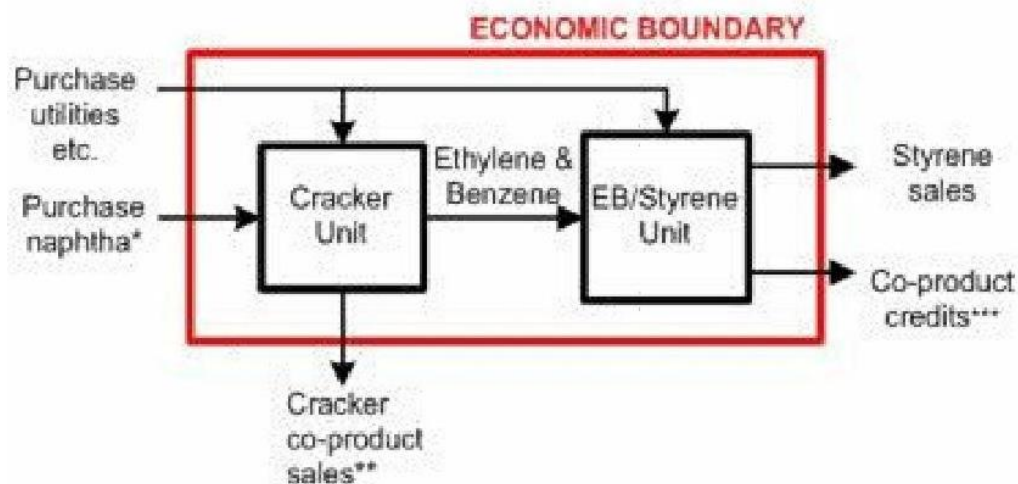


## ICIS Margin – Styrene Asia Methodology

This document is intended to provide methodology support for customers receiving the ICIS Margin – Styrene Asia report.

### THE BUSINESS MODEL

The diagram below shows the main method of making styrene monomer (SM) from naphtha, a product mainly derived from crude oil. Naphtha with steam is fed into the cracker unit where ethylene and co-products (propylene, butadiene, benzene, etc.) are made. The ethylene and benzene from the cracker are then further processed (catalytic alkylation) to make ethylbenzene. This is then fed into a dehydrogenation reactor to make styrene (with minor co-product toluene and fuel by-product). The styrene is then typically piped to other chemical plants where it is further processed into derivative products such as polystyrene.



\*Naphtha is the dominant cracker feedstock in Asia

\*\*Includes propylene, butadiene, raffinate-1, fuel gas, benzene gasoline blending components

\*\*\*Includes minor amounts of toluene

## 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 for the cracker unit by Linde Engineering, a division of Linde AG. Linde Engineering ([www.linde-engineering.com](http://www.linde-engineering.com)) is a leading international chemical plant designer, process engineering, procurement and construction contractor. It has extensive experience in ethylene 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.
- Ex-works product price assessments are linked to ICIS pricing quotations for large volume commodity products with netbacks assessed using typical logistic cost assessments.

Below is a detailed calculation of how the styrene margin is calculated for northeast Asia. The figures refer to averages for 2011; 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.

## Styrene margin calculation - averaged for 2011

### Integrated margin

**\$/tonne SM**

Styrene price	1,408	
Logistics costs	<u>(25)</u>	
Net selling price		1,383
Purchase feedstock (naphtha) <sup>1</sup>	(901)	
Benzene (from the cracker)	(876)	
Co-product sales/tonne of styrene produced <sup>2,3</sup>	673	
Variable cost of ethylbenzene/styrene unit <sup>4</sup>	<u>(220)</u>	
		(1,324)
<b>Integrated margin</b>		<b>59</b>

### Standalone margin

**\$/tonne SM**

Styrene price	1,408	
Logistics costs	<u>(25)</u>	
Net selling price		1,383
Ethylene price	(1,198)	
Freight / terminalling saving for not exporting	<u>105</u>	
Net ethylene price paid	(1,093)	
Net ethylene price paid/tonne of styrene produced <sup>3</sup> i.e. purchase feedstock (ethylene)	(317)	
Purchase benzene/tonne of styrene produced	(876)	
Co-product value of toluene and fuel By-product/tonne of styrene produced	29	
Variable cost of ethylbenzene/styrene unit <sup>4</sup>	<u>(220)</u>	
		(1,384)
<b>Standalone margin</b>		<b>-1</b>

<sup>1</sup>The model assumes 3.278 tonnes of naphtha are required to produce 1 tonne of ethylene and 0.29 tonnes of ethylene and 0.79 tonnes of benzene are required to produce 1 tonne of styrene. The average net naphtha price (including freight costs) for 2011 was \$941/tonne.

<sup>2</sup>Co-product sales include credits for propylene, butadiene, raffinate-1, benzene, pygas and a fuel export balance from the cracker and credits for toluene and fuel by-product from the styrene unit.

<sup>3</sup>The model assumes 0.29 tonnes of ethylene and 0.79 tonnes of benzene are required to produce 1 tonne of styrene.

<sup>4</sup>Includes power and catalysts/chemicals for the ethylbenzene/styrene.

## **DIFFERENCE BETWEEN NON-INTEGRATED AND INTEGRATED**

- Non-integrated or standalone: market participant involved with styrene production only. The business model is to buy ethylene and benzene, convert it into styrene and sell the styrene. Our margin model assumption is that the plants are co-located and ethylene and benzene are transferred at FOB values.
- Integrated: market participant involved with ethylene, benzene and styrene production. Buy naphtha feedstock, process it into ethylene, benzene and other cracker co-products, convert the ethylene with the benzene into ethylbenzene and then styrene monomer, and sell both the styrene and cracker co-products.

## **WHY INTEGRATED ANALYSIS**

- Most Asian styrene plants (approximately 50% by capacity) are integrated back to cracker sources of ethylene and benzene. 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 styrene unit.
- The margin is therefore measured across the supply chain from cracker feedstock (naphtha) through to styrene and cracker co-products.
- 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 50% (by capacity) of Asian styrene plants are considered as standalone or non-integrated.
- Standalone analysis considers the styrene unit in isolation, which may be useful for understanding marginal opportunities where optimisation processes could result in ethylene and benzene being preferentially used for other 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 tonne of ethylene produced, a cracker requires 3.2 tonnes of naphtha feedstock, and will produce co-products (including, but not limited to propylene, butadiene and benzene) of 2.2 tonnes in addition to the 1 tonne of ethylene. This plant manufacturing and feedstock yield model data for the cracker unit have been provided by Linde Engineering, a division of Linde AG.

The exact yield patterns of the cracker used cannot be published in an unrestricted document such as this methodology statement. However, for ICIS Margin – Styrene Asia 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 pricing inputs are used to generate the full content of the ICIS Margin – Styrene Asia report.

### NORTHEAST ASIA

- Styrene in Asia Pacific Spot CFR NE Asia (ICIS pricing, weekly average) (\$/tonne)
- Naphtha in Asia Pacific Spot CFR Japan (ICIS pricing, Friday assessment) (\$/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

- Styrene in Asia Pacific Spot CFR SE Asia (ICIS pricing, weekly average) (\$/tonne)
- Naphtha in Asia Pacific Spot FOB Singapore (ICIS pricing, Friday assessment) (\$/bbl)
- 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 methodology associated with each individual pricing quotation referenced above can be found on the compliance website: <https://www.icis.com/compliance>



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 price quotations are not available for individual days or weeks due to public holidays, then prior day or 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 Margin – Styrene Asia report is denominated in US dollars.

### **LONGER RANGE VIEWS**

The ICIS Margin– Styrene Asia report will provide longer range views for NE Asia and SE Asia margins on alternate months.

### **SOUTHEAST ASIAN MARGIN VERSUS NORTHEAST ASIAN MARGIN (INTEGRATED)**

This provides a weekly comparison of the calculated integrated styrene spot margin for southeast Asian operators minus the calculated integrated styrene spot margin for northeast Asian operators. When this differential provides a positive numerical output, this implies that integrated styrene spot margins are higher for southeast Asian operators than for northeast Asian operators. Similarly, when this differential provides a negative numerical output, this implies that integrated styrene spot margins are higher for northeast Asian operators than for southeast Asian operators.

### **SOUTHEAST ASIAN MARGIN VERSUS NORTHEAST ASIAN MARGIN (STANDALONE)**

This provides a weekly comparison of the calculated standalone styrene margin for southeast Asian operators minus the calculated standalone styrene spot margin for northeast Asian operators. When this differential provides a positive numerical output, this implies that standalone styrene spot margins are higher for southeast Asian operators than for northeast Asian operators. Similarly, when this differential provides a negative numerical output, this implies that standalone styrene spot margins are higher for northeast Asian operators than for southeast Asian operators. The ICIS – Styrene Asia report will provide a longer range view (integrated) and a longer range view (standalone) on alternate months.





## **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 styrene (yellow) and the standalone styrene 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.

## **PUBLISHING FREQUENCY – MONTHLY\***

The ICIS Margin – Styrene Asia report is produced on a Monday using data from the last Friday of the month close of business in Asia and distributed to customers on the following Tuesday, subject to schedule planning. The report is not published on some public holidays. Holiday dates and days of publication may be subject to revision.

\*Published monthly from September 2014; previously weekly. Margins continue to be calculated on a weekly basis.

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

