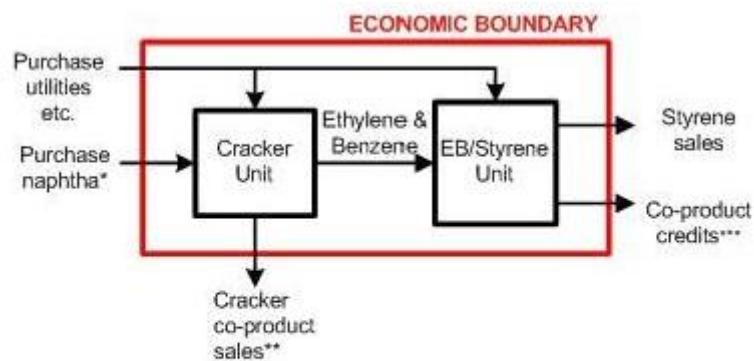


## ICIS Margin – Styrene Europe Methodology

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

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.

### THE BUSINESS MODEL



\*Naphtha is the dominant cracker feedstock in Europe

\*\*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. The figures refer to averages for contract sales values for 2011; the calculation for spot sales values 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	1,193
Logistics costs / netbacks	<u>(141)</u>
Net selling price	1,052
Purchase feedstock (naphtha) <sup>1</sup>	(639)
Benzene (from the cracker)	(633)
Co-product sales/tonne of styrene produced <sup>2,3</sup>	489
Variable cost of ethylbenzene/styrene unit <sup>4</sup>	(172)
	955
<b>Integrated margin</b>	<b>97</b>

Standalone margin	€/tonne SM
Styrene price	1,193
Logistics costs / netbacks	<u>(141)</u>
Net selling price	1,052
Ethylene price	(1,138)
Freight / terminalling saving for not exporting	<u>104</u>
Net ethylene price paid	(1,034)
Net ethylene price paid/tonne of styrene produced <sup>3</sup> i.e. purchase feedstock ethylene	(300)
Purchase benzene/tonne of styrene produced	(633)
Co-product value of toluene and fuel	
By-product/tonne of styrene produced	20
Variable cost of ethylbenzene/styrene unit <sup>4</sup>	<u>(172)</u>
	(1,085)
<b>Standalone margin</b>	<b>-33</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 \$933/tonne (with an average \$:€ conversion rate of 1.39).

<sup>2</sup>Co-product sales include credits for propylene, butadiene, benzene, raffinate- 1, 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. This business model is applicable to just under half the manufacturing facilities in Europe.
- 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. This business model is applicable to over half of the manufacturing facilities in Europe.

## **WHY INTEGRATED ANALYSIS**

- Most west European styrene plants (approximately 60% 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 40% (by capacity) of the west European 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 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 ICIS Margin - Styrene Europe 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 Europe report:

- Styrene in Europe contract average FOB Barge ARA [from 1 May 2013, previously Styrene in Europe contract average FD Barge NWE from 1 July 2011, and previously Styrene in Europe contract FD Barge NWE] (€/tonne)
- Styrene in Europe spot CIF Rotterdam (weekly average) (\$/tonne)
- Naphtha in Europe spot CIF NWE (Friday assessment) (\$/tonne)
- Gasoline: unleaded premium in Europe spot FOB barges ARA (weekly average) (\$/tonne)
- Fuel oil 1% in Europe spot CIF cargoes NWE (weekly average) (\$/tonne)
- Ethylene in Europe monthly contract FD NWE [from January 2009, previously quarterly] (€/tonne)
- Ethylene in Europe spot CIF NWE (\$/tonne)

- Propylene in Europe monthly contract FD NWE [from January 2009, previously quarterly] (€/tonne)
- Propylene (polymer grade) in Europe spot CIF NWE (€/tonne)
- Butadiene in Europe monthly contract FD NWE [from January 2011, previously quarterly] (€/tonne)
- Butadiene in Europe spot FOB Rotterdam (\$/tonne)
- Benzene in Europe monthly contract FOB NWE [from January 2004, previously quarterly] (€/tonne)
- Benzene in Europe spot CIF ARA (\$/tonne)
- Raffinate-1 in Europe spot CIF NWE (\$/tonne)
- Toluene in Europe monthly contract FOB NWE [from January 2004, previously quarterly (€/tonne)] (\$/tonne)
- Toluene in Europe spot FOB Rdam (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>

In addition to the above pricing inputs, ICIS pricing uses the \$/€ mid-market exchange rate on the date of the report publication issued at 16:00 GMT/UTC by XE ([www.xe.com](http://www.xe.com)). Mid-market rates are derived from the mid-points between the buy and sell rates of large-value transactions in the global currency markets.

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 Margin –Styrene Europe report is denominated in euros unless specifically indicated otherwise.

## **LONGER RANGE VIEWS:**

### **SPOT VERSUS CONTRACT MARGIN (INTEGRATED)**

This provides a weekly comparison of the calculated margin for spot-based styrene sales minus contract-based sales. This switch of ICIS pricing reference is also considered for the naphtha cracker products, so the analysis is deeper than a simple comparison of spot versus contract styrene price netbacks. When this differential provides a positive numerical output, this implies that spot-based styrene sales derive a higher margin for an integrated producer than contract-based sales. Similarly, when this differential provides a negative numerical output, this implies that spot-based styrene sales derive a lower margin for an integrated producer than contract-based sales.

For the avoidance of any doubt, the basis on which ICIS pricing data is utilised for each of these respective models is summarised in the table below. For more detailed information about these quotations, please refer to the assessment inputs section above.

ICIS price	Spot margin model	Contract margin model
Styrene	Spot	Contract
Naphtha	Spot	Spot
Gasoline	Spot	Spot
Fuel oil	Spot	Spot
Ethylene	Spot	Contract
Propylene	Spot	Contract
Butadiene	Spot	Contract
Benzene	Spot	Contract
Raffinate-1	Spot	Spot
Toluene	Spot	Contract



## **SPOT VERSUS CONTRACT MARGIN (STANDALONE)**

This provides a comparison of the calculated margin for spot-based styrene sales minus contract-based sales measured across the styrene unit. When this differential provides a positive numerical output, this implies that spot-based styrene sales derive a higher margin than contract-based sales. Similarly, when this differential provides a negative numerical output, this implies that spot-based styrene sales derive a lower margin than contract-based sales.

The ICIS Margin – Styrene Europe report will provide a spot versus contract margin (integrated) and a spot versus contract margin (standalone) chart on alternate months.

The ICIS Margin – Styrene Europe report will also provide a longer range view of integrated styrene contract margins and integrated styrene spot margins on alternate months.

## **READING THE CHARTS**

In the short-term charts and longer range margin views, 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 Europe is produced on a Monday using data from the last Friday of the month close of business in Europe 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.

Find more information about ICIS' full portfolio of margin reports, visit:

<http://www.icis.com/chemicals/channel-info-about/margin-reports/>

