ETHYLENE EUROPE

THE BUSINESS MODEL

The simplified diagram below shows the main method of making ethylene from naphtha, a product mainly derived from crude oil. Ethylene is also made from other feedstocks including liquefied petroleum gas (LPG) which can be derived from gas separation processes and as a byproduct of refinery processes. Naphtha with steam is fed into the cracker unit where ethylene and other coproducts (such as propylene, butadiene and benzene) are made. The ethylene from the cracker unit is separated from other coproducts and then typically piped to other chemical plants where it is further processed into derivative products such as polyethylene. The other coproducts are also separated and sold for use in other chemical plants or used for fuel.

THE MARGIN CALCULATION

- Margin measure provides assessment of the ex-works cash margin obtained for the product over raw material costs, credit for selling coproducts and key variable manufacturing costs such as power and steam. 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, credit for selling coproducts and key variable manufacturing costs as this ceases to be generic to the 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 has 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 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 ethylene margin (naphtha feed) is calculated for Europe. The figures refer to averages for contract sales values for 2011; the calculation for spot sales values is similar, as is that for the ethylene margin (LPG feed). Figures indicated in red are those found in the tables of the margin report; others relate to underlying assumptions of the model.
Ethylene margin (naphtha feed) calculation (€/tonne) – averaged for 2011

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene contract price</td>
<td>1,138</td>
</tr>
<tr>
<td>Logistics costs/netbacks</td>
<td>(106)</td>
</tr>
<tr>
<td>Net ethylene selling price</td>
<td>1,032</td>
</tr>
<tr>
<td>Purchase feedstock (naphtha)¹</td>
<td>2,203</td>
</tr>
<tr>
<td>Co-product sales²</td>
<td>1,617</td>
</tr>
<tr>
<td></td>
<td>(586)</td>
</tr>
<tr>
<td>Ethylene margin (naphtha feed)</td>
<td><strong>446</strong></td>
</tr>
</tbody>
</table>

¹The model assumes 3.278 tonnes of naphtha are required to produce 1 tonne of ethylene. The average net naphtha price (including freight costs) for 2011 was $933/tonne (with an average $:€ conversion rate of 1.393)
²Co-product sales include credits for propylene, butadiene, benzene, raffinate-1, pygas and a fuel export balance.

**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, for 1 tonne of ethylene produced, a cracker requires 3.2 tonnes naphtha feedstock, and will produce coproducts (such as propylene, butadiene and benzene) of 2.2 tonnes in addition to the 1 tonne of ethylene.
This plant manufacturing and feedstock yield model data has been provided by Linde Engineering, a division of Linde AG.

- Naphtha is the dominant cracker feedstock in Europe. The report also models LPG feedstocks (propane and butane) as some cracker units have a degree of flexibility to increase LPG usage when better economics are available for its use.

- Due to the different cracker yield patterns for using naphtha or LPG feedstocks, this comparative analysis is not a simple case of comparing feedstock price differences; it takes into account the different coproduct credits.

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

The exact yield patterns used cannot be published in an unrestricted document such as this methodology statement. However, for ICIS Weekly Margin – Ethylene 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 14 ICIS pricing inputs are used to generate the full content of the ICIS Weekly Margin – Ethylene Europe report

- Naphtha in Europe Spot CIF NWE (Friday assessment) ($/tonne)
- Butane in Europe Spot CIF NWE 3000mt+ (Friday assessment) ($/tonne)
- Propane in Europe Spot CIF NWE 3000mt+ (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)

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

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). Mid-market rates are derived from mid-point 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 Weekly Margin – Ethylene Europe report is denominated in euros unless specifically indicated otherwise.

LONGER RANGE VIEWS:
LPG VERSUS NAPHTHA FEED

This provides a weekly comparison of the calculated contract LPG margin minus the calculated contract naphtha margin. When this differential provides a positive numerical output, this implies that LPG feedstocks derive a higher margin for a cracker operator compared with naphtha feedstock. Similarly, when this differential provides a negative numerical output, this implies that LPG feedstocks derive a lower margin for a cracker operator compared with naphtha feedstock.

CONTRACT VERSUS SPOT (NAPHTHA)

This provides a comparison of the calculated margin for spotbased cracker product sales (ethylene plus coproducts) minus contract-based sales. When this differential provides a positive numerical output, this implies that spot-based cracker product sales derive a higher margin compared with contract-based sales. Similarly, when this differential provides a negative numerical output, this implies that spot-based cracker product sales derive a lower margin compared with contract-based sales.

CONTRACT MARGIN

This provides a longer range view of the contract naphtha margin and the spot naphtha price.

For the avoidance of any doubt, the basis in 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.
<table>
<thead>
<tr>
<th>ICIS price</th>
<th>Spot margin model</th>
<th>Contract margin model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naphtha</td>
<td>Spot</td>
<td>Spot</td>
</tr>
<tr>
<td>Butane</td>
<td>Spot</td>
<td>Spot</td>
</tr>
<tr>
<td>Propane</td>
<td>Spot</td>
<td>Spot</td>
</tr>
<tr>
<td>Gasoline</td>
<td>Spot</td>
<td>Spot</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>Spot</td>
<td>Spot</td>
</tr>
<tr>
<td>Ethylene</td>
<td>Spot</td>
<td>Contract</td>
</tr>
<tr>
<td>Propylene</td>
<td>Spot</td>
<td>Contract</td>
</tr>
<tr>
<td>Butadiene</td>
<td>Spot</td>
<td>Contract</td>
</tr>
<tr>
<td>Benzene</td>
<td>Spot</td>
<td>Contract</td>
</tr>
<tr>
<td>Raffinate-1</td>
<td>Spot</td>
<td>Spot</td>
</tr>
</tbody>
</table>

The ICIS Weekly Margin – Ethylene Europe report will provide contract versus spot (naphtha) and contract margin data charts on alternate weeks.

**PUBLICATION FREQUENCY**

The ICIS Weekly Margin – Ethylene Europe report is produced on a Friday at the close of business in Europe 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/](http://www.icis.com/chemicals/channel-info-about/margin-reports/)