Negative marginal margin, to be investigated!

Feedstock Optimisation Analysis

How to Improve Your Business Results Significantly Using Feedstock Optimisation Analysis?

Is your refinery, petrochemicals or any other production plant making less actual financial margin than originally planned or aimed for?

Then execute a Feedstock Optimisation Analysis which describes in detail WHERE exactly on the feedstock site there is negative and positive contribution to this deviation.

Taking a refinery as an example where crude oil is the main feedstock, the core purpose of 'Crude Oil Optimisation Analysis' to identify potential opportunities for further improvement of future business results and increase Gross Refinery Margin (GRM). This by a better understanding of actual crude selection performance defining follow-up actions to implement improvements.

Refineries and petrochemical plants usually execute linear programming (LP) margin optimisation models to execute the planning and sometimes backcasting (look-back or retro-analysis) as well.

To answer the question 'Did we actually buy the best crudes versus the Monthly and/or Annual Plan?', the Refinery Economist should at least execute a detailed LP study of five runs which includes these four categories:

- **Throughput versus Plan Effect** (M$): actual throughput changes to Monthly- or Annual Plan.
- **Crude Quality Effect** (M$): when compelling evidence is available that (some of) the crude properties were significantly different to the assay used to buy it, and there were material impacts on refinery yields.
- **Mode Shift Effect** (M$): changes to refinery/unit mode (such as Low Sulphur, High Sulphur, Bitumen, Lube Oil, etcetera.) of operation - other than throughput - for economic reasons or to accommodate changes to product specifications.
- **Crude Optimization Effect** (M$): changes to the crude diet based on re-optimization subject to latest price/market expectations.

The Overall Crude Oil Optimisation result is the sum of the above four contributions (expressed in M$ per month or year).

The Crude Oil Optimisation Analysis-concept includes processes for the consistent allocation of variances to causes between actual results and the (monthly) plan. See attached picture for an impression. The analysis also includes consideration of the results obtained and historic trend analysis.

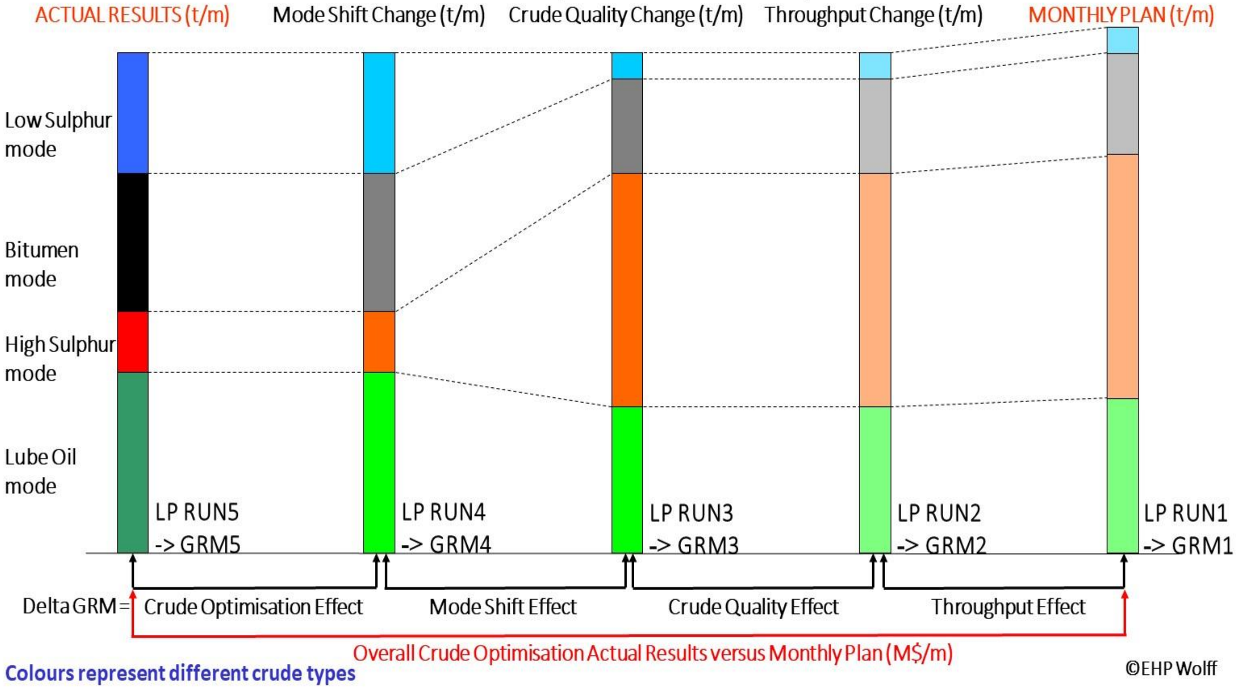
With a Feedstock Optimisation Analysis executed you are in a better position to take focussed corrective action, improve the planning process and consequently realise (much) more margin. For medium-size refineries up to several millions of dollars per year.

Note that Feedstock Optimisation Analysis may also be applicable to other branches such as chemicals, utilities, pharmaceuticals and food & beverages. Especially where there are several types of feed with different price/quality ratios, such as crude oil & condensates (to a refinery), naphtha & gasoil (to a steam cracker), coal (to a power plant or gasifier), biomass (to a power plant or gasifier) milk to a cheese plant, … etcetera.

Feedstock Optimisation Analysis is best performed as a joint consultant – client team operation.

The author of this article has personally executed approximately 60 crude and chemical Feedstock Optimisation studies and has over 30 years of experience in technical consultancy and operational auditing.

Crude Oil Optimisation Analysis



Backcasting (Retrospective-Analysis)

Increase Your Financial Margin Significantly via Backcasting (Retrospective-Analysis)

Do you want to increase the financial margin of your refinery, petrochemicals or any other production plant?

Then execute Backcasting (also called retrospective-analysis or look-back analysis).

What is Backcasting?

Backcasting is a process used to provide a clear and accurate representation of the relationship between the planned and actual performance of a refinery, petrochemicals plant or similar. This in terms of margin and with respect to feedstocks and products yields. Usually, linear programming (LP) margin optimisation models are used to execute the planning process and they can be used for Backcasting as well.

What are the benefits?

The Backcasting analysis will lead to identification of the contributing elements and provide opportunities for further significant margin improvement, such as:

- Drives improvements in forward margin decisions from previous periods learnings
- Supplements better understanding of margin optimization opportunities
- Increases margin competency and ownership in all layers of the organisation (top-down)
- Provides key insights into feedstock optimisation and buying strategy
- Provides steers to which plant (capacity) constraints are most valuable to debottleneck
- Assess actual margin performance against true site potential; 'Max Capacity' or 'Blue Skies'
- Forces basic data improvement in linear programming (LP fine-tuning), leading to more realistic plan preparation

From backcasting, the combination of opportunity identification and LP upgrades frequently results in the refinery capturing profit improvement worth 20 to 40 US$ cent per barrel (for a say medium-sized 200,000 barrels per day refinery potentially about 15 to 30 M$/year).

How to execute Backcasting?

Ideally, all of the next four steps should be included (flyers with more detailed information on each step are available):

1. Feedstocks & Products Marginal Margin Analysis
Determining the value of the 'last drop' feedstocks processed and of products produced and investigate weakest contributions to take corrective action.

2. Margin Variance Analysis
Finding the weaknesses in the supply and production chain and take corrective action.

3. Feedstock & Product Yield Analysis
Finding deviations between model prediction and reality, fine-tuning planning model.

4. Feedstock Optimisation Analysis
Determining the contributing value of the feedstock batches processed and take corrective action.

Note that Backcasting may also be applicable to other branches such as chemicals, utilities, pharmaceuticals and food & beverages. Especially where there are several types of feed with different price/quality ratios, such as crude oil & condensates (to a refinery), naphtha & gasoil (to a steam cracker), coal (to a power plant or gasifier), biomass (to a power plant or gasifier), milk to a cheese plant, … etcetera.

Backcasting is best performed as a joint consultant – client team operation.

The author of this article has personally executed approximately 50 Backcasting studies for both refineries and petrochemicals and has over 30 years of experience in technical consultancy and operational auditing.


MVA Waterfall Chart
Crude Oil Optimisation Analysis
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©EHP Wolff

Maintenance Material Working Capital Reduction

Are you running a refinery, a petrochemicals-, a utilities-, a pharmaceuticals-, a food & beverages or any other production plant?

And do you want to improve on your (financial) results without (much) CAPEX investment?

Then reduce your working capital as much as reasonably possible. See a recent real-life example on maintenance material storage efficiency gaining several M$ as described below.

Situation:
A major European Refinery consisting of several Operating Units and a governing Maintenance Department had more than ten so-called ‘Squirrel Stores’ on their site. These locations host various types of unregistered materials from bolts and gaskets to pieces of equipment of major size such as valves, pumps, e-motors, steam silencers, etc. This led to significant working capital.

There was no communication between these stores on what was held in storage. Consequently, new material was purchased although readily available on-site. Existing material deteriorated over time as it was inappropriately stored.

Task:
A multi-disciplinary Materials Management initiative was started and led by the author to transform the Squirrel Stores into a few ‘Zone Stores’ where only a small inventory will be held for daily use by the Operation Units and Maintenance Department.

Action:
All inventories were sorted out and inspected. The surplus materials were transferred to the Central Warehouse following inspection. The main benefits are accessibility of spares for all operating units through central registration, quality control and preservation.

Results:
A conservative estimate of the inventory value that was transported from the various Squirrel Stores to the Central Warehouse is circa 3 - 4 M$. The Operation Units and Maintenance Department have electronic access to the Central Warehouse registration system to search for equipment in their inventory. Some surplus material was sold, e.g. back to the original supplier. Poor-quality material was sold as scrap.

A thorough clean-up of the Zone Stores was executed at the same time creating a nicer and safer working place (see pictures below). The total project leap time was one and a half year.

This kind of project is best performed as a joint consultant – client team operation.

The author of this Article has over 30 years of experience in technical consultancy and operational auditing.

Squirrel Store (before clean-up)

Squirrel Store (after clean-up)

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Leadership Engagement - Action Management

Do you have the feeling that the leadership team of your organisation is lacking on performance to get things thoroughly done?

One of the reasons could be that your team has defined corrective actions but is lacking on their follow-up:

- There are too many actions where the action is closed without the root cause being addressed,
- Many ‘open ends’ at closing actions,
- Incidents with site-wide issues are only picked up locally (issue too large for initial action party).

Consequence: many repeat incidents and extra work!

Action follow-up starts with:

1. What we do, we have to do well in one go. Otherwise it means a lot of extra work,
2. Only log-out an action once you have truly completed the action,
3. Make choices. We cannot take everything on board (immediately),
4. Deliver together!
   - Do I only complete my step in the process, or do I commit myself to a good overall result?
   - Do we only look and judge at efforts, or also for results?

If we do not have enough time to carry out all the actions thoroughly, we have to make choices:

- Start a ‘crisp’ study that matches the potential risk of the incident. Use professional judgment (involve Subject Matter Experts). Good ranking based on knowledge and experience and consultation with colleagues is essential. A so-called Risk Matrix can be very helpful. See picture.

- Use an Action Management Database, also record well on what the choice is based not to investigate an incident and not to execute an action.

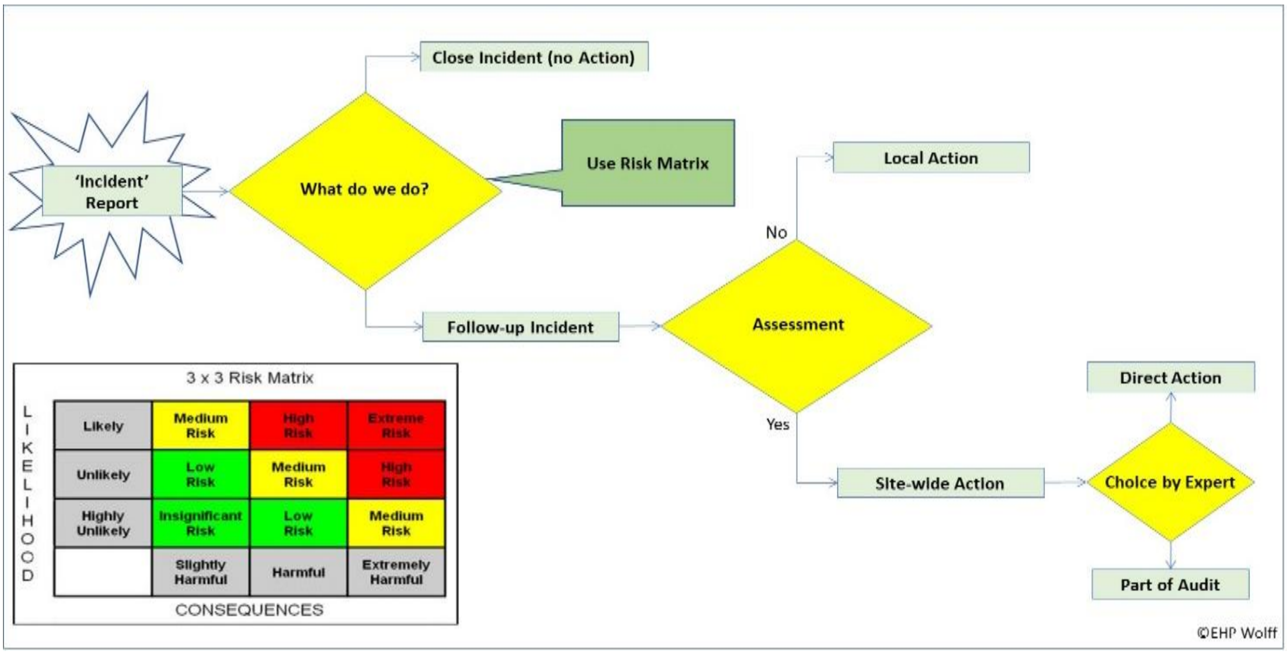
- Choose after a survey for the 'top 3' actions with the greatest sustainable desired effect. What counts is what changes in the field. Register the choice for the actions so that it is clear what has been done with the recommendations.

- In principle, personal safety and process safety actions take priority.

- Do not distribute actions without **upfront** buy-in from the action executing party.

When Action Management is implemented this way, the leadership team of the organisation should be able to get matters thoroughly done.

The author of this Article has implemented Action Management in a major European Refinery and has over 30 years of experience in technical consultancy and operational auditing.



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Leadership Engagement - Peer Coaching and Feedback Exchange

Do you have the feeling that the leadership team of your organisation is lacking on performance to get things thoroughly done?

And do you recognise this:
Current situation: Management lacking visibility and leadership skills suboptimal.
Desired situation: Management clearly visible and engaged to all employees with excellent leadership skills.

The solution is to improve on leadership quality, including behaviour. To support this, we advocate constructive collegial coaching / exchange of experience at the same (peer) level:

Who:
Between sparring partners, there should be:
- sympathy, trust, openness
- no conflict situation present

Where:
Private and quiet environment (use a private room as obviously a canteen is only conditionally suitable)

What:
Concrete theme, or general feedback, of your choice

How:
- take your time
- listen more than talk
- respectful interaction with each other
- communicate openly / exchange experience
- look for a positive 'loop'
- maintain confidentiality about conversation content

Frequency:
About 2-3 times a year.

The author of this Article has implemented Peer Coaching and Feedback Exchange in a major European Refinery and has over 30 years of experience in technical consultancy and operational auditing.

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Refinery and Petrochemicals Margin Optimisation using Linear Programming Models

Do you want to increase the financial margin of your refinery, petrochemicals- or any other production plant?

Refineries and petrochemical plants usually have linear programming (LP) margin optimisation models to execute the planning and sometimes backcasting (also called look-back or retro-analysis) as well. The LP models should first be able to simulate the refinery's input and output streams properly. The next phase is executing optimisation studies to maximise financial profit.

The following sequential steps are suggested as good practice for margin optimisation:

Step 1: **Execute an LP Review (LP fine-tuning)**
Before using LP for optimisation purposes, it should be assured that it simulates the production process input and output streams for several scenarios (winter, summer, …) within the tolerances set. We have developed a simple procedure called 'Feedstock & Product Yield Analysis' to execute just this.

Step 2: **Find Quick Opportunities for Improvement**
Often quick wins can be achieved while using the LP for exploring opportunities by de-constraining feedstock supplies, unit capacity constraints and product demands as much as reasonably feasible. This process takes place with support from typically Supply & Trading, Refinery Economist(s), Operations, Technology Services and Retail & Marketing departments. A more in-depth process to find opportunities for improvement is called Backcasting.

Step 3: **Execute Backcasting**
Backcasting is a dedicated process used to provide a clear and accurate representation of the relationship between the planned and actual performance of a refinery, petrochemicals plant or similar. This in terms of margin and with respect to feedstocks and products yields.
The Backcasting analysis will lead to identification of the contributing elements and provide opportunities for further significant margin improvement.

Ideally, all of the next three Backcasting steps should be included:

1. Feedstocks & Products Marginal Margin Analysis - determining the value of the 'last drop' feedstocks processed and of products produced and investigate weakest contributions to take corrective action.

The LP is able to calculate for the optimised case for each feedstock its marginal margin (also called marginal value or marginal profit). Some may be zero (optimal), others positive or negative. Especially the latter needs a detailed analysis for explanation. What constraints did we hit? Did we buy the right quality crude oil or naphtha type? Did we process too much of one type versus the others in the feedstock mixture? Similar on the products site. Any options to increase the demand?

2. Margin Variance Analysis (MVA) - finding the weaknesses in the supply- and production chain and take corrective action.

The core purpose of MVA is to clearly identify potential opportunities for further margin improvement through a better understanding of Actual performance versus Plan. It reports variances between the planned- and actual margin using categories (prices, feeds, products, logistics, production unit capability, …) and identifies for every significant variance the main cause of the difference.

3. Feedstock Optimisation Analysis - determining the contributing value of the feedstock batches processed and take corrective action.

To answer the question 'Did we buy the best crudes versus the Annual Plan?', the Refinery Economist executes a detailed study which includes four categories:

- Throughput versus Plan Effect: actual throughput changes to Annual Plan.

- Crude Quality Effect: when compelling evidence is available that (some of) the crude properties were significantly different to the assay used to buy it, and there were material impacts on refinery yields.

- Mode Shift Effect: changes to refinery/unit mode (such as LSGP, HSGP, Bitumen, Lube Oil, etc.) of operation (other than throughput) for economic reasons (excluding changes in supply or demand as per other categories) or to accommodate changes to product specifications.
- Crude Optimization Effect: changes to the crude diet based on re-optimization subject to latest price/market expectations.

The combination of LP Review, Opportunities of Improvement identification, and full Backcasting frequently results in the refinery capturing profit improvement worth 20 to 40 US$ cent per barrel (for a say medium-sized 200,000 barrels per day refinery potentially about 15 to 30 M$/year).

Refinery and Petrochemicals Hydrocarbon Mass Balance & Hydrocarbon Loss

Are you having a problem with your hydrocarbon mass balance? Coping with a relatively high hydrocarbon loss? There are several actions one can execute to get the mass balance 'closing' and minimizing the hydrocarbon loss.

A mass balance is an application of conservation of mass to the analysis of physical systems. It revolves around mass conservation, i.e., that matter cannot disappear or be created spontaneously. For many reasons, refineries and petrochemical plants need to have a good record on their feedstock intake, products exported and inventory changes.

This information is used for financial accounting purposes, tax obligations, safety & security (mass lost – whereto? – environment or theft?), blending, design, engineering, energy and CO2, monitoring, troubleshooting, project work, tuning planning models, strategy studies, and more.

A mass balance is per definition closing (accumulation = in – out, i.e. 100%m), but in practice some mass cannot be (easily) measured and is called 'hydrocarbon loss'. Part of it can be back-calculated ('Accounted HC loss') such as Flare emissions and the rest is called 'Unaccounted HC loss'. An Unaccounted Loss can be either a 'paper loss' (not correctly allocated in the financial books but molecules still physically present in refinery) or a 'physical loss' (molecules lost, e.g. miscalculated intake/export, spilled into the environment or theft).

For a typical refinery the 'hydrocarbon loss' is less than 1%m, but unlikely to be below 0.15%m. A hydrocarbon loss of 0.5%m represents for a throughput at 100,000 bbl/day (340 days/year), and a hydrocarbon price at 100 $/bbl, a potential value loss of about 17 M$/year. This underpins the importance of minimizing hydrocarbon loss. Theoretically, a calculated hydrocarbon 'gain' is possible as well requiring similar follow-up.

Key for good mass balancing and minimizing hydrocarbon loss expressly includes but is not limited to:

Feedstock intake and products export:
1. Correctly measure the intake and export by using recently calibrated measuring equipment.
2. Representative sampling.
3. Correction for water or other non-hydrocarbons incorporated (e.g. water/moisture in crude oil).
4. Use correct densities for conversion from volume flow to mass flow.
5. Flow measuring equipment should be properly sealed to avoid interference such as theft.

Inventory changes:
1. Feedstock, intermediate product and final product tank inventories are correctly measured (mind tank layering).
2. Correction for water and sediment.
3. A correct tank strapping chart (volume versus level) using calibrated gauging/dipping tapes or similar.
4. Correctly manage active tank pump-and-run situations.
5. Incorporate materials in transit (e.g. a pipeline).

Mass balance accounting practices:
1. Keep good monthly Finance Accounting records (including owned storage at Third Parties), consistent with (preferably) own measurements and Bill of Lading's (especially on amount and density).
2. Make sure slops, flares, purge gas, seepage, evaporation, G/L/S waste and spills are included.
3. Incorporate impact of utilities, such as refinery fuel and gas (own consumption).
4. Assure Finance Accounting tools (such as IT SAP) are correctly configured.
5. Make a daily balance and execute a monthly reconciliation including trend monitoring.

Management governance:
1. Clear and updated Roles and Responsibilities (GM, FM, E&S, Operations, Technology, …).
2. Clear, complete, specific/relevant, updated and used documentation, policies, and procedures.
3. Regular Management Reviews with efficient (follow-up) Key Performance Indicators (KPI's), action- and performance management.
4. Typically the Finance Manager is site process owner for Custody Transfer Measurement, Mass Balance and Hydrocarbon Loss.
5. People appropriately trained and motivated.

Calculations are typically executed on daily basis. An audit-type of investigation could be executed to solve any unacceptable hydrocarbon loss problems.

In a recent project for a client an on-site hydrocarbon loss workshop was held to reduce hydrocarbon losses from around 1.0%m to circa 0.15%m. Several ideas were listed that could lead to clarifying (part of) the observed losses.


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Mitigating Refinery Hydrocarbon Loss by Reduction of Flaring

In ppPLUS Flyer 13 the (financial) impact of Refinery Hydrocarbon Loss was described. Part of the hydrocarbon loss can be accounted for (typically two-third of the hydrocarbon loss, but this varies widely), leaving the rest unaccounted.

The biggest accounted contributors of hydrocarbon loss is most likely flaring. Typically 25% of the hydrocarbon loss, but this varies considerably. Flares are first and foremost safety devices that must be available at all times for use in various situations to prevent accident, hazard, or release of refinery gas directly to the atmosphere.

However, minimizing flaring is of economic and environmental benefit and best-in-class refineries have almost no flaring (except of a purge to prevent air ingress and a pilot burner to provide a source of ignition in case flaring is indeed needed). Other main contributors for hydrocarbon loss are transfer/storage losses and all kinds of evaporation and diffusion.

To minimize flaring, several measures can be considered (but not always – economically – attractive):

1. Create a system evaluation to identify miscellaneous gas streams that are (erroneously) routinely routed to the Flare Gas Header (FGH) and determine if these streams can be eliminated, reduced or re-routed directly to the Fuel Gas Unit (FGU). Portable ultrasonic flow monitoring equipment is to be used to troubleshoot leaking valves to the Flare Header.
2. Upgrade condensers to improve performance, especially during hot weather periods. This improved performance reduces production of fuel gas and decreases the likelihood of fuel gas imbalance.
3. During unit shut-down:
   - hot strip reactors with H_2 then N_2; Recycle H_2/N_2 within reactors and minimize that quantity of gas that is purged to the FGH.
   - cool reactors (and purge downstream vessels) with N_2; Recycle N_2 within reactors and minimize that quantity of gas that is purged to the FGH.
   - route the low Btu gases (H_2 and N_2) to the FGU and add natural gas to meet Btu specifications for fuel gas.
   - segregate low Btu gases (H_2 and N_2) and routine base-load flare gases. Route the low Btu gases to the flare and the routine base-load flare gases to fuel gas recovery.
4. During unit start-up:
   - warm reactors with hot H_2 and/or N_2; Recycle H_2 and/or N_2 within reactors and minimize that quantity of gas that is purged to the FGH.
   - activate catalyst with H_2/N_2 (e.g. isomerisation); Recycle H_2/N_2 within reactors and minimize that quantity of gas that is purged to the FGH.
   - send off-spec products to the FGH. Utilize multiple compressors in a staged process to slowly start the units and minimize the production of off-spec products.
   - route the low Btu gases (H_2 and N_2) to the FGU and add natural gas to meet Btu specifications for fuel gas.
   - segregate low Btu gases (H_2 and N_2) and routine base-load flare gases. Route the low Btu gases to the flare and the routine base-load flare gases to fuel gas recovery.
5. Install or expand Flare Gas Recovery System.
6. Switch from fuel oil to fuel gas firing otherwise this gas being routed to the flare.
7. Purge the flare with (surplus) N_2 rather fuel gas.
8. … and many more (operational, maintenance-, organisational-, and governance-wise, …).

In a recent project for a client in Asia, the above-mentioned options were taken into account and will lead to substantially less flaring (aiming for 75% reduction).


Source: https://www.scoopnest.com/user/KTLAnewsdesk/568103295140683776

Refinery Hydrocarbon Mass Balance and Loss, Get-It-Right!

Are you having a problem with your refinery (or petrochemicals) hydrocarbon mass balance? Struggling with a relatively high hydrocarbon loss? In Flyers 13 and 14 I described the necessity and key requirements for proper mass balancing and minimizing hydrocarbon loss.

This flyer helps you further to get it right! A mass balance is per definition closing, but in practice some mass cannot be (easily) measured and is called 'hydrocarbon loss'. It should be noted that loss figures are generally derived as differences between comparatively large numbers (Intake – Export – Own Fuel Consumption, corrected for Inventory Changes). These large numbers need to be estimated very accurately to arrive at an accurate loss number.

Therefore, we need to look way beyond the 'usual' refinery intake (crude, other feedstocks, …) and export (LPG, mogas, diesel, fuel oil, …). In the attached figure, and below, is a more complete overview presented of the relevant intake and export. Elemental C, H, S, N, O, … mass balances have to be considered and also multiple – relatively small contributions – have to be included for an accurate mass balance.

Intake:

- Crudes & Condensates (calculated free from water, moisture and sediment).
- Other (chemical) feedstocks, such as VGO, platfeed, platformate, methanol, FAME, additives, slops, fuel, H_2, …etcetera.
- Natural gas (typically fed to a steam reformer for hydrogen production).
- Steam fed to the steam reformer.

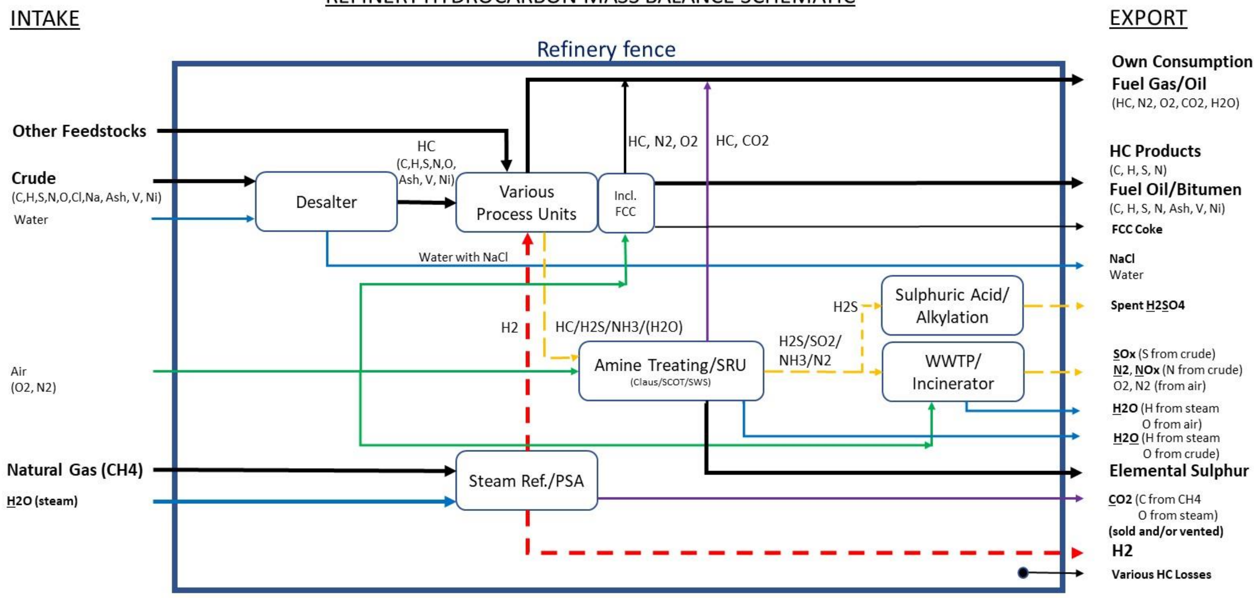
Export:

- The usual refinery hydrocarbon products.
- Own refinery fuel gas and fuel oil consumed.
- CO_2 (sold or vented) where the carbon originates from the natural gas feed to the steam reformer (the other CO_2 should already be accounted for in the refinery own fuel oil and gas production).
- Elemental sulphur.
- Hydrogen.
- SOx, NOx and H_2O where the sulphur, nitrogen and oxygen (in H_2O) originate from the feedstocks (i.e. not the nitrogen from combustion air), and the hydrogen from steam reformer steam intake.
- Spent catalyst containing carbon and/or hydrogen, such as FCC coke on catalyst and spent H_2SO_4 from an alkylation unit.
- Salts from crude oil.
- Various 'accounted' hydrocarbon losses such as flares, pilots, purges, HC in the excess air from a mercaptans oxidation process (such as MEROX), evaporation, fugitives, diffusion (especially H_2), vents, effluents, slops, sludge, spills, fires, and other G/L/S wastes.

The difference between all above mentioned Intake, Export and Own Fuel Consumption (all corrected for inventory changes) over a certain period of time is the 'unaccounted loss' (typically one-third of the total hydrocarbon loss, but this varies widely) and should be further investigated for identification. An unaccounted loss can be either a 'paper loss' (not correctly allocated in the financial books but molecules still physically present within the refinery fence) or a 'physical loss' (molecules lost, e.g. miscalculated intake/export, spilled into the environment or even theft).

In recent projects for clients in Italy and India, on-site hydrocarbon loss workshops were held to determine the mass balance correctly and reduce hydrocarbon loss from around 0.5%m - 1.0%m to circa 0.15%m which is best-in-class. Several new ideas were listed that could lead to clarifying (part of) the observed loss.

REFINERY HYDROCARBON MASS BALANCE SCHEMATIC



Note: This schematic only shows streams relevant for the hydrocarbon mass balance calculations and therefore does intend to show a complete refinery MB.

How to Improve Food & Medical Grade Plastics Production using a Dedicated Standard

Situation:
A multinational chemicals company wanted to increase its production rate of several medical grade plastic pellet products. This without product contamination (by colorants, particle shape, types of plastic, additives, oils, dust, …) sustainably in two locations in Europe. There was however a lack of standardisation amongst all production locations and multiple contamination problems occurred in the recent past.

Task:
Determine the potential failure modes, their effects and causes within the production process. Match current procedures and protocols with these critical points and include external (quality) requirements. Assess the gaps and define standards to close these gaps between current and desired situation. Trigger management & operators on awareness and transfer new standards, required knowledge and skills by training of the company's core team.

Action:
Use the so-called ADKAR Model (Awareness, Desire, Knowledge, Ability, Reinforcement) for goal-oriented change management to guide individual and organizational change.

Then use the Failure Mode and Effect Analysis (FMEA) technique on a newly team-wise created Process Flow Diagram to identify and evaluate failures, risks and gaps of products, processes and services. This PFD is a visual representation of the complete production process from receiving the production request to delivery of the final product – via a haulier – to the customer. Note: More information on FMEA can be found in ppPLUS Flyer 03.

Interviews, site visits and workshops to be held at both company's locations. Write a dedicated report and execute training according to the 'train-the-trainer' principle.

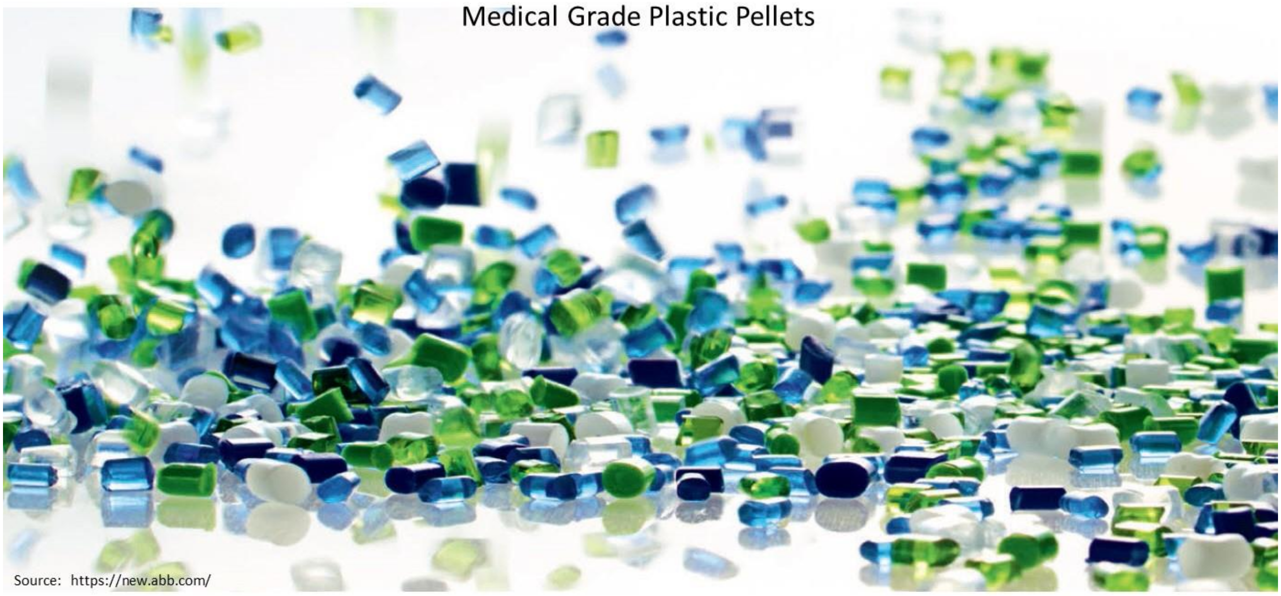
Results:
A Medical Grade Standard was written and presented to standardise the procedures and quality controls of medical grade plastic pellets production in both locations. The purpose is to minimise the risk of contamination, off-spec material, deviation from agreed recipes, inefficiencies by non-standardisation amongst the production locations, and increase production rate.

The following departments were considered; Scheduling & Logistics, Laboratory, Production, Technical/Maintenance/Cleaning Services, Quality Management and Site Management. The associated risks have been rated (High/Medium/Low) and categorized comprising Machines, Materials, Methods and People. An extensive list of tangible implementation suggestions for improvement is included in the Standard document.

The first hardware changes in the process plants were made quickly after finishing the work. Due to its success, the same project is yet also to be executed at other production locations.

Although focus is in this article on medical grade / health & diagnostics products, many aspects may also be applicable for other product types, such as for Food Contact.

Medical Grade Plastic Pellets



Source: https://new.abb.com/

Use a Dedicated 'Key Performance Indicators' Dashboard to improve your Business Results

A Key Performance Indicator (KPI) is a quantifiable value that demonstrates how effectively a company is achieving its key business objectives versus a pre-set KPI target, while being monitored over time.

For example, many refineries and petrochemical plants use KPI's at multiple levels in their organisation to evaluate their success at reaching the targets. High-level KPI's focus (on site/management level) on the overall performance of the business, while lower-level KPI's (in the various units/departments) focus on sub-processes.

Typical high-level production process KPI's may include:

- Health, Safety, Security, Environment and Quality (HSSEQ)
- Product Quality (PQ)
- Margin
- Cost
- Energy
- Reliability
- People

A typical refinery high-level KPI dashboard could look like as in the attached picture.

The lower-level KPI dashboard is far more detailed as shown by a major European refinery where around 80 individual items are evaluated on monthly basis. Examples of these production process KPI's are:

- Lead the Business: percentage of legal compliance, percentage of audits completed, …
- Assure HSSEQ: number of API Tier-1 and Tier-2 incidents, number of fires, …
- Make Products: number per hour of total alarm rate, tons per month flare rate, …
- Provide Asset Availability: number of overdue inspections, number of temporary repairs (clamps), …
- Finance Management: site cash flow, site manufacturing cost, …
- People & Organization: percentage of shift coverage, percentage training exams success rate, …
- Asset Capability: number of overdue plant changes, percentage of projects progress on time, …

The relevance of a KPI is determined by so-called SMART criteria (Specific, Measurable, Attainable, Relevant, Time-bound). Measuring KPI's on a – say – monthly basis enables management to take timely corrective action and improve the production processes in favour of more positive overall business results.

Interested to improve your business results as well using dedicated KPI dashboards? Contact ppPLUS.

Result Area	High-Level KPI Dashboard REFINERY X, March 2019 Description	Lowest level	Units	Improvement direction	Year target	Month target	March 2019	Cumulative Year 2019
	Numerical examples are fictitious and for illustration purposes only							
HSSEQ	API Tier-1 Process Safety Incidents	Unit	#	↓	0	0	0	1
HSSEQ	Loss Of Primary Containment (LOPC) > 10kg/event	Unit	#	↓	100	8	7	24
HSSEQ	Total Recordable Case Frequency (TRCF)	Site	# / mhrs	↓	0	0	1.4	1.5
HSSEQ	Environmental Incidents ('Non-Compliances')	Unit	#	↓	5	0	1	2
PQ	Product Quality Incidents (outside the fence (medium, high))	Unit	#	↓	0	0	0	0
PQ	Product Quality Reliability Incidents (Inside the fence (all))	Unit	#	↓	180	15	12	41
Margin	Gross Refining Margin (GRM)	Site	M$	↑	500	42	47	130
Margin	Margin Improvement delivered by Special Projects	Site	M$	↑	30.0	2.5	2.3	7.9
Margin	Refinery Utilization	Unit	%	↑	85.0	85.0	87.2	85.7
Cost	Turnaround Cost (Plan minus Latest Estimate)	Site	M$	↑	0	0	3	2
Cost	Site Manufacturing Cost	Unit	M$	↓	280	23	27	68
Energy	Refinery Energy Intensity Index (EII, Solomon Associates)	Unit	-	↓	86.0	86.0	86.2	86.6
Reliability	Mean Time Between Maintenance (MTBM)	Unit	Weeks	↑	80	80	75	78
Reliability	Refinery Unplanned Downtime	Unit	%	↓	3.0	3.0	1.6	2.2
People	Continuous Improvement Culture Index (measured yearly)	Site	%	↑	90			92

Oil-Chemical Integration Optimisation to Increase your Margin

Oil-Chemical Integration is to increase the company's margin by having refineries and chemical business entities working close(r) together.

Why Pursue Oil-Chemical Integration?

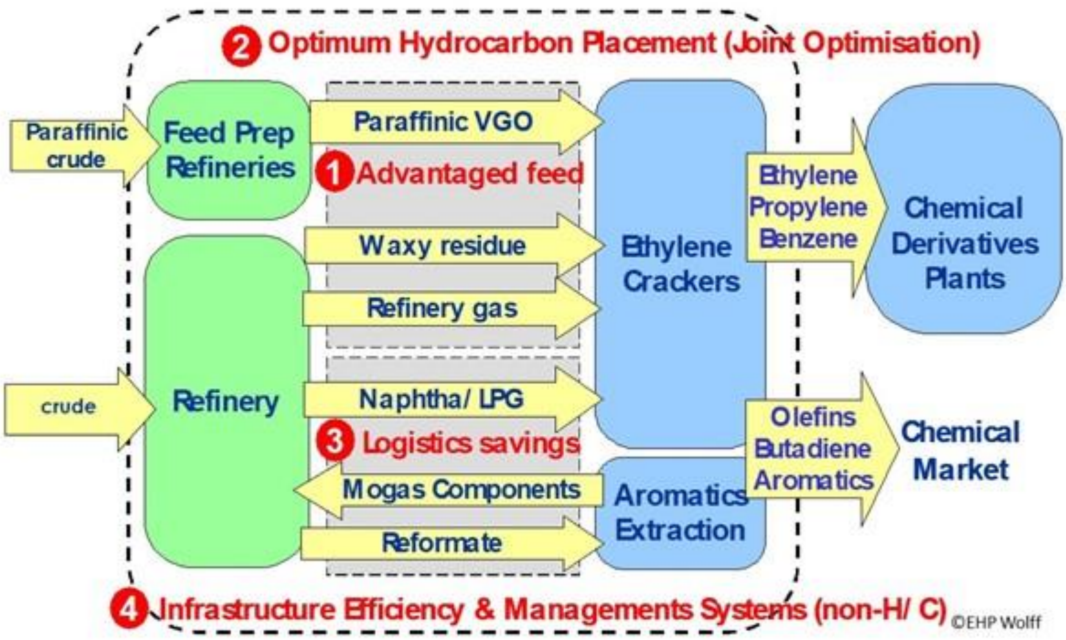
- Greater profit versus non-integrated operations.
- Competitive advantage over non-integrated refiners & chemical producers. More flexibility handling streams.
- Petrochemicals integration provides refiners with access to fast-growing chemicals markets and a natural hedge against weakening demand growth for gasoline and diesel (if any).
- More stable cash flows (possibly….).
- Reduced capital cost versus non-integrated refining and base petrochemical investments. Potentially lower Capex to accommodate new specifications on products.

Components of Oil-Chemical Integration Value:

1. Structural (feedstock integration);
2. Use of feedstocks/product streams with low alternative values due to e.g. logistics costs or local situations.
3. Good examples are extra heavy gasoil, hydrowax from a hydrocracker, catcracker dry gas, some aromatic streams.
4. Operational (integration – feedstock choice & flexibility/synergy);
5. Right choice of feedstocks & utilisation of co-product streams to optimise vale.
6. Exploitation of seasonal opportunities in refined products/cracker feeds, e.g. LPG, gasoil.
7. Logistics;
8. Avoidance of transport costs for feedstock and co-product streams (due to co-location).
9. Infrastructure/management services;
10. Sharing economies of scale in, e.g. site overheads, fire brigade, utilities, logistics infrastructure, control rooms, maintenance workshops, procurement & trading.

Typical Oil-Chemical Integration Strategies using Hydrocarbon Synergies:

- Make & gather waxy gas oil streams as ethylene cracker feed.
- Extract benzene and xylenes from reformate & pygas streams – to meet mogas regulations and to respond to chemical market.
- Use ethylene cracker capability to help manage refinery fuel balance and production of H2 for refinery.
- Use ethylene cracker capability to avoid capex related to distressed refinery streams.
- Recover propylene from refinery FCC streams.
- Converting difficult-to-market chemical by-products to more easily marketed fuels products.



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Refinery Introduction Course

ppPLUS offers the following in-house course for those interested in getting a solid broad awareness of the refinery business:

Title: Refinery Introduction Course

Level, Duration, Place: Basic, 3 days, in-house class room or VILT (remote).

Purpose:

- Getting a broad awareness of the refinery business.
- Providing a global perception of the refinery as a business, by providing basic technical information on refining processes, the place of the refinery in the value chain and future trends.
- Getting awareness of the basic tools and techniques used for economic evaluations in refineries.

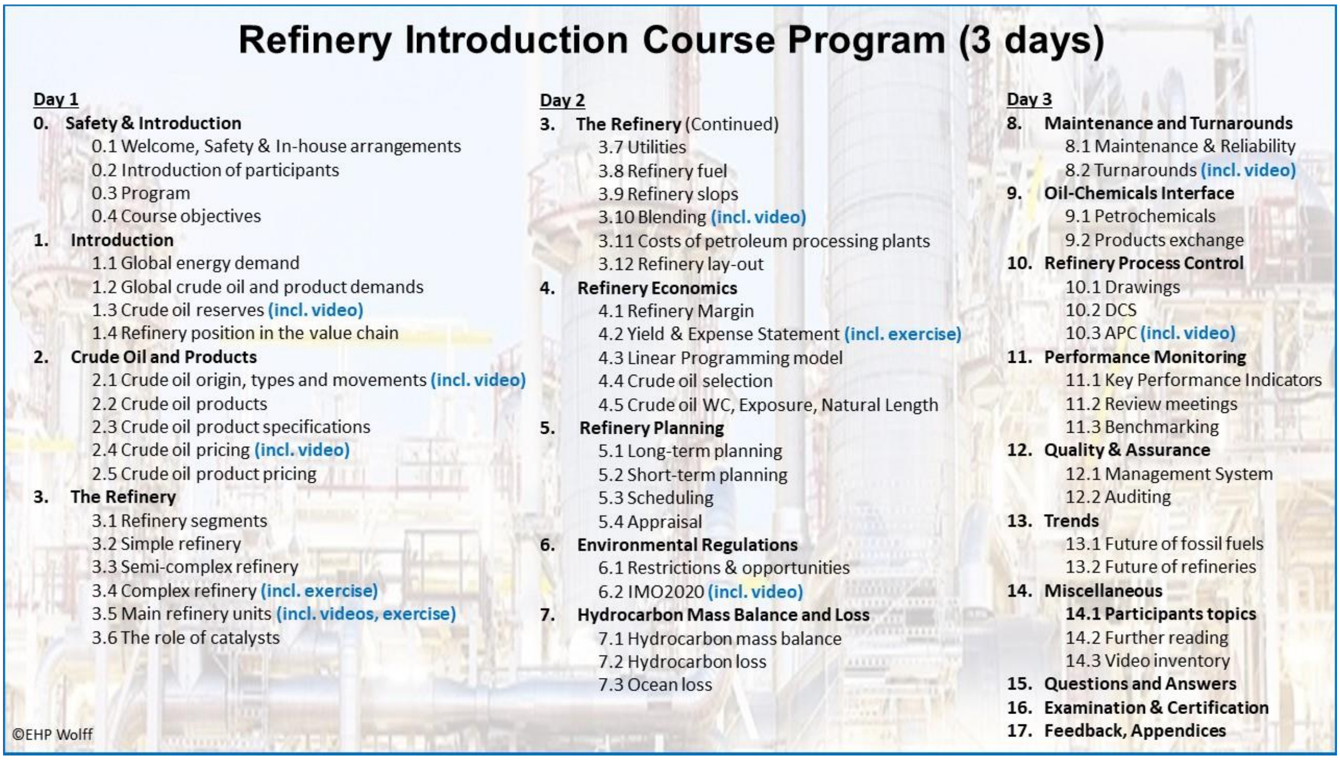
Target Audience:

- Non-refinery professionals in the Oil & Gas industry or related sectors, such as consultants, contractors, suppliers and other interrelated companies interested in the oil refining business.
- Newly-hired refinery personnel and current semi-technical personnel who require introductory training to acquire the broader perspective.
- Employees of Private Equity firms and other investors interested in the refinery business.
- Environmental professionals, insurance representatives, government officials, energy industry journalists & reporters and other professionals who desire a better understanding of the subject matter.

Learning Objectives:

- State the role of the main refining processes, operating characteristics, crude and products quality parameters, economics and planning.
- Describe the place of the refinery in the value chain from 'well to wheels', including petrochemicals.
- Recognize the need for performance monitoring, Quality & Assurance.
- Explain the challenges (including environmental), opportunities and future trends in the refining industry.
- Understand and use the crude oil refining terminology.

This course includes presentations, short video's, exercises, interactive sessions (participants can propose relevant topics upfront to discuss in class) and an (optional) examination with certification. Full 3-day program in the picture attached below.



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How to Select the Best Crude Oils for Your Refinery

Introduction
In a generally low-refinery-margin environment an optimal selection of your feedstocks is essential. The feedstock of a refinery typically consists of:
Crude oil and condensates
Intermediate feedstock imports (such as platfeed, platformate, gasoil, …)
Blending components (such as additives, MTBE, ETBE, alkylate, isomerate, FAME, ethanol, …)
Chemical feedstocks (such as methanol for MTBE production and returns from petrochemical plants)
Natural gas (for steam reforming)
Hydrogen (for hydrotreating, hydrodesulphurisation and hydrocracking)
Others

Volume-wise, crude oil is by far the dominant feedstock. It typically accounts for minimal 95% of the refinery intake.

To meet market demand for fuels (such as LPG, gasoline, kerosene, diesel, heating oil, fuel oil, …), bitumen, chemical feedstocks (for steam cracking) and lube-oils, most refineries run on multiple types of crude. This, as there is no single crude available that can be economically refined into all products required. Moreover, some crude oil products can be made from specific crudes only. For example, low-sulphur gasoline is (less-costly) produced from a low-sulphur crude. Bitumen production needs specially selected high-sulphur crudes. Chemical feedstocks for a steam cracker require high-paraffinic low-sulphur crudes, etcetera.

Crude Assays and Crude Acceptance Matrixes
To facilitate the selection process (feasibility), Crude Assays and Crude Acceptance Matrixes are used. Crude Assays give us information about the bulk crude properties and indicate the key properties (yield and quality) to be expected in the fractional components when the crude oil is distilled and refined. Using the crude assay data, the qualities of crude and products/components can be compared with the site-specific limits and requirements. A summary of this data for all crudes reviewed by the refinery leads to the Crude Acceptance Matrix (CAM). The output of this CAM-process is a 'Crude Category' (such as 1. acceptable, 2. constraints to be discussed first, 3. not acceptable).

Optimisation steps
There are several steps to follow while selecting the optimal crude package:

1. Determine the market product demand (short- and long-term), offtakes, specifications/qualities, and netbacks at refinery fence (tranche-ed and including premiums/discounts). Mind seasonal effects. The refinery hydrocarbon margin and upgrading economics are determined by the price differentials (cracks and spreads), such as crude – product, gasoline – naphtha, gasoil – fuel oil, gasoline – gasoil.
2. Get clarity on the availability and capacities of the refinery units' hardware (turndowns/slowdowns, maximum capacities, unit yields, utilities performance, specifications, operational costs including catalysts, environmental constraints, …).
3. Determine the feedstock availabilities including their amounts, properties/qualities, and their refinery-fence landed prices.
4. Optimizing the feedstock intake is typically done with a linear program (LP) model. An LP model is a mathematical model of the refinery, simulating and optimises all refinery unit yields, unit capacities, utilities consumption, and the like, as well as product blending operations of the refinery. It maximises profit by also selecting the 'best' feedstocks. Make sure the LP is in the first place correctly simulating the refinery performance for all scenarios within the pre-defined operating window.

The profitability of a refinery is to be evaluated in the company's total value chain, i.e. from 'well to wheels'. This includes crude exploration & production, trading, supply & distribution, refining, to marketing & retail. The facilitating optimisation process is called Sales & Operations Planning (S&OP).

Crude Added Value (CAV)
Typically, the Refinery Economist selects the margin-wise optimal (and of course feasible to process) crudes from the trading offers using his refinery LP. The margin contribution of a crude is calculated versus a pre-defined reference crude (or crude diet). The so-called Crude Added Value equals:

CAV = Margin Crude X – Margin Reference Crude [$/bbl]

The CAV is the key number in determining which crude to buy for a refinery as it represents the best estimate of the margin generated at the time the deal is made. Generally, of importance is the crude price/quality ratio (not solely price or quality).

Crude Indifference Value (CIV)
These CAVs are usually calculated by dedicated software systems in the Supply & Trading organization (to include freight, insurance, inspection, taxes, duties, fees, …) with input from the Refinery Economist. The required input is amongst others the Crude Indifference Values. The CIV is the difference in products values at the same crude price. Therefore, the CIV does not depend on crude market price — just on the product prices and yield slate (depending on hardware configuration. i.e. refinery complexity) and are usually calculated by the refinery LP based on crude marginal margin values. Now one can write for the CAV (the CAV and CIV of the Reference Crude are zero by definition):

CAV = CIV Crude X – (landed purchase price Crude X – landed purchase price Reference Crude) [$/bbl]

Generally, the refinery prefers those crudes with the highest CAV, but mind the whole value chain optimisation aspects!

Refinery Appraisal
After processing the crudes, refinery appraisal is the process to evaluate how the refinery performed versus plan, typically a monthly plan and a yearly plan. The objective is to learn where one did well and where not. This to be able to take corrective actions for better performance in the future. Each organisation likely has its own appraisal process. But a well-equipped refinery should have a so-called 'backcasting process'
(or 'retro-analysis') that uses multiple LP runs to verify the impact of various 'buckets' such as prices, feedstocks, refinery capability, products, others/unexplained. This goes thus beyond the comparison of simply 'Actual' versus 'Plan' missing the necessary granularity to improve.

Which crudes and/or condensates do you take for your refinery?

Picture source: www.abcmach.com

How to Make Sure Your Refinery is Fit for the Future (20 suggestions)

In a generally sustained low-refinery-margin environment it is essential to make sure your refinery is fit for the future. This article describes twenty measures that can be taken. Some are easier to implement than others but are listed anyway for inspiration to say the least.

What refineries are best situated to survive?

The shift to a low-carbon economy and the rise of digital technologies raise the stakes for refiners. Smaller and simpler refineries will be extremely challenged. True to Darwinian principles, the survivors may not be the strongest but the most adaptable. A mid-sized refinery of say 200,000 barrels/day crude oil throughput with a Nelson Complexity Index (NCI) of less than 5 is less likely to survive. The averaged competition is at this throughput rate at an NCI of around 10-11. Leading global refineries have a throughput of around 400 barrels/day with an NCI of around 13. A refinery with a higher complexity number is assumed to have higher yields of valuable light products per barrel of crude processed. Apart from throughput and complexity, also location, storage (depots, terminals), transportation options (road, rail, pipeline, waterways), and import- and export facilities for (intermediate) products are key. Sea-shore refineries nearby a port have an advantage over inland refineries. Integration with petrochemicals can be very advantageous. Unfortunately, in most cases the above conditions are a ‘given’ and cannot be easily adapted for the better without (major) capex investments.

What can a refinery manager do to improve the competitive position?

There are many measures that can be considered to improve the competitive position without major capex of which 20 are short-listed below in three sections, being Planning & Optimisation, Operational and Governance. Some suggestions may be open-doors indeed but will hopefully inspire for more. This is just a selection and there is truly much more available!

<u>Planning & Optimisation</u>:
1. Obtain a solid future outlook on refinery product demands. A long-term plan of at least 10 years with focus on the next 3 years. What products are in demand and how are the crude – product prices (Crack Spreads) developing. Include possible future environmental regulations (like IMO2020, CO2 costs, …), energy transition, impact of other types of energy carriers (such as electricity and hydrogen), the impact of the growing chemicals demand, …
2. Execute detailed planning for the coming year (the Annual Plan) and next three months using a dedicated and fine-tuned Linear Program. (*)
3. Use most recent Crude Assays and a state-of-the-art Crude Acceptance Matrix to determine the crude feasibilities. Execute risk management to manage decisions, such as for less quality crude intake at a distressed price. (*)
4. Consider long-term contracts to assure crude supply for the best price. However, leave room to be able to accept spot opportunities.
5. Optimise your crude oil intake for the next three months with most focus on the first month to come. There are several options to buy the best crudes using dedicated Linear Program evaluations using high-quality data. The financial impact of crude selection can be truly significant. Final optimisation takes place during the scheduling phase. (*)
6. Optimise as per above the other feedstock intake (and intermediate products export) as well, such as VGO, platfeed, platformate, methanol, FAME, additives, slops, fuel, H2, natural gas, utilities (such as steam to the steam reformer), …etcetera.
7. Optimise the integration with (nearby) petrochemical plants. Preferably using an integrated Linear Program and dedicated Sales & Operations Planning (execute Enterprise First Optimisation). (*)

<u>Operational</u>:
8. Execute regular Hydrocarbon Management Reviews (HMR). All feedstocks & products, process units, utilities, blending, logistics, constrains & specifications, and interfaces are to be scrutinized for improvement. Execute brainstorming sessions with subject matter experts. HMR’s will be addressed in a separate LinkedIn Article soon.
9. Consider increasing the turnaround frequency from say 4 to 5 or 6 years. Sweat the hardware assets (for example on catalyst usage). This requires a dedicated maintenance and inspection program and agreement with the relevant governmental institutions.
10. Minimize hydrocarbon waste production such as slops reprocessing.
11. Apply heat integration (using so-called ‘pinch analysis’) to reduce energy costs (typically around 50% of the total Operating Costs so potentially a lot to gain).
12. Develop a detailed hydrocarbon mass balance and estimate the hydrocarbon loss. This covers ocean loss and on-site losses. Accept a maximum loss of not higher than 0.5%m on-site. (*)
13. Execute refinery appraisal (backcasting) using LP to evaluate the refinery performance and take

corrective actions asap. A very powerful tool to discover where exactly the financial problem areas are. The combination of LP Review, Opportunities of Improvement identification, and full Backcasting frequently results in the refinery capturing profit improvement worth 20 to 40 US$ cent per barrel (for a say medium-sized 200,000 barrels per day refinery potentially about 15 to 30 M$/year). (*)

<u>Governance</u>:
14. Develop and maintain a Key Performance Indicator (KPI) dashboard, SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and Risk Visual Matrix. Discuss regularly what to action when required and implement asap. (*)
15. Execute independent internal enhanced operational audits regularly to further identify and implement improvement opportunities. (*)
16. Execute benchmarking externally to further identify and implement improvement opportunities. Get to know what you don't know.
17. Develop and execute a Robust Transition Strategy (to a long-term structural change in energy systems). This includes digitalisation & modernisation.
18. Sweating the Assets: Gross margin optimisation, cost control (incl. overheads), working capital (stock control) management. This includes crude oil working capital. Minimize these inventories but maintain enough to avoid slow-downs or even shutdowns as the consequential margin loss is not easily recovered. (*)
19. Portfolio Management: Focus on profitable capital expenditure versus the future outlook (see bullet 1. above).
20. On the People Side: execute leadership engagement continuously (on coaching, feedback exchange, action management, and performance management to name a few) and training. (*)

(*) These above-mentioned measures have been (partly) described in more detail in my other LinkedIn articles.

Recognise that the business environment will continue to be tough and competitive. Strive for a sustained very high performance and be continuously innovative!

Typical example of a refinery's CAM (part of):

Crude	Crude Category				Miscellaneous		Notes / Details
	1	2	3	9	C* (kt)	S (%m)	
Alba				X		1.3	Quality falls outside limits of acceptability in terms of handling in areas of density/V50 and TAN.
Anasuria		X				0.3	Do not blend with Curlew, Residue High Sulphur 0.65
Antan				X		0.26	Hi Tan, Poor Kero Gasoil + Residue
Arabian Lt						1.90	
Asgard	X					0.21	
Balder						0.67	
Banff		X				0.23	Limit to +/- 30% of CDU4 feed in CCU mode re: level of basic nitrogen in L/R. Also an issue with wax content of Gasoil.
Beatrice				X		0.05	Pour Point of crude outside handling limit.
Beryl		X				0.35	
Blenheim		X				0.38	Limited re: TAN of 0.67,L/R CCR also high at 5.8
Bonny Light		X			70	0.14	limit to 20% re: Gasoil properties are an issue with regard to ULSD blending.
Brass River		X				0.08	High basic nitrogen and Gasoil Density
Brega					70	0.2	Following data is missing Wax content of crude Naphthalenes data for Kero fraction Long Res quality would rank crude as cat 2
Brent		X				0.35	Cat 1 For Lube Slots
33%Curlew/ 67% Kyle			X			0.18	Cat 3 re High LPG yield

*** C = ship cargo size in kiltons.**

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How to Make Sure Your Refinery is Fit for the Future (20 suggestions)

In a generally sustained low-refinery-margin environment it is essential to make sure your refinery is fit for the future. This article describes twenty measures that can be taken. Some are easier to implement than others but are listed anyway for inspiration to say the least.

What refineries are best situated to survive?

The shift to a low-carbon economy and the rise of digital technologies raise the stakes for refiners. Smaller and simpler refineries will be extremely challenged. True to Darwinian principles, the survivors may not be the strongest but the most adaptable. A mid-sized refinery of say 200,000 barrels/day crude oil throughput with a Nelson Complexity Index (NCI) of less than 5 is less likely to survive. The averaged competition is at this throughput rate at an NCI of around 10-11. Leading global refineries have a throughput of around 400 barrels/day with an NCI of around 13. A refinery with a higher complexity number is assumed to have higher yields of valuable light products per barrel of crude processed. Apart from throughput and complexity, also location, storage (depots, terminals), transportation options (road, rail, pipeline, waterways), and import- and export facilities for (intermediate) products are key. Sea-shore refineries nearby a port have an advantage over inland refineries. Integration with petrochemicals can be very advantageous. Unfortunately, in most cases the above conditions are a ‘given’ and cannot be easily adapted for the better without (major) capex investments.

What can a refinery manager do to improve the competitive position?

There are many measures that can be considered to improve the competitive position without major capex of which 20 are short-listed below in three sections, being Planning & Optimisation, Operational and Governance. Some suggestions may be open-doors indeed but will hopefully inspire for more. This is just a selection and there is truly much more available!

Planning & Optimisation:
1. Obtain a solid future outlook on refinery product demands. A long-term plan of at least 10 years with focus on the next 3 years. What products are in demand and how are the crude – product prices (Crack Spreads) developing. Include possible future environmental regulations (like IMO2020, CO2 costs, …), energy transition, impact of other types of energy carriers (such as electricity and hydrogen), the impact of the growing chemicals demand, …
2. Execute detailed planning for the coming year (the Annual Plan) and next three months using a dedicated and fine-tuned Linear Program. (*)
3. Use most recent Crude Assays and a state-of-the-art Crude Acceptance Matrix to determine the crude feasibilities. Execute risk management to manage decisions, such as for less quality crude intake at a distressed price. (*)
4. Consider long-term contracts to assure crude supply for the best price. However, leave room to be able to accept spot opportunities.
5. Optimise your crude oil intake for the next three months with most focus on the first month to come. There are several options to buy the best crudes using dedicated Linear Program evaluations using high-quality data. The financial impact of crude selection can be truly significant. Final optimisation takes place during the scheduling phase. (*)
6. Optimise as per above the other feedstock intake (and intermediate products export) as well, such as VGO, platfeed, platformate, methanol, FAME, additives, slops, fuel, H2, natural gas, utilities (such as steam to the steam reformer), …etcetera.
7. Optimise the integration with (nearby) petrochemical plants. Preferably using an integrated Linear Program and dedicated Sales & Operations Planning (execute Enterprise First Optimisation). (*)

Operational:
8. Execute regular Hydrocarbon Management Reviews (HMR). All feedstocks & products, process units, utilities, blending, logistics, constrains & specifications, and interfaces are to be scrutinized for improvement. Execute brainstorming sessions with subject matter experts. HMR’s will be addressed in a separate LinkedIn Article soon.
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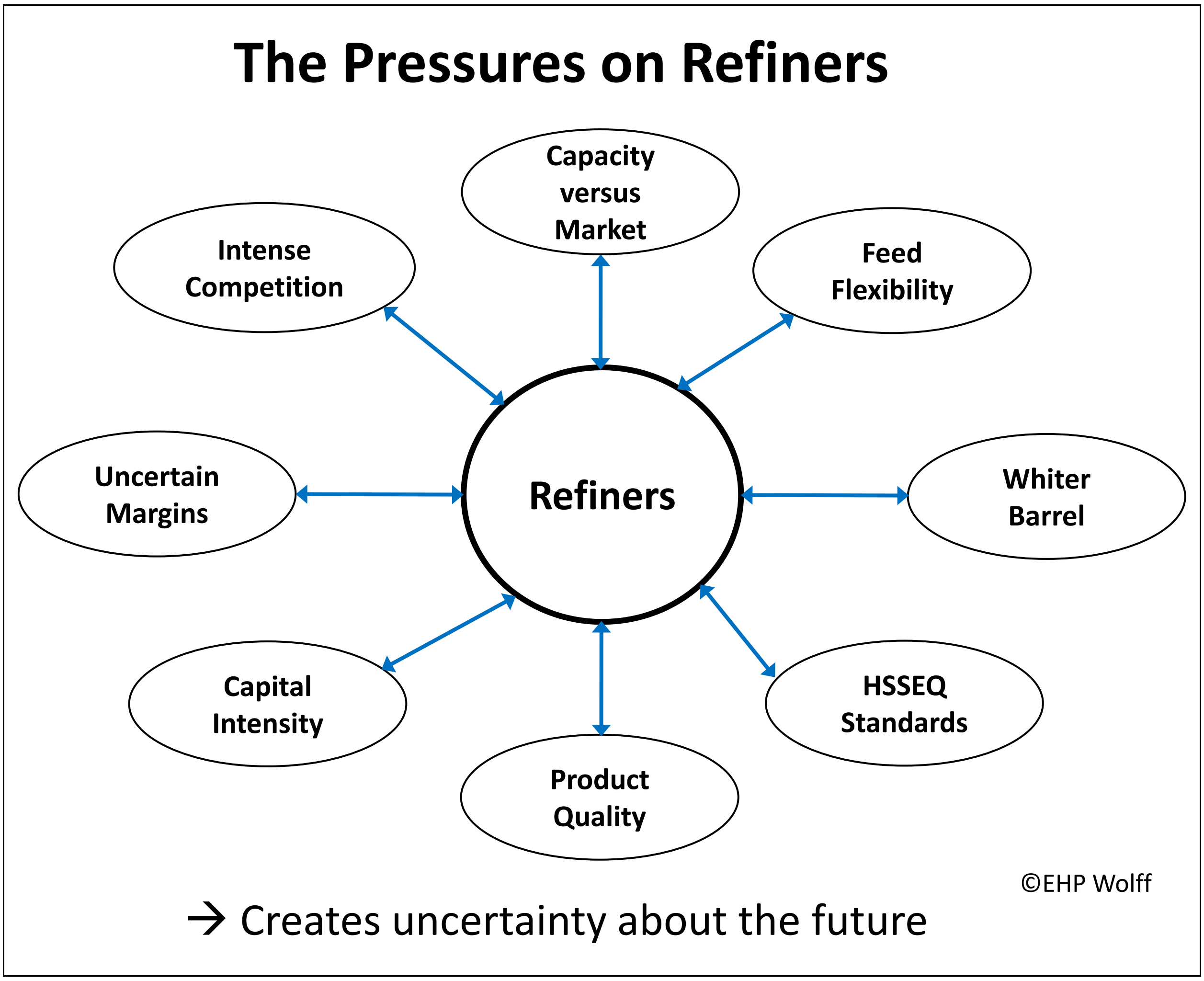


Execute Hydrocarbon Management Reviews to Maximise Your Refinery and Petrochemicals Profit

In my previous Article, I listed 20 measures that can be taken to support your refinery is fit for the future. One of them was regularly executing Hydrocarbon Management Reviews (HMR's). Below, you will find more details about this powerful tool including examples of real-life ideas gained in the past. HMR's can also be applied in the petrochemicals industry.

What is a Hydrocarbon Management Review?

An HMR is a structured process to create ideas to achieve - after implementation - the maximum benefits of a production site such as a refinery or petrochemicals plant. Typically, brainstorming sessions are used to create the ideas. Thereafter, an initial ranking takes place based on feasibility, safety, costs, margin gain and priority. The following categories are usually considered [within square brackets are typical examples of their sub-themes listed]:

1. Crude and Condensates [increase crude flexibility, optimise logistics, planning & optimisation]
2. Other feedstocks, such as VGO, platfeed, platformate, pyrolysis gas, heartcut, … etcetera [chemical feedstock maximisation, create feasibility]
3. Products [mogas reduction, middle distillate maximisation, residue (Fuel Oil) minimisation]
4. Environment [meet environmental requirements, CO_2/SO_x/NO_x emission reduction]
5. Logistics [mitigate constraints, optimise import/export/storage opportunities]
6. Manufacturing [develop/optimise capabilities, chemical feedstock maximisation, mitigate constraints]
7. Oil-Chemicals Advantage [create feedstock integration, improve feedstock choice & flexibility/synergy, chemical feedstock maximisation]
8. Others [miscellaneous]

How is an HMR executed?

A dedicated HMR Core Team is the executing body on-site. Participants are typically:
• External facilitator and coach (a highly experienced and recognised expert in hydrocarbon management)
• Economics & Scheduling Manager or Senior Refinery Economist
• Dedicated Refinery & Chemicals Technologist(s) (servicing production units and utilities)
• Dedicated Technical Advisor (for example an Inspection/Reliability Engineer for corrosion aspects)
• Plant Operations and/or Oil Movements representative
• Site Management Team representative (typically Technology Manager or Business Development Manager)
• 'Guests' where necessary (for example from Supply, Trading, Marketing, Laboratory, …)
A successful HMR is truly all about good teamwork!

How much effort is required to execute an HMR and what are the financial benefits?

The overall time required to execute an HMR for a mid-sized refinery (say 300,000 barrels/day) including petrochemicals is roughly 3 weeks (but not full time for every participant). This includes detailed preparation, several brainstorm sessions per category, ranking & prioritisation, create ownership, reporting and preparation for action execution and review. The frequency of executing HMR's is typically every four years.

The potential financial benefits gained varies widely per site depending on kick-off status, CAPEX availability, risk appetite, etcetera. Assuming a total gain of 0.1 $/barrel crude, the profit would be ca. 11 million $/year.

Typical outcomes of an HMR session

Below is a brief sample of a list of 22 ideas presented generated in the past for a major European refinery. The original list comprised over 350 raw ideas. About 90 ideas thereof are applicable to most other refineries as well for their consideration. More ideas are continuously added to this list!

1. <u>Crude and Condensates</u>: Execute crude topping, stretch TAN (Total Acid Number) limits by installing cladding or injecting corrosion inhibitors, blending of feedstocks into crude to ease current logistic constraints, mix heavy crudes with condensates, …
2. <u>Other feedstocks</u>: Increase capacity/flexibility to process advantage feedstock (such as butane) in steamcracker (rather blending into mogas or making LPG), create import/export facilities for (intermediate) feedstocks, …
3. <u>Products</u>: Minimise naphtha cutpoint (130ºC rather 160ºC, i.e. no C9+ in platformer to reduce mogas production), relax specifications to maximise import VGO, use excess Fuel Oil to make electricity and sell to grid, …

4. Environment: Use of a risk-based Leak Detection And Repair (LDAR) programme in order to identify leaking components and to repair these leaks, replace liquid refinery fuel by gas firing (to reduce CO_2), install CO_2 liquefaction to sell CO_2 to food industry and/or greenhouses, …
5. Logistics: Do a Pareto on the logistic constraints; (1) What are the 20% of issues causing 50% of the problems and (2) challenge whether we can eliminate the need, isolate physically the oxygenates from the naphtha logistics, have import/export options (from/to the market) for also intermediate refinery- and petrochemicals products available, ….
6. Manufacturing: Review and stretch all unit feedstock constraints (e.g. enable import poor quality VGO to HCU), for hot environments; Install air-coolers with water sprays, feed catcracker cycle oil to HCU (rather to Fuel Oil), N+A and paraffinic naphtha split/segregation, …
7. Oil-Chemicals Advantage: Feed hydrowax to steam cracker (rather FCC), use ethylene cracker capability to help manage refinery fuel balance and production of H_2 for refinery, buy distressed (off-spec) cargo's such as butane (originally meant for mogas blending or LPG production) for steam cracking, …
8. Others: Various digitalisation & modernisation topics, …

Picture source: https://www.abcmach.com/oil-mill-machinery/impurities-in-crude-oil-and-refining-methods.html

Refinery Planning & Optimisation, Scheduling and Appraisal

To run a crude oil refinery in a safe and financially optimal way the following three elements have to be carefully considered:

1. Planning & Optimisation; creating optimal production plans, both long- and short-term, for maximum Gross Refinery Margin, GRM.
2. Scheduling; creating and executing a safe and feasible implementation plan derived from the above mentioned short-term optimal plan.
3. Appraisal; evaluating the actual performance versus the original long- and short-term optimal plans to activate corrective actions where applicable to further improve on Planning & Optimisation and GRM (close-the-loop!).

Below, these three elements are briefly described:

1. **Planning & Optimisation** involves developing (very) long-term and short-term views:
   Long-term planning and optimisation covers a time frame from – say – one year to several years and is also executed to evaluate future options and for budgeting reasons. The more detailed annual plan is often called the Targets & Resources (T&R) plan. The tools used are usually Linear Programming (LP) models.
   A 'very' long-term planning (say up to 10 years), is sometimes referred to as a 'Refinery Improvement Plan' or 'Site Value Growth Plan' (SVGP) that typically covers Growth, Asset Integrity, Cost Management, and Maintain Margin portfolios and has a more strategic purpose and also for budgeting reasons. The tool used is typically a web-based programme and does not involve an optimisation step as done with LP.

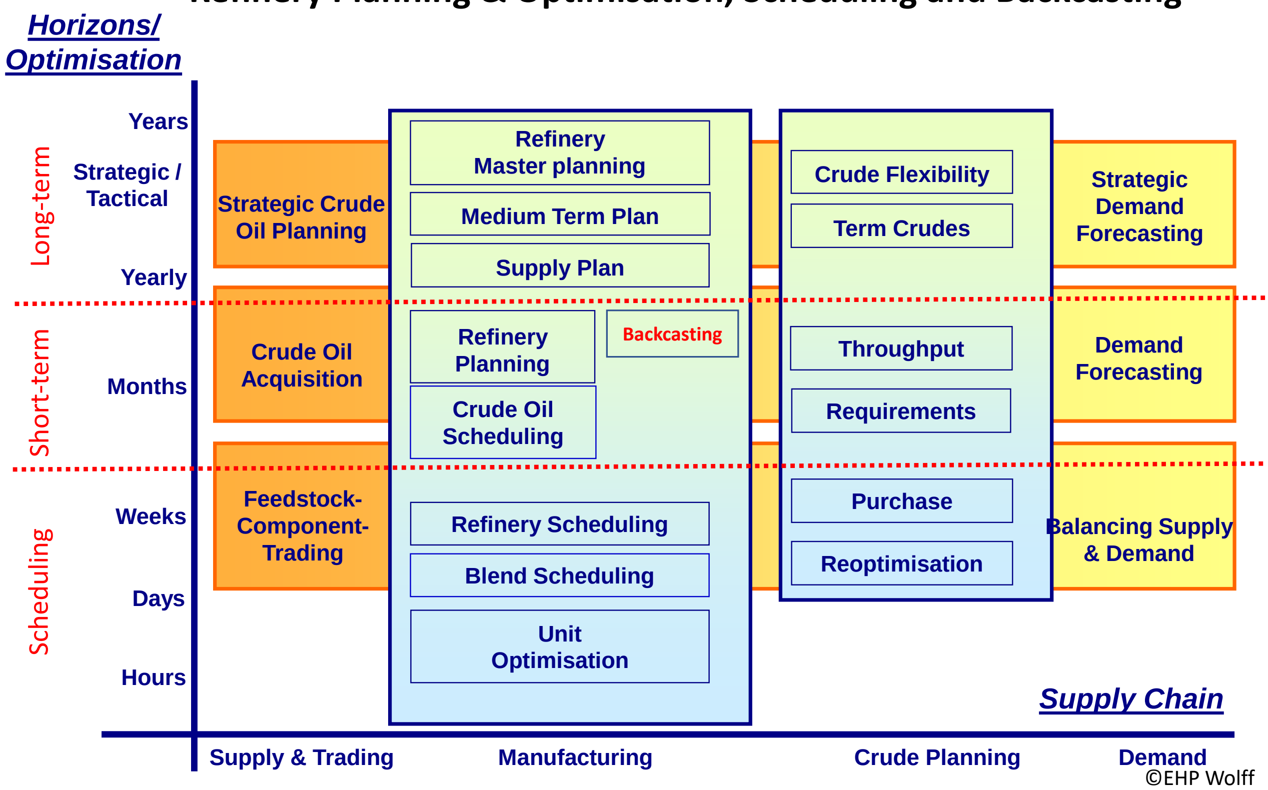
   Short-term planning and optimisation covers a time frame from – say – a week to several (1 to 3) months. The refinery GRM-optimised and feasible plans should be ready for the Refinery Scheduler to implement. Most focus is generally on the first month to come. The process is similar to long-term planning using the same LPs but uses more up-to-date information. Excellent crude oil planning is key as crude represents the major cost factor with lots of optimisation potential.
2. **Scheduling** covers a time frame from – say – a day to a week. The Refinery Economist (not the Refinery Scheduler) still runs sometimes LP models for re-optimisation depending on short-notice changed conditions. The scheduling activities mainly aim at implementing the final optimised plan into practice by determining when to execute certain production activities.
   Although profitability is still essential (e.g. minimised product quality give-away), the focus is on feasibility and operability including process safety aspects. A scheduling tool commonly used is 'Orion/Aspen Petroleum Scheduler', but can also be company homemade (e.g. in Microsoft Excel).

3. **Appraisal** is the process to evaluate how the refinery actually performed versus the final original optimised plan, typically a monthly plan and the annual T&R plan. The objective is to learn where the refinery did well and where not. This, to be able to take corrective actions for better planning & optimisation and ultimately improved financial performance in the future.
   A well-equipped refinery should have a so-called 'backcasting process' (or 'retro-analysis'). The same LP – as for planning & optimisation – is used to run multiple LP cases to verify the financial impact of various 'buckets', such as 'prices', 'feeds' (where crude is key), 'products', 'refinery capability', 'unexplained', etcetera. This process creates far more granularity than just comparing Actual versus Plan which is still the standard in many refineries unfortunately.

Development and evaluation of refinery production plans is not only a matter of the refinery (Manufacturing) itself, but part of a Supply Chain process. Also involved are Supply & Trading (for feedstocks), Marketing & Trading (for products) and some other stakeholders. The governing process is called 'Sales & Operations Planning'. S&OP involves five steps, being (1) New Activities, (2) Demand Forecasting, (3) Supply Planning, (4) Integrated Reconciliation, and (5) Management Review.

Each organisation in the value chain likely has its own appraisal process already, but they may need alignment with the refinery appraisal process (for example to avoid conflicting Key Performance Indicators, KPIs). This, because the profitability of a refinery is to be evaluated in the company's total value chain for enterprise-first optimisation. Therefore, successful refinery planning & optimisation, scheduling and appraisal is truly all about high people competences & availability, the right tools and good teamwork!

Refinery Planning & Optimisation, Scheduling and Backcasting



Petrochemicals Planning & Optimisation, Scheduling and Appraisal

To run a petrochemicals plant in a safe and financially optimal way the following three elements have to be carefully considered:

1. Planning & Optimisation; creating optimal production plans, both long- and short-term, for maximum Gross Petrochemicals Margin, GPM (comparable to a refinery's GRM).
2. Scheduling; creating and executing a safe and feasible implementation plan derived from the above mentioned short-term optimal plan.
3. Appraisal; evaluating the actual performance versus the original long- and short-term optimal plans to activate corrective actions where applicable to further improve on Planning & Optimisation and GPM (close-the-loop!).

These three elements are very similar to refinery planning & optimisation, scheduling and appraisal as described in another Flyer.

While refineries run on a mixture of crude oils and/or condensates, petrochemical plants (such as steam crackers with its various downstream units) run typically on various types of naphtha – with recycled ethane – and optionally on vacuum gasoil, heavy gasoil, propane, butane and even hydrowax. Using Linear Programming (LP) optimisation models, amongst others, the (financially) optimum feedstock intake package is determined.

Although planning & optimisation and scheduling for petrochemicals are quite similar to their refinery operation equivalents, their appraisal process is often not as matured as for refineries. Therefore, we will focus below on petrochemicals appraisal.

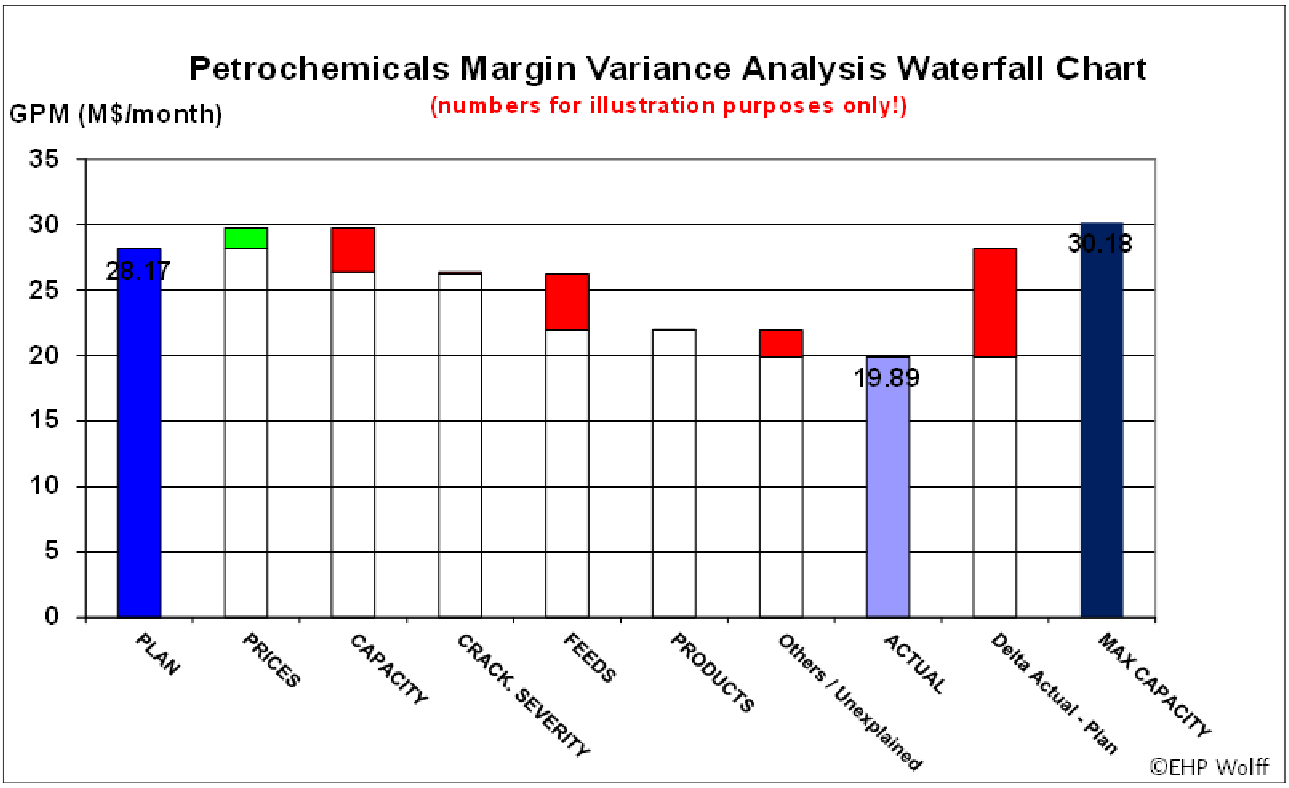
Petrochemicals Appraisal is the process to evaluate how the petrochemicals plant actually performed versus the final original optimised plan, typically a monthly plan and/or an annual plan. The objective is to learn where the petrochemicals plant did well and where not. This to be able to take dedicated corrective actions for better planning & optimisation and ultimately improved financial performance in the future.

A well-equipped petrochemicals plant should have a so-called 'backcasting process' (or 'retro-analysis'). The same LP – as for planning & optimisation – is used to run multiple LP cases to verify the financial impact of various 'buckets', such as 'prices', 'plant capacities', 'steam cracker severity' (e.g. by steam cracker furnace coil outlet temperatures), 'feeds' (where naphtha is key), 'products', 'others / unexplained', etcetera. Optional is to assess actual margin performance against true site potential; 'Max Capacity'.

This process creates far more granularity than just comparing Actual versus Plan which is still the standard for many petrochemical plants unfortunately.

Several flyers are available from the author diving into more detail on above mentioned elements.

Interested to learn more about optimising your petrochemicals plant? ppPLUS can provide your support.


Petrochemicals Margin Variance Analysis Waterfall Chart
GPM (M$/month)
(numbers for illustration purposes only!)
35
30
25
20
15
10
5
0
28.17
19.89
30.18
PLAN
PRICES
CAPACITY
CRACK. SEVERITY
FEEDS
PRODUCTS
Others / Unexplained
ACTUAL
Delta Actual - Plan
MAX CAPACITY
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Refinery and Petrochemical Integrated Management Systems

A Management System is a set of policies, processes and procedures used by an organization to ensure that it can fulfil the tasks required to achieve its objectives. These objectives cover many aspects of the organization's operations (including safe operation, financial success, reputation, client relationships, product quality, legislative & regulatory conformance and worker management).

For instance, an environmental management system enables organizations to improve their environmental performance and an Occupational Health and Safety Management System (OHSMS) enables an organization to control its occupational health and safety risks, etcetera.

A so-called **Integrated** Management System comprises Quality Management (QM), Data Security (DS), Compliance Management (CM) and Risk management (RM). All of these integrally covered by Process Management (describes how to manage these elements, amongst others with actions, reviews and management sign-offs).

Integrated Management System elements for a refinery or petrochemicals plant may include (main elements between brackets, overlap occurs):

• Leadership Involvement & Responsibility (QM, DS, CM, RM)

• Audit, Assurance and Management System review & Intervention, Code of Conduct (QM, DS, CM, RM)

• Documentation, Records & Knowledge Management (QM, DS, CM, RM)

• Employee Selection, Placement & Competency Assurance (QM)

• Workforce Involvement (QM)

• Contractor/Vendor Selection & Management (QM)

• Communication with Stakeholders (QM)

• Project Monitoring, Status and Handover (QM)

• Management of Interfaces (QM)

• Documented Procedures (QM, CM)

• Management of Change & Project Management (QM, RM)

• Operational Readiness & Start-up (QM, RM)

• Standards & Practices (QM, RM)

• Identification & Compliance with Legislation & Industry Standards (CM)

• Management of Critical systems (CM, RM)

• Incident Reporting & Investigation (CM, RM)

• Identification & Assessment of potential failures & other hazards (RM)

• Emergency Preparedness (RM)

• Inspection & Maintenance of facilities (RM)

• Work Control, Permit to Work & Task Risk Management (RM)

Elements of an Integrated Management System

Source: https://www.indiamart.com/proddetail/integrated-management-systems-compliance-audit-services-in-india-20882841173.html

Refinery and Petrochemicals Process Unit Monitoring

Process unit monitoring in an oil refining/petrochemicals complex requires an understanding of the significance of any changes that occur in the process parameters (temperatures, pressures, flows, levels, valve openings, densities, chemical compositions, qualities, …). The effort required to monitor every change in the process parameters of a complex plant is huge and thus infeasible to execute manually.

Commercially available software enables you to easy monitor closely all refinery/petrochemicals units and more. An example is ‘PI ProcessBook’, a software tool – integrated with the local Distributed Control System (DCS) – used to display and record real-time data transparent in a dynamic, interactive graphical manner. It provides tools for analysing data on the display and special activities or routine chores can be automated.

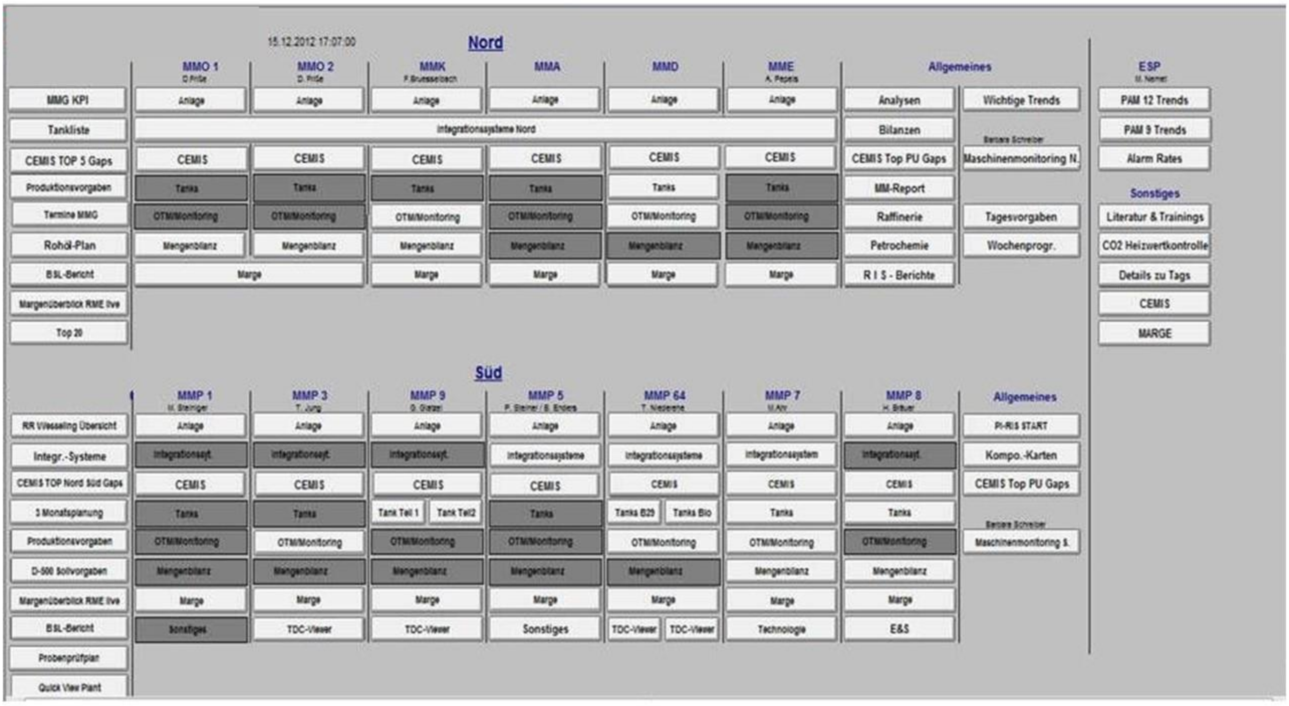
Main users are typically from Operations, Technology, Economics & Scheduling and HSSEQ departments. They use it, for example, for real-time monitoring, analysis, optimisation, troubleshooting, historical trending, benchmarking, quality control & assurance, crisis management and inter-departmental communication.

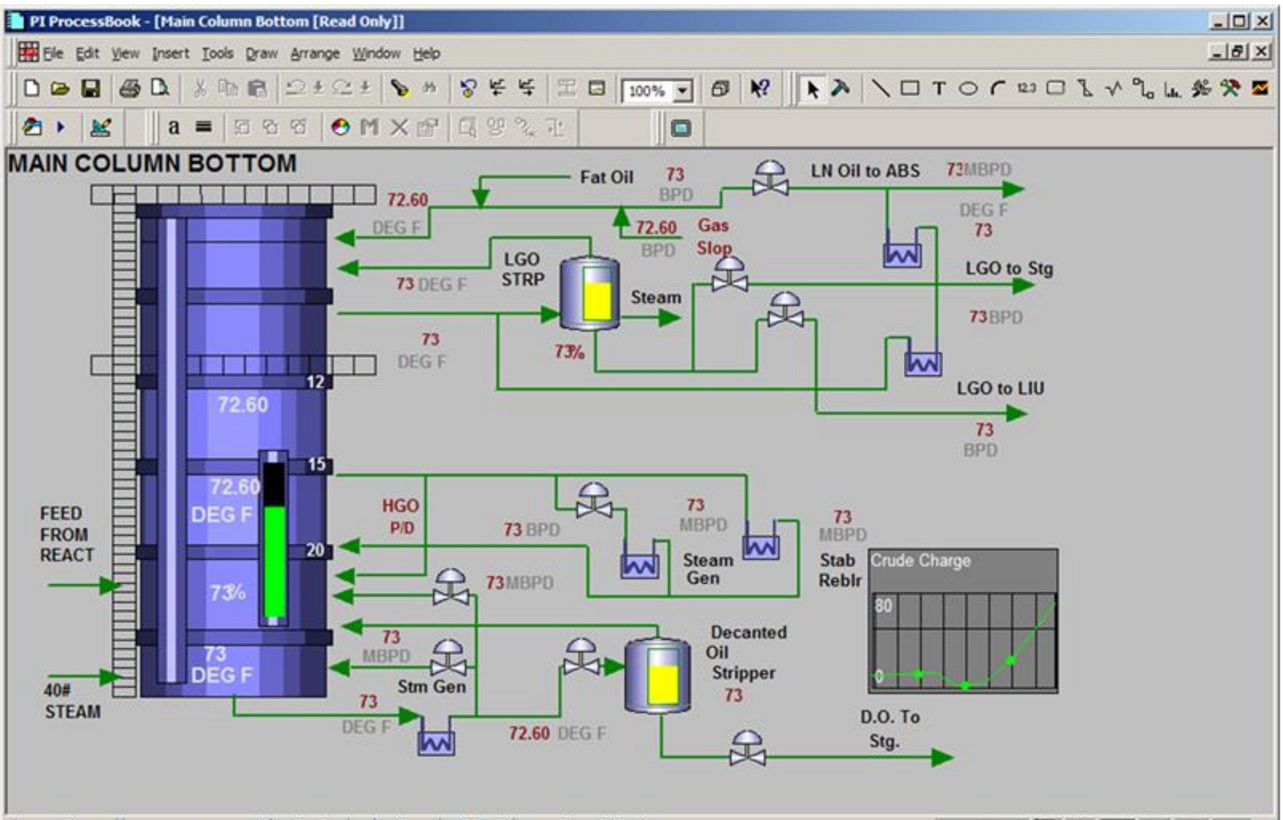
The first picture shows an example of a PI ProcessBook refinery monitoring opening sheet, where MMxx stands for the various process plants. For example, ‘MMO’ represents mainly ADU, VDU, HDS, VBU and TGU, all visible in great detail in their submenus.

The second picture attached shows an example of a detailed PI ProcessBook crude distillation process plant submenu.

For each reading a historical trend can be displayed. For example, these trends can be used to predict heat exchanger fouling rates. For this purpose, two mass flows and four temperatures (twice inlet/outlet) together with a constant heat transfer area are needed to calculate the ‘overall heat transfer coefficient’ (U in $W/m^2/K$). The decrease of this overall heat transfer coefficient (preferably graphically presented) is a measure of the fouling rate. Below a pre-defined threshold value corrective action is needed, such as cleaning the heat exchanger. This is only one, relatively simple, example of many possible process unit monitoring topics.

Interested to learn more about refinery and petrochemicals plant monitoring? ppPLUS provides your support.





Source: https://www.teampower.it/index.php/en/industry/osisoft-pi/processbook.html

Refinery and Petrochemicals Decarbonisation

In December 2015 the world committed to the historic COP21 Paris Agreement which saw 195 countries commit to take action to reduce carbon (CO_2, CH_4, …) emissions. This Agreement included the goal of keeping the global mean temperature rise to well below 2 ˚C, whilst pursuing efforts to limit temperature rises to less than 1.5 ˚C. For example, Europe envisages carbon reductions of 55% by 2030 and 90% or more by 2050 both vs. 1990.

Burning fossil fuel hydrocarbons in process furnaces and the production of H2 (via steam methane reforming) are the main reasons for the direct CO2 emissions in the refinery and petrochemical industry. Indirect emissions are related to the purchase of electricity and H2.

Directly and indirectly, the oil and gas industry accounts for 42% of the global emissions (33% O&G value chain – associated with the final use of refining products, 8% direct O&G operations, 1% indirect O&G operations). Therefore, also this industry is severely pushed to decarbonise to make its contribution.

Short-term and long-term options to enhance refinery and petrochemicals decarbonisation are for example,

Mostly short-term (less CAPEX):
• Processing lighter (high API) and sweeter (low sulphur) types of crude oil
• Feed-in of biofuels (vegetable oil, pyrolysis oil and algae-based) within refinery processes
• Heat exchange to residential districts or nearby industries (such as greenhouses)
• CO2 exchange to greenhouses for their cultivation (replacing cogeneration units)
• Technologies that reduce the CO2 emissions of the crude distillation unit (process/energy optimisation, install pre-flash, integration of atmospheric distillation with vacuum distillation and decoking)
• Technologies that reduce the CO2 emissions of the other refining processes (new catalyst, new design, install residual hydroconversion)

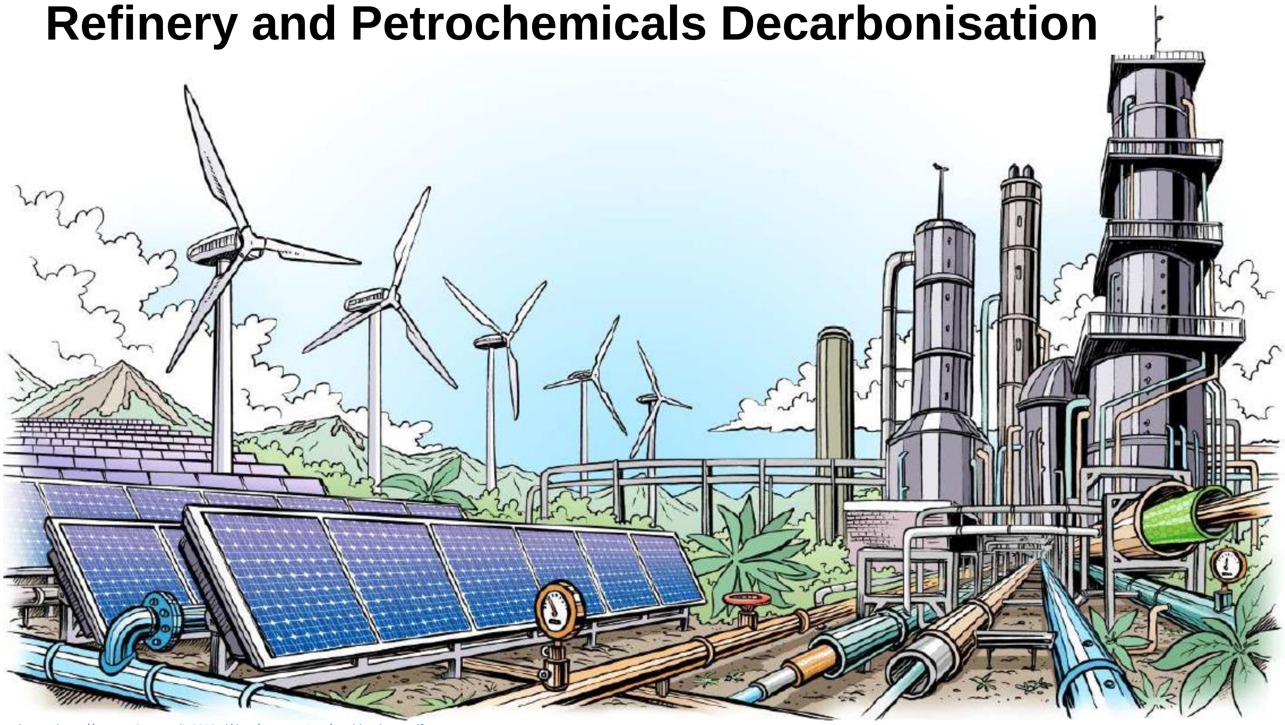
Mostly long-term (more CAPEX):
• Implementation of process integrated cogeneration units
• Using renewable energy for electricity requiring processes within refinery and petrochemicals
• Using renewable energy in combination with power-to-heat or power-to-gas
• Carbon Capture and Storage (CCS, normally in an underground geological formation)
• Carbon Capture and Utilisation (CCU, converting the captured CO2 into more valuable substances or products; such as plastics, concrete or biofuel, while retaining the carbon neutrality of the production processes)

There are already available techniques to reduce the carbon footprint of an industrial operator that focus both on internal and external factors.

By-the-way, nuclear energy is carbon-clean but debatable for costs, construction time, safety and nuclear waste reasons.

Interested to learn more about refinery and petrochemicals decarbonisation? ppPLUS can provide your support.

Refinery and Petrochemicals Decarbonisation



Source: https://www.co2neutraalin2050.nl/docs/presentations/ruud-kortlever.pdf