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Variable Margin Methodology: Light Olefins North America

ICIS
Independent Commodity Intelligence Services

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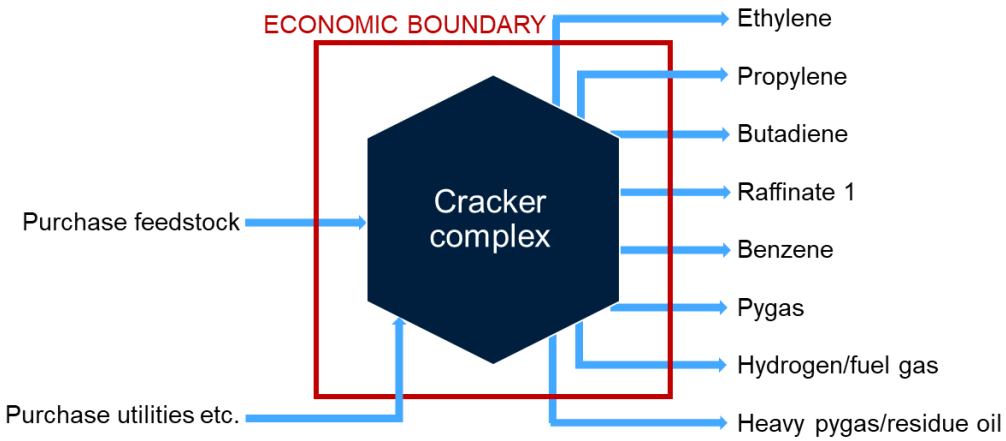
THE BUSINESS MODEL

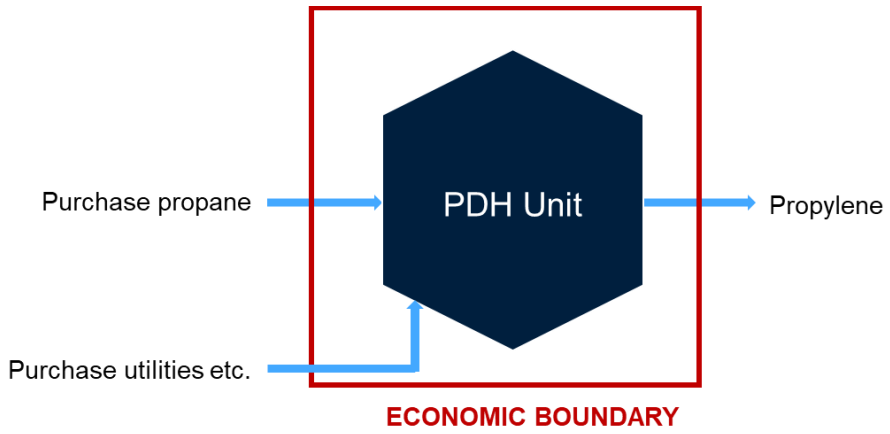
For the US, ICIS calculates light olefins (2:1 ethylene-to-propylene ratio) margins based on naphtha, liquefied petroleum gas (LPG), and propane feedstocks.

The diagram below shows a simplified light olefins production process using ethane/naphtha/LPG. Naphtha is a product mainly derived from crude oil, while LPG derives from gas separation processes and as a by-product of refinery processes. Ethane is a gaseous feedstock derived via separation from natural gas or petroleum gas.



In the steam cracking process, the feedstock, along with steam, is fed into a cracker unit where ethylene and propylene, and their co-products (such as butadiene and benzene) are made. The light olefins are separated from co-products and typically piped to other chemical plants where they are further processed into derivative products such as polyethylene or polypropylene. Their co-products are also separated, and either sold for use in other chemical plants, or used as fuel.

Propane dehydrogenation (PDH) is a common method for producing propylene. Propane is fed into a PDH unit over a catalyst to produce propylene, which is then sold, or further processed to make polypropylene.



THE MARGIN CALCULATION

- The margin measure provides an assessment of the ex-works cash margin obtained for the product over raw material costs, credit for selling co-products and key variable manufacturing costs, including power and steam, chemicals and catalysts. This measure can also be termed as a variable margin, contribution or benefit.

- This margin measure provides simple signals on the direction of business margins as dictated by the environment, thus informing market positioning by sellers, buyers and traders.

- ICIS does not model beyond raw material costs, credit for selling co-products and key variable manufacturing costs. Further analysis would cease to be generic to the industry and would be 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.

- ICIS models plant operations for a series of 'representative' plants around the world. These representative plants have no flexibility with respect to feedstock or process configuration and ICIS assumes the plants to be purchasing inputs and selling outputs at constant prices. In the US Gulf, this representative plant is situated in Houston.

- As the process model is generic and not based on any individual operation, the contribution measure is indicative. Instead of absolute value terms, it is most valuable as an index and in step-change terms.

- Ex-works product price assessments link to ICIS pricing quotations for large-volume commodity products, with netbacks assessed using the ICIS petrochemicals logistics model. To estimate representative transport costs, the ICIS logistics model considers a network with nodes at individual production sites connected by streets and ports linking each continent. The logistics model incorporates shipping data from Xeneta (www.xeneta.com), and duties data from SimplyDuty (www.simplyduty.com).

- ICIS calculates light olefins margins rather than pure propylene margins as most market participants produce both ethylene and propylene through steam cracking. This margin model also gives measure of the profitability of the propane dehydrogenation process. From this, comparisons can be drawn between margins for ethylene and propylene, and their derivative products, polyethylene and polypropylene.

The calculation below shows how ICIS derives the light olefins margin (feedstock LPG) for the US. The example is based on contract sales prices, is denominated in US dollars per tonne, and uses average prices for the year 2017.

LPG-based cracker margin ($/tonne)

Light olefins* weighted contract price		809
Co-product sales		405
Total income		**1,214**
Purchase feedstock (naphtha)		887
Logistics costs/netbacks		65
Utilities		30
Variable costs		**982**
Light olefins margin	1,214 – 982 =	**232**

*2:1 ethylene-to-propylene ratio

MODEL YIELD PATTERN AND CALCULATION

Plant manufacturing data relates to the variable cost components of the cracker operations. Yield pattern data relates to the overall material balance of the cracker unit. For example, a cracker will use approximately two tonnes of naphtha as feedstock to produce one tonne of light olefins. In addition to the one tonne of light olefins, the cracker will produce approximately one tonne of co-products (including butadiene, benzene, raffinate-1, pygas, fuel oil and fuel gas).

- US light olefins margins are calculated for the following production processes:
  - Propane dehydrogenation
  - LPG steam cracking with benzene and butadiene extracted
  - Naphtha 80/LPG 20 with benzene and butadiene extracted
  - Naphtha steam cracking with benzene and butadiene extracted

- Due to the different cracker yield patterns when using different feedstocks, a comparative analysis is not a simple case of comparing feedstock price differences, but must take into account the different co-product credits.

- This analysis demonstrates business volatility and the influence of price floors (as an uneconomic margin generally forces supply reductions).

- ICIS cannot publish the exact yield patterns used in an unrestricted document such as this methodology statement.

ASSESSMENT INPUTS

ICIS users the following inputs to generate the full content of the ICIS Light Olefins US margins:

- Ethane Mt Belvieu FOB USG Spot (weekly average) (cts/US gal converted to $/tonne)
- Naphtha in US Gulf Spot Del USG Paraffinic (weekly average) ($/tonne)
- Ethylene – Net US Gulf Contract Delivered (cts/lb converted to $/tonne)
- Ethylene in US Gulf Spot Del (Pipeline) (weekly average) (cts/lb converted to $/tonne)
- Propane Mt Belvieu FOB USG Spot (cts/US gal converted to $/tonne)
- N-Butane, Assessment, In Store, 10-30 Days, Closing Value, Weekly, Mt Belvieu FOB USG Spot (cts/US gal converted to $/tonne)
- Propylene in US Gulf Contract P Grade (cts/lb converted to $/tonne)
- Propylene (P Grade) in US Gulf Spot Pipeline (weekly average) (cts/lb converted to $/tonne)
- Butadiene in US Gulf Contract FOB USG (cts/lb converted to $/tonne)
- Butadiene in US Gulf Spot CIF (weekly average) (cts/lb converted to $/tonne)
- Crude C4s in US Gulf Spot CIF (weekly average) ($/tonne)
- Benzene in US Gulf Contract FOB ($/US gal converted to $/tonne)
- Benzene in US Gulf Spot FOB Barges (Friday assessment) ($/US gal converted to $/tonne)
- Gasoline Premium Unleaded (Pipeline) in US Gulf Spot US Gulf (weekly average) (cts/US gal converted to $/tonne)
- Residual Fuel Oil: FOB US Gulf (barges) Spot No 6 1.0% (weekly average) (cts/bbl converted to $/tonne)
- NYMEX Henry Hub Natural Gas forward month (ICIS energy, weekly average) ($/MMBtu converted to $/tonne)

CONVERSIONS

The following conversion factors are used:

- Ethane: 742.2 US gal per tonne
- Benzene: 299 US gal per tonne
- Gasoline: 358.8 US gal per tonne
- Residual Fuel Oil: 264 US gal per tonne (42 US gal/bbl)
- Natural Gas: 0.0173 tonnes of fuel oil equivalents per MMBtu

The methodology associated with each individual ICIS pricing quotation referenced above is available on the ICIS Compliance and Methodology website.

In addition to the listed ICIS pricing inputs, the model also takes into account logistics costs (calculated through the ICIS logistics model), and utility costs.

A key objective of the calculation process is to provide a weekly summary that strongly aligns to the reported market price positions on the date of release.

Where inputs are unavailable for individual weeks, e.g. due to public holidays, prior-week data is carried forward to the current week. This is for the specific purpose of populating the model and preventing model inconsistency. This form of data interpolation infers some limited data points that may not be market derived, and customers should be aware of this assumption.

The basis on which ICIS pricing data is used for the calculation of spot and contract prices is summarised in the table below. For detailed information about these quotations, please refer to the Assessment Inputs section above.

ICIS price	**Spot margin**	**Contract margin**
Ethane	Spot	Spot
Naphtha	Spot	Spot
Butane	Spot	Spot
Propane	Spot	Spot
Gasoline	Spot	Spot
Fuel Oil	Spot	Spot
Ethylene	Spot	Contract
Propylene	Spot	Contract
Butadiene	Spot	Contract
Benzene	Spot	Contract
Crude C4	Spot	Spot

LIGHT OLEFINS US WEBPAGE

Filter data on the website using the following criteria.

- **Process**: Select from propane dehydrogenation, LPG steam cracking, naphtha 80/LPG 20 steam cracking, and naphtha steam cracking
- **Price terms**: ICIS generates variable margins for both contract and spot price terms.
- **Frequency**: Viewable at weekly, monthly, quarterly, or yearly granularity.

- **Currency**: Allows conversion from displayed currency to currency of choice.
- **Unit**: Allows conversion from displayed unit to unit of choice.

Variable margins data are available online from January 2014 onwards. Six months trailing data shows as default

The website deploys the following data, all per tonne of light olefins.

- **Main product value, ex-works**: the estimated light olefins netback value for the producer, taking into account the ICIS assessed price, shipping costs, handling costs and applicable duties.
- **Co-product credits**: the revenues from the other products generated in a process, also ex-works. This data is also available broken down into co-product types.
  Feedstock and utility costs: or total variable input costs for a process. This data is also available broken down into the component feedstock costs and utility costs.

Calculated outputs are:

- **Variable cost** = [Feedstock and utility costs] – [Co-product credits]
- **Variable margin** = [Main product value] + [Co-product credits] – [Feedstock and utility costs]

A selected variable margin (i.e. a margin for a specific location, process and price term) is comparable with margins of different process technologies in the same region, and with margins using the same technology in different regions. Subscribers can review margin performance by week, month, quarterly and per annum.

Subscribers can view the flows of different products, in terms of their volume and value, into and out of the representative production unit used to calculate the light olefins variable margin.

PUBLICATION FREQUENCY

The ICIS Weekly Margin – Light Olefins US model is based on the latest data at the close of business in the US on Friday and released to customers on the following Monday, along with written commentaries, subject to schedule planning. When the Monday is a public holiday in the UK, commentaries will be made available the following day. ICIS does not publish an update on some public holidays. Holiday dates and days of publication may be subject to revision.