

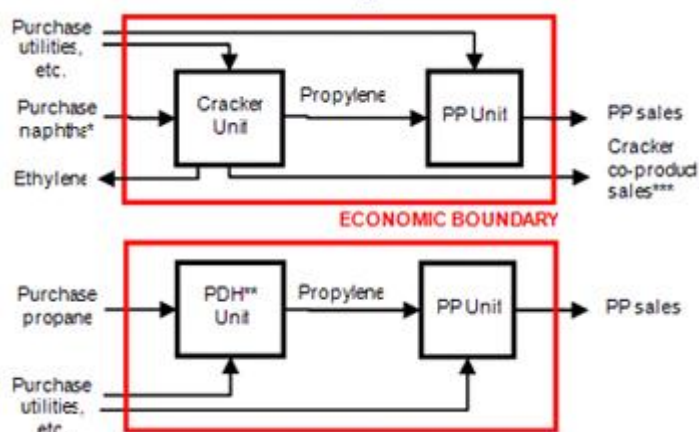
ICIS Weekly Margin – Polypropylene (PP) Asia Methodology

This document is intended to provide methodology support for customers receiving the ICIS Weekly Margin - PP Asia report.

THE BUSINESS MODEL

The diagram below shows the two main methods of making [polypropylene](#) (PP): from [naphtha](#), a product mainly derived from [crude oil](#); or [propane](#), a [petroleum gas](#).

Naphtha with steam is fed into the cracker unit where [ethylene](#), [propylene](#) and other co-products ([butadiene](#), [benzene](#), etc.) are made. Propane is fed into a propane dehydrogenation (PDH) unit over a catalyst where propylene is the only main product. The propylene from the cracker or PDH unit is then further processed (polymerised) in the PP plant to make the PP pellets for sale.



*Naphtha is the dominant cracker feedstock in Asia

**PDH (propane dehydrogenation)

***includes butadiene, raffinate-1, fuel gas, benzene, gasoline blending components

THE MARGIN CALCULATION

- Margin measure provides assessment of the ex-works cash margin obtained for the product over raw material costs and key variable manufacturing costs, such as power, steam, catalysts and chemicals. This measure can also be termed as a variable margin, contribution or benefit.
- It represents a cash margin measure available for supporting the direct and allocated fixed manufacturing costs, working capital, taxes, royalties, corporate costs, debt service costs, capital costs and owner's returns from the business.

- This margin measure provides simple signals on the direction of business margins, as dictated by the environment alone, thus informing market positioning by sellers, buyers and traders.
- ICIS chooses not to model beyond raw material costs and key variable manufacturing costs as this ceases to be generic to the integrated industry and highly specific to individual business operations, their site structure, location, ownership and financial structures. Such detail would not fairly reflect or be applicable in a wider industry context. It may also be more subjective, open to fair challenges and not feasible to reference in commercial discussions.
- Plant manufacturing and feedstock yield model data have been provided by Linde Engineering, a division of Linde AG. Linde Engineering (www.linde-engineering.com) is a leading international chemical plant designer, process engineering, procurement and construction contractor. It has extensive experience in steam cracker, PDH and PP plant design.
- The process model is generic and not referenced to any individual operation, so that the contribution measure is only indicative. It can be most valuably referenced in index and step change terms as opposed to absolute value terms.
- Naphtha feedstock has been chosen as this represents the most commonly used feedstock for ethylene and propylene manufacture in Asia. As such, the cost model is broadly applicable to the majority of the Asian commodity PP business.
- Margin measure from the cracker is calculated on a 'per tonne of olefin' basis i.e. the margin achieved when producing one tonne of ethylene and propylene. A combined olefin analysis is used because ethylene is the primary product from the cracker.
- Ex-works product price assessments are linked to ICIS pricing quotations for large volume commodity products with netbacks assessed using typical logistic cost assessments.
- The PP grade referenced in the ICIS PP - Asia Margin report is the PP flat yarn/raffia grade. This generally represents large-volume commodity grades in the PP market. The ICIS spot China main port and spot SE Asia quotes are referenced as these are broadly representative of the northeast Asian and southeast Asian markets respectively.

Below is a detailed calculation of how the integrated (naphtha based and PDH based) and standalone margins are calculated. The figures refer to averages for northeast Asia for 2008; the calculation for southeast Asia is similar. Figures indicated in red are those found in the tables of the margin report; others relate to underlying assumptions of the model.

NORTHEAST ASIA

Integrated margin - naphtha base - averaged for 2008

| | | \$/tonne PP |
|--|--------------|----------------|
| PP flatyarn/raffia price | 1,433 | |
| Logistics costs | <u>(38)</u> | |
| Net selling price | | 1,395 |
| Purchase feedstock (naphtha) ¹ | (1,783) | |
| Co-product sales/tonne of PP produced ^{2,3} | 732 | |
| Variable cost of PP unit | <u>(132)</u> | |
| | | (1,183) |
| Integrated margin | | 212 |

Integrated margin - PDH base - averaged for 2008

| | | \$/tonne PP |
|---|--------------|----------------|
| PP flatyarn/raffia price | 1,433 | |
| Logistics costs / netbacks | <u>(38)</u> | |
| Net selling price | | 1,395 |
| Purchase feedstock (propane) ⁵ | (916) | |
| Export fuel balance | (120) | |
| Variable cost of PP unit ⁴ | <u>(132)</u> | |
| | | (1,168) |
| Integrated margin | | 227 |

Standalone margin - averaged for 2008

| | | \$/tonne PP |
|---|-------------|----------------|
| PP flatyarn/raffia price | 1,433 | |
| Logistics costs | <u>(38)</u> | |
| Net selling price | | 1,395 |
| Propylene price | (1,212) | |
| Logistics costs/netbacks | <u>70</u> | |
| Net propylene price paid | (1,142) | |
| Net propylene price paid /tonne PP produced, i.e. | (1,153) | |
| Purchase feedstock (propylene) | | |
| Co-product sales/tonne of PP produced | - | |

| | | |
|---------------------------------|--------------|----------------|
| Variable cost of PP unit | <u>(132)</u> | <u>(1,285)</u> |
| <i>Standalone margin</i> | | 110 |

¹The model assumes 2.115 tonnes of naphtha are required to produce 1 tonne of olefin (ethylene and propylene) and 1.01 tonnes of propylene are required to produce 1 tonne of PP. The average net naphtha price (including freight costs) for 2008 was \$828/tonne.

²Co-product sales include credits for butadiene, benzene, raffinate-1, pygas and a fuel export balance. Since the cracker margin is based on 1 tonne of olefin (ethylene and propylene) produced, the figure also allows for the difference in net price between ethylene and propylene on transfer to the PP unit.

³The model assumes 1.01 tonnes of propylene are required to produce 1 tonne of PP.

⁴Includes power and catalysts/chemicals for the PP.

⁵The model assumes 1.16 tonnes of propane are required to produce 1 tonne of propylene and 1.01 tonnes of propylene are required to produce 1 tonne of PP. The average net propane price (including freight costs) for 2008 was \$772.

DIFFERENCE BETWEEN NON-INTEGRATED AND INTEGRATED

- Non-integrated or standalone: market participant involved with PP production only. The business model is to buy propylene, convert it into PP resin and sell the PP. Our margin model assumption is that the plants are co-located and that the propylene is transferred at an FOB value. This business model is applicable to around 30% of manufacturing facilities in Asia.
- Integrated: market participant involved with both propylene and PP production. There are two business models. The first is to buy naphtha feedstock, process it into ethylene, propylene and cracker co-products, convert the propylene into PP, and sell both the PP, ethylene and cracker co-products. The second business model is to buy propane feedstock, dehydrogenate it into propylene, convert the propylene into PP and sell the PP resin. These integrated business models are applicable to over half of the manufacturing facilities in Asia.

WHY INTEGRATED ANALYSIS

- Most Asian PP plants (approximately 70% by capacity) are integrated back to cracker or PDH sources of propylene. This may be co-located and/or connected by pipeline and with common equity ownership across both assets

in the supply chain, that is, the economic boundaries for the majority of the industry producers are bigger than a standalone polymer unit.

- The margin is therefore measured across the supply chain from cracker feedstock (naphtha) through to PP or PDH feedstock (propane) through to PP and cracker coproducts.
- This analysis demonstrates the volatility of the business and the influence of price floors that can lead to an uneconomic integrated margin, and generally forcing a reduction in supply.

WHY NON-INTEGRATED ANALYSIS

- Approximately 30% (by capacity) of Asian PP plants are considered as standalone or non-integrated.
- Standalone analysis considers the polymer unit in isolation, which may be useful for understanding marginal opportunities where optimisation processes could result in propylene being preferentially used for other propylene derivative products. However, analysis of standalone historical data does show lower margins, which may not justify fresh business investment to meet growing market demands.

MODEL YIELD PATTERN AND CALCULATION

Plant manufacturing data relates to the variable cost components of the chemical unit operations. Yield pattern data relates to the overall material balance of the cracker unit, for example for 1.0 tonne of ethylene and propylene produced, a cracker requires 2.1 tonnes of naphtha feedstock, and will produce other co-products (butadiene, benzene, etc.) of 0.7 tonnes. A PDH unit will require 1.16 tonnes of propane feedstock, and will make 1.0 tonnes of polypropylene with no other co-products. The plant manufacturing and feedstock yield model data have been provided by Linde Engineering, a division of Linde AG.

The exact yield pattern used cannot be published in an unrestricted document such as this methodology statement. However, for PP Asia Margin report subscribers with a specific requirement to see this data, it can be shared on a case-by-case basis. Please contact the [Global ICIS Customer Support Centre](#) if this data is required.

ASSESSMENT INPUTS

The following ICIS pricing inputs are used to generate the full content of the ICIS Weekly Margin - PP Asia report:

NORTHEAST ASIA

- Polypropylene (Flatyarn) in Asia Pacific Spot CFR China Main Port [from 18 October 2002, previously Polypropylene (Flatyarn) in Asia Pacific Spot CFR Hong Kong] (\$/tonne)

- Naphtha in Asia Pacific Spot CFR Japan (ICIS pricing, Friday assessment) (\$/tonne)
- Propane (refrigerated cargo) CFR China (C1 Energy, Thursday assessment) [from 13 June 2014, previously weekly average from 1 November 2010, previously Propane C+F Tokyo Term Spot (Reuters, weekly average)] (\$/tonne)
- Ethylene in Asia Pacific Spot CFR NE Asia (ICIS pricing, weekly average) (\$/tonne)
- Propylene in Asia Pacific Spot CFR NE Asia (ICIS pricing, weekly average) (\$/tonne)
- Propylene in Asia Pacific Spot CFR China Main Port (ICIS pricing, weekly average) (\$/tonne)
- Butadiene in Asia Pacific Spot CFR NE Asia (ICIS pricing, weekly average) (\$/tonne)
- Benzene in Asia Pacific Spot CFR NE Asia (ICIS pricing, Friday assessment) (\$/tonne)
- Benzene in Asia Pacific Spot FOB Korea (ICIS pricing, Friday assessment) (\$/tonne)
- Toluene in Asia Pacific Spot CFR NE Asia (ICIS pricing, Friday assessment) (\$/tonne)
- Xylene (Solvent Grade) in Asia Pacific Spot FOB Korea (ICIS pricing, Friday assessment) (\$/tonne)
- High Sulphur Fuel Oil mixed/cracked 180 cst FOB Singapore Spot (C1 Energy, weekly average) [from 29 August 2011; previously Fuel Oil 180 cst FOB Singapore Spot (Reuters, weekly average)] (\$/tonne)

SOUTHEAST ASIA

- Polypropylene (Flatyarn) in Asia Pacific Spot CFR SE Asia [from 18 October 2002, previously Polypropylene (Injection) in Asia Pacific Spot CFR SE Asia] (\$/tonne)
- Naphtha in Asia Pacific Spot FOB Singapore (ICIS pricing, Friday assessment) (\$/bbl)
- Naphtha in Asia Pacific Spot FOB Singapore (ICIS pricing, weekly average) (\$/bbl)
- Propane (refrigerated cargo) CFR China (C1 Energy, Thursday assessment) [from 13 June 2014, previously weekly average from 1 November 2010, previously Propane C+F Tokyo Term Spot (Reuters, weekly average)] (\$/tonne)
- Ethylene in Asia Pacific Spot CFR SE Asia (ICIS pricing, weekly average) (\$/tonne)
- Propylene in Asia Pacific Spot CFR SE Asia (ICIS pricing, weekly average) (\$/tonne)
- Butadiene in Asia Pacific Spot CFR SE Asia (ICIS pricing, weekly average) (\$/tonne)

- Benzene in Asia Pacific Spot FOB SE Asia (ICIS pricing, Friday assessment) (\$/tonne)
- Toluene in Asia Pacific Spot CFR SE Asia (ICIS pricing, Friday assessment) (\$/tonne)
- Gasoline 95 Unleaded FOB Singapore Spot (C1 Energy, weekly average) [from 29 August 2011; previously Gasoline 95 Unleaded FOB Singapore Cargo Spot (Reuters, weekly average)] (\$/bbl)
- High Sulphur Fuel Oil mixed/cracked 180 cst FOB Singapore Spot (C1 Energy, weekly average) [from 29 August 2011; previously Fuel Oil 180 cst FOB Singapore Spot (Reuters, weekly average)] (\$/tonne)

The ICIS pricing methodology associated with each individual pricing quotation referenced above can be found in the free access methodology area of www.icispricing.com.

A key objective of the calculation procedure is to provide a weekly summary that is most strongly aligned to the reported market price positions on the date of publication.

Where ICIS price quotations are not available for individual weeks due to public holidays, then prior week data is carried forward for the specific purpose of populating the model and preventing model inconsistency. This form of data interpolation is inferring some limited data points that may not be market derived, and customers should be aware of this assumption.

All data in the ICIS Weekly Margin - PP Asia report is denominated in US dollars.

LONGER RANGE VIEWS:

The ICIS Weekly - PP Asia report will provide comparative data charts for naphtha feed (northeast and southeast Asia) and propane feed (northeast and southeast Asia) on alternate weeks.

PROPANE FEED VERSUS NAPHTHA FEED

This provides a comparison of the calculated integrated PP spot margin (propane feed) minus the calculated integrated PP spot margin (naphtha feed). When this differential provides a positive numerical output, this implies that integrated PP spot margins (propane feed) are higher than integrated PP spot margins (naphtha feed). Similarly, when this differential provides a negative numerical output, this implies that integrated PP spot margins (naphtha feed) are higher than integrated margins (propane feed). Charts are provided for both northeast and southeast Asia. These charts will alternate with...

...SOUTHEAST ASIAN MARGINS VERSUS NORTHEAST ASIAN MARGINS

This provides a comparison of the calculated integrated PP spot margin for southeast Asian operators minus the calculated integrated PP spot margin for northeast Asian operators. When this differential provides a positive numerical output, this implies that integrated PP spot margins are higher in southeast Asian operators than for northeast Asian operators. Similarly, when this differential provides a negative numerical output, this implies that integrated PE spot margins are higher for northeast Asian operators than for southeast Asian operators. Charts are provided for both naphtha feed and propane feed.

READING THE CHARTS

In the short-term charts and longer range margin view, the integrated margin is derived by reading the top of the wedge, the sum of the ethylene margin per tonne of PP (yellow) and the standalone PP margin (blue). Where the standalone margin is a loss (red), the integrated margin is read as the top of the yellow wedge or, where there is no yellow wedge, the bottom of the red.

COMBINING PE AND PP MARGINS

It should be noted that, to assess a petrochemical complex margin, for a petrochemical producer engaged in both the PE and PP businesses, requires looking at the integrated PE margin (from the ICIS Weekly Margin - PE Asia report) and adding the standalone PP margin from this report.

PUBLICATION FREQUENCY

The ICIS Weekly Margin - PP Asia report is produced on a Friday at the close of business in Asia and distributed to customers on the following Monday, subject to schedule planning. When the Monday is a public holiday in the UK, the report is distributed on the Tuesday. The report is not published on some public holidays. Holiday dates and days of publication may be subject to revision.

For information on ICIS' full portfolio of margin reports, visit <http://www.icis.com/chemicals/channel-info-about/margin-reports/>

