

The shale gas revolution and its  
impact on the chemical industry in  
the Netherlands

Addendum to VNCI Vision  
2030-2050



# VNCI and Deloitte have assessed the potential impact of the shale gas revolution on the Dutch chemical industry

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In 2012, the ‘Vereniging van de Nederlandse Chemische Industrie’ (VNCI), the national chemical industry association of the Netherlands, and Deloitte published a long term vision for the sector: “The Chemical Industry in the Netherlands: World leading today and in 2030–2050”. The chemical industry in the “Antwerp Rotterdam Ruhr Rhine Area” (ARRRA), was their conclusion, can continue its role as a world leading cluster that generates substantial wealth and creates jobs. Achieving this would require the implementation of a more integrated physical network of plants, using a wide range of feedstock and developing a leading innovation ecosystem, supported by a clear regulatory framework.

This strategy will enable the industry to thrive in four distinct scenarios for the global chemical industry in 2030/50: “Fragmentation”, “Green Transition”, “Abundant Energy” and “High-Tech World”.

“Abundant Energy” assumes wide availability of cheap gas, geothermal energy and solar energy. Considering the abundance of unconventional hydrocarbons in North America increases, this scenario is quite likely to unfold. However, an uneven distribution of the benefits is equally likely. Shale gas and shale oil seem to be today’s new energy sources. As they are mainly produced in the US and Canada, this clearly puts Europe and East Asia at a serious disadvantage.

So, as a follow up to the 2012 study, the VNCI wanted a better understanding of how the ‘shale gas revolution’ would affect the industry. Subsequently, it wanted to define appropriate courses of action. It has requested Deloitte to write this addendum to the Vision 2030/50 study. This document first summarises the current position of the Dutch chemical industry and then analyses the emergence of US shale gas. This has resulted in a joint impact assessment and a set of recommendations.

This report is based on extensive desk research and interviews with industry experts. The appendix lists all data sources used and the contributors.





# Executive summary

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In 2012, the 'Vereniging van de Nederlandse Chemische Industrie' (VNCI), the national chemical industry association of the Netherlands, and Deloitte published a long term vision for the sector: "The Chemical Industry in the Netherlands: World leading today and in 2030-2050".

It stated that the industry can continue its role as a major contributor to the Dutch economy through further physical integration of plants, flexibility to use a wide range of feedstock and development of a leading innovation ecosystem, supported by a clear regulatory framework.

Today, the emergence of shale gas is fundamentally changing the global chemical industry. Shale gas, which is found all over the world but mostly produced in the US, has resulted in a very steep drop in US gas prices. In sharp contrast, European gas prices have risen. Consequently, gas is much more expensive in the Netherlands than in the US, even though Dutch gas is not more expensive to produce than US shale gas.

For the US, these favourable gas prices translate into an unprecedented advantage in feedstock and energy costs, resulting in a surge in capacity expansion. This negatively impacts the competitive position of the Netherlands and European chemical industry on the short and long run.

Initially the impact will be mostly in the ethylene, ammonia and chlorine and caustic soda chains, negatively affecting about 29% of the Dutch chemical industry employment and 48% of revenue. But over time, ripple effects may occur throughout the cluster. It could ultimately disintegrate, putting 8% of national output, 20% of export value and nearly half a million jobs at risk with far reaching consequences for the Dutch economy as a whole.

Relief might come from a number of mitigating factors, but these are not certain and may take years to materialise. Margins in the European chemical industry could be maintained by a combination of higher global demand and restrained capacity expansion in China and the Middle East. Or the ratio of European naphtha to US ethane prices - now at an all-time high - may drop over time and narrow the margin gap between Europe and the US.

The trend toward more global competition for the European chemical industry was already identified in the Vision 2030/2050 study. Now the industry will also have to respond to cost effective plants in the US. Therefore, the fundamentals of long term strategy for the Dutch chemical industry remain unchanged, but the urgency to act has increased.

For the sector itself this means a stronger emphasis on all of the VNCI's strategic objectives. But because most of these are insufficient to counter short term effects, they need to be supplemented by policies that could range from subsidies and allowing additional tax write-offs for investments to a transition away from current European gas supply contract prices.

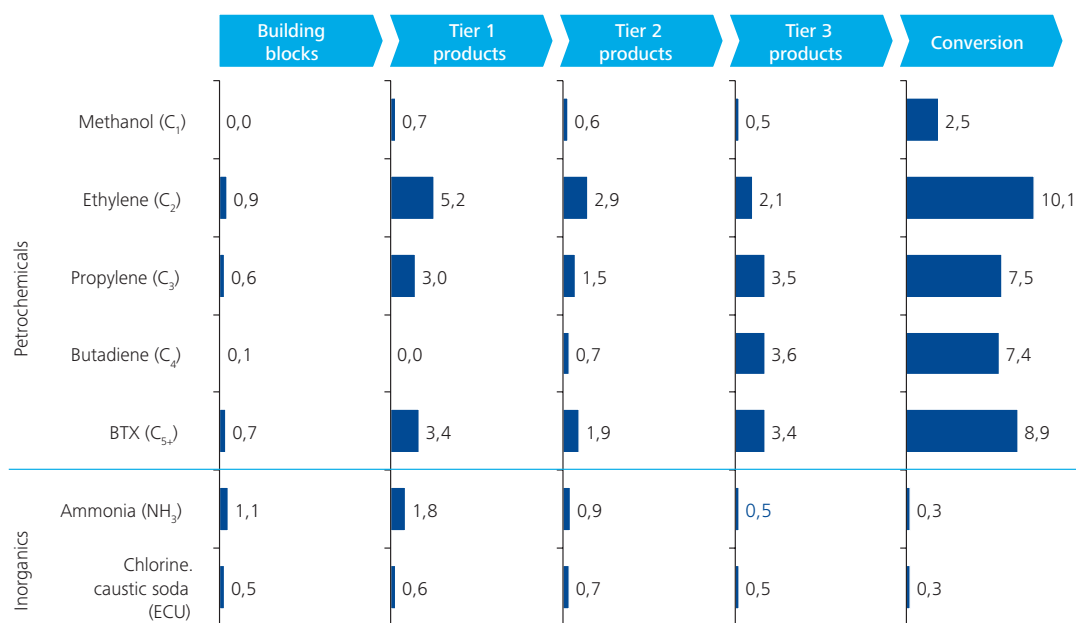


# The chemical industry is a major contributor to the Dutch economy

With EUR 60bn in annual revenues, 8% of national output, 20% of export value and 79,000 direct and over 400,000 indirect and even more induced jobs<sup>1</sup>, the chemical industry is a critically important sector for the Dutch economy.

The sector is also a key driver of national competitiveness as one of two world leading manufacturing clusters in the Netherlands (the other is the high-tech electronics cluster, built around Philips and ASML). This follows from the "Atlas of Global Complexity", produced by Harvard University and MIT, which measures the strength of hundreds of industries in over 200 countries. The study also shows cluster strength to be the key driver of GDP. A thriving chemical industry is therefore critical to a successful Dutch economy.

Figure 1. Direct employment in the Dutch chemical industry (2012, thousands of jobs)



Source: CBS, VNCI, Deloitte analysis

Total is 79,000 jobs

1) Based on a Deloitte analysis of the OECD Input – Output table of the Dutch economy

The strength of the Dutch chemical industry is rooted in a large network of highly integrated plants. As shown in the insert on page 8, together they cover a wide area of the chemical value chain<sup>2</sup>. Employment is spread across C<sub>2</sub> through C<sub>5+</sub> products, with an emphasis on conversion (Figure 1).

The wide scope of the Dutch chemical industry originates from the usage of naphtha, an oil derivative, as the prime feedstock. This oil based route towards chemical building blocks results in a broad range of products (see figure 2). This is also the main route used in the rest of Europe and most of Asia.

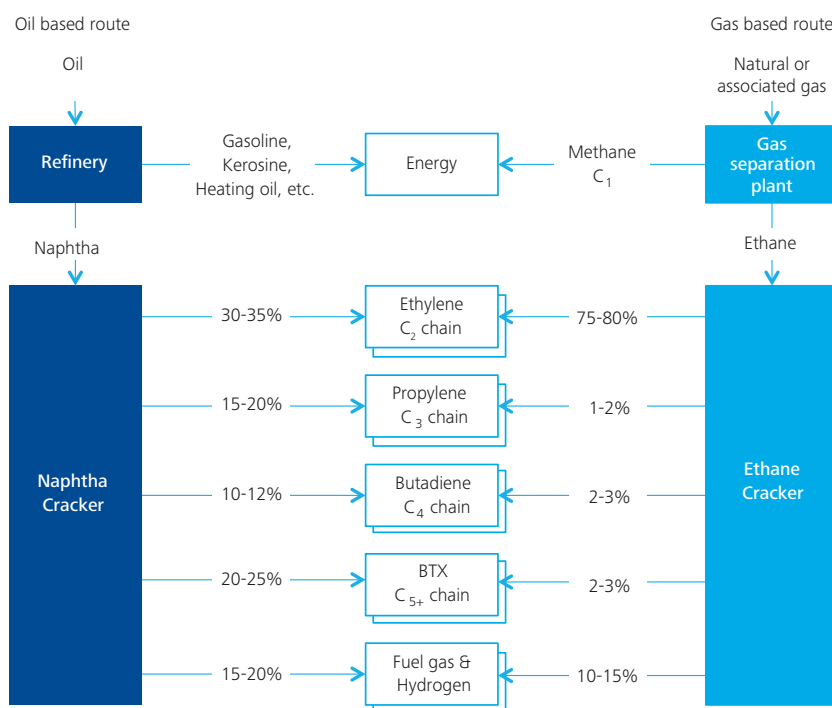
**“A thriving chemical industry is critical to a successful Dutch economy”**

This makes the Netherlands a large player in the global chemical industry. With only 1.1% of global GDP, the Netherlands has a more than its fair share in the global production of many chemicals, e.g., 14% of benzene, 7% of fluor polymers, 8% of polyphenylene-ester resins, 3% of ethylene and 2% of polypropylene.

In the U.S. and Middle East, the primary route to basic chemical building blocks is gas based. Gas liquids (primarily ethane) from natural gas are cracked to produce basic chemicals. The resulting product range is more narrow and highly focused on ethylene.

**“The chemical industry in the Netherlands generates EUR 60bn in revenues and is responsible for 79,000 direct and over 400,000 indirect jobs”**

**Figure 2. Feedstock routes to chemical products**



2) Appendix A provides an overview of the main chemical industry building blocks and their corresponding value chains



### Key components of the Dutch chemical industry

Six Dutch naphtha crackers produce most of the petrochemical “building blocks”, ranging from methane ( $C_1$ ), ethylene ( $C_2$ ), propylene ( $C_3$ ) and butadiene ( $C_4$ ) to BTX ( $C_5$  and higher). In addition, the industry produces key inorganic building blocks like ammonia ( $NH_3$ ), chlorine and caustic soda ( $Cl_2$  and  $NaOH$ ).

From each of these, the industry produces huge numbers of other products. These start with “Tier 1” products, the direct derivatives of the building blocks. Examples are fertilizer and methanol (from  $C_1$ ), PE (from  $C_2$ ), styrene (from  $C_{5+}$ ) and melamine and fertilizers (from ammonia).

This results in yet another category, the intermediate “Tier 2” products, including ethylene amines ( $C_2$  chain), polyols and adiponitrile ( $C_3$ ), caprolactam ( $C_{5+}$ , ammonia) and vinyl chloride (chlorine).

These are then processed into “Tier 3” products, which include well know end-products like PET containers ( $C_3$  chain), de-icing fluids ( $C_2$ ), latex ( $C_4$ ), EPS, nylon6 ( $C_{5+}$ ), polyurethane (ammonia), bleach (chlorine) and PVC (chlorine).

Finally, these products are converted into an almost infinite number of engineering plastics and applications, such as mobile phones, car parts, furniture, paint, building materials, shopping bags, et cetera

# US shale gas puts the Dutch chemical industry at a disadvantage

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“Abundant energy” is one of the four scenarios for the global chemical industry examined in the VNCI 2030/50 study in 2012. High oil prices are assumed to stimulate the discovery and development of new energy sources. These could include solar energy, geothermal energy and new hydrocarbons.

Oil and gas trapped inside non-porous rock formations, commonly known as shale oil and shale gas, is emerging as one of these new hydrocarbons. The US Energy Intelligence Agency (EIA) estimates global shale gas reserves of 7,201 trillion cubic feet, a 31% addition to the world’s gas reserves. This excludes substantial areas that have not been properly surveyed such as large parts of the former Soviet Union, Central Europe, Africa and Brazil. Shale and tight oil reserves are almost as impressive. The known reserves alone would add 13% to the global oil reserves.

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“Initially, the ethylene, ammonia and chlorine and caustic soda chains will be most affected, but over time the entire cluster may disintegrate”

Although shale gas basins are found all over the world, the US is the most important producer today. It was the first to develop large scale production and is years ahead of other countries. This has led to a gas glut in the US market. Because many gas buyers are stuck with long term contracts, and oil users face high switching costs, demand has not grown in line with supply. As a result the spot price of gas in the US has plummeted to USD 4 per MBTU, lower than USD 30 per barrel of oil equivalent.

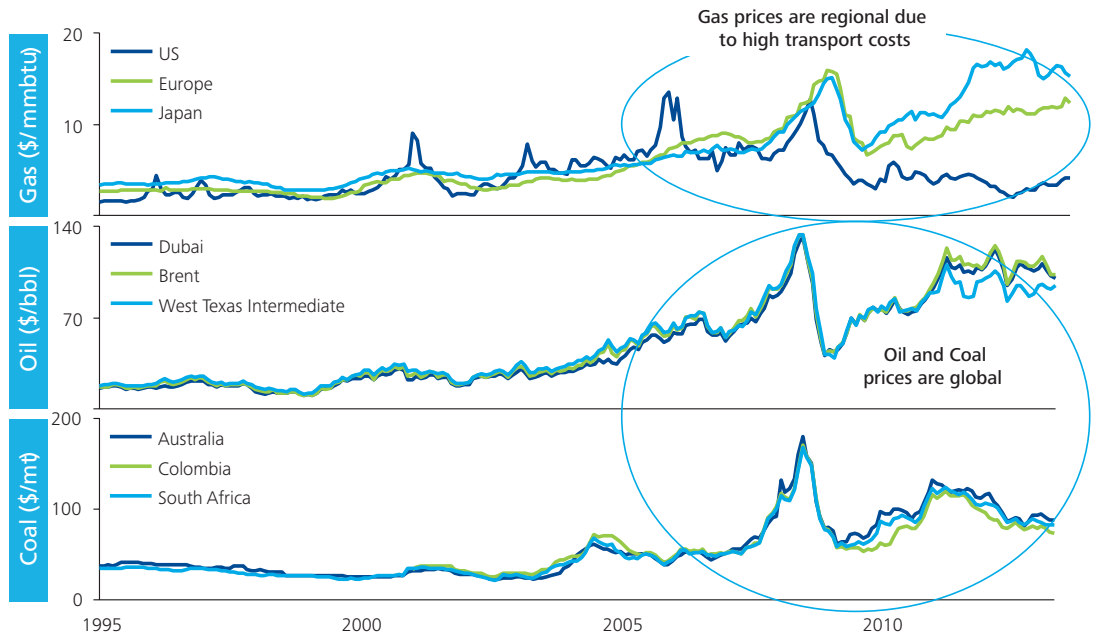
In sharp contrast European gas prices have risen to over USD 12 per MBTU (Figure 3). Paradoxically, gas is now more expensive in the Netherlands than in the US, even though Dutch gas is not more expensive to produce than US shale gas.

The price difference will not easily disappear because the US government restricts export permits and transport of US gas to Europe is expensive. With liquefaction costs in the US, transportation across the Atlantic Ocean, and regasification in Europe, the gap would remain at least USD 4 per MBTU in favour of the US.

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“Paradoxically, gas is now more expensive in the Netherlands than in the US, even though Dutch gas is not more expensive to produce than US shale gas”

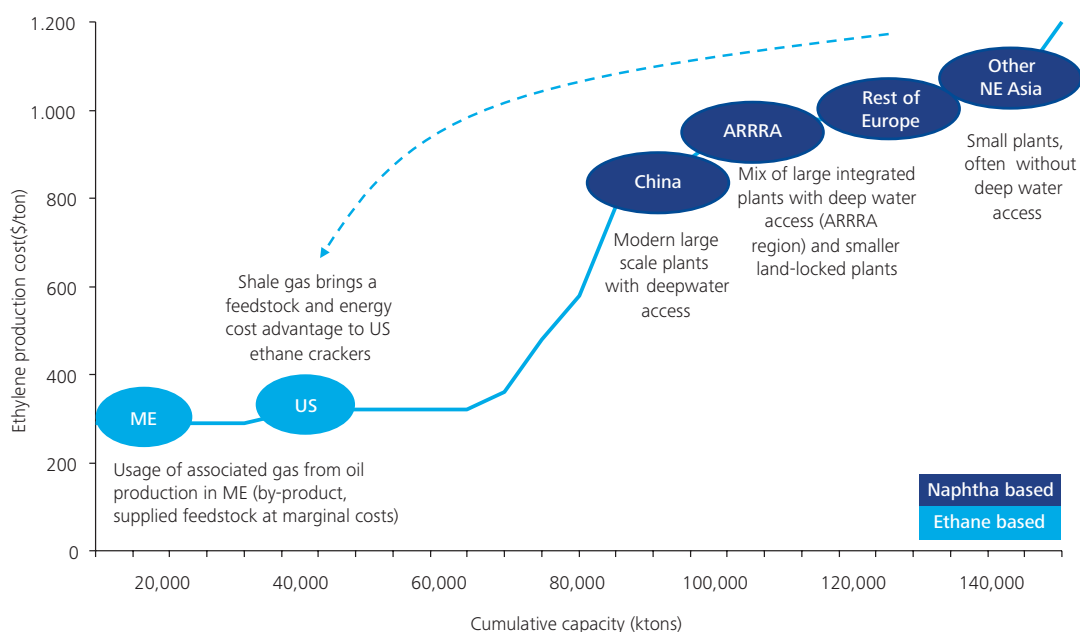
Figure 3. Prices of energy carriers



Source: IEA; World Bank

For the US chemical industry, abundant supply of gas, leading to low prices, translates into a huge advantage in feedstock and energy cost. Once among the most expensive in the world, the US crackers are now very cost competitive, pushing back Europe on the cost curve (Figure 4). Not surprisingly, this has led to over \$ 100bn industry investments in the US, as shown in the insert 'Planned US chemical industry capacity expansion'.

Figure 4. Global ethylene (C<sub>2</sub>) industry cost curve (2012)



Source: Cefic, Deloitte analysis

### Planned US chemical industry capacity expansion

Methanol (C<sub>1</sub>): five plants are expected to come on stream before 2016 adding 80% to US and 8% to world capacity.

Ethylene (C<sub>2</sub>): 19 expansion and new plant projects are planned, accompanied by several new polyethylene and other derivatives plants. US ethylene capacity will increase by 43%, 7% on a global level.

Propylene (C<sub>3</sub>): seven on-purpose plants have been announced to balance the growth of ethylene output. These will increase US capacity by 20% and global capacity by 5%. On-purpose plants will also increase capacity in the C<sub>4+</sub> chain

Inorganics: 14 ammonia expansion projects are planned (35% more US and 5% more global capacity). And seven new plants have been announced for the production of chlorine and caustic soda. Following this the capacity for PVC, the most important chlorine derivative, will grow substantially as well.

# Risk of underinvestment and cluster disintegration

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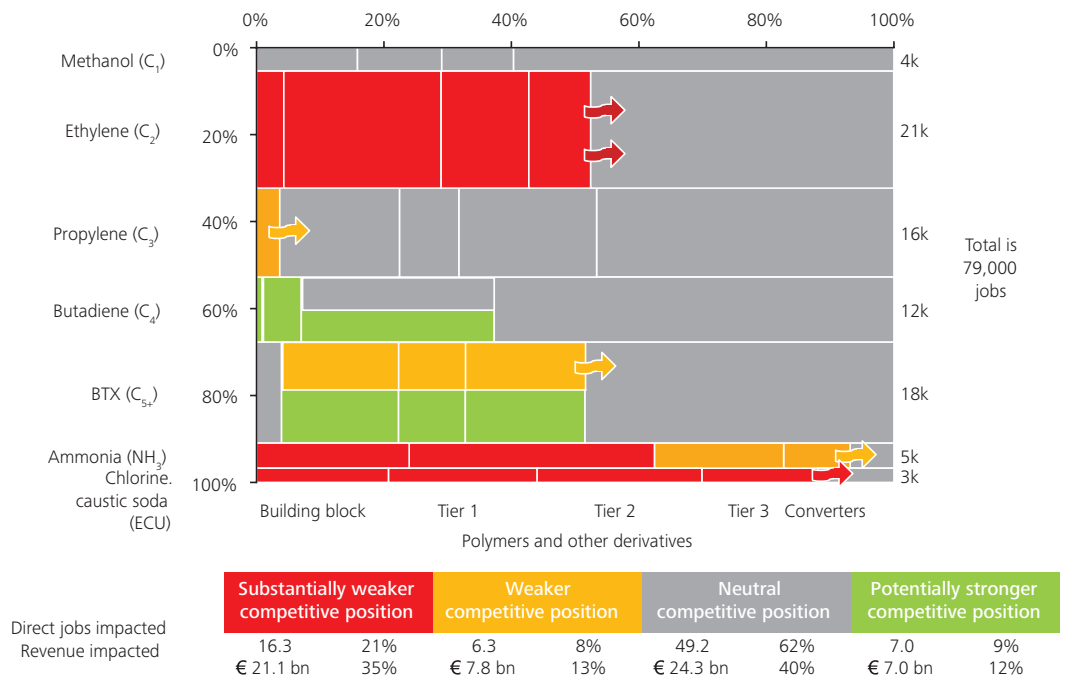
## Cheaply priced US shale gas can negatively impact the competitive position of the Netherlands and European chemical industry on the short and long run.

Initially the impact will be mostly limited to the ethylene (C<sub>2</sub>), ammonia and chlorine and caustic soda chains, negatively affecting about 29% of the Dutch chemical industry employment and 48% of revenue (figure 5).

- Europe's competitive position in ethylene (C<sub>2</sub>), ammonia and chlorine and caustic soda chains will be severely weakened, all the way from building block to Tier 3 products (21% of direct employment). New US ethane crackers will have a substantial cost advantage over the European naphtha crackers, which will also give the US an edge in the key Tier 1 product polyethylene and even in ethylene oxide derivatives in Tier 2. Inorganic building blocks are also negatively affected due to their heavy use of gas, either as a feedstock (ammonia) or as a source of energy (chlorine).
- A moderate loss of the competitive position in propylene (C<sub>3</sub>) will arise at the building block level and in selected BTX (C<sub>5+</sub>) products (8% of employment). This is mainly caused by on-purpose production in the US. The C<sub>5+</sub> impact relates to polystyrene (which uses ethylene (C<sub>2</sub>) as a raw material), as well as nylon 6 (C<sub>5+</sub>).
- Butadiene (C<sub>4</sub>, utilizing yield improvement or from bio-based sources) and BTX (C<sub>5+</sub>) products up to the Tier 3 level offer growth opportunities, as new US ethane crackers cannot abundantly supply them. Here Europe may benefit from a global rebalancing.
- All other activities, mainly conversion into end products, will initially see little changes. As the share of transport costs drops with the addition of more value to a product, most converters can still source their raw materials from overseas at competitive prices.

In the short term these effects may create a disincentive for global players to invest in plant upkeep and innovation. This could trigger a vicious circle of lower investments, higher costs and lower returns. Over time, ripple effects may occur that will even impact those activities initially deemed safe. Downstream plants (Tier 2 and 3 and conversion) that are physically integrated with upstream facilities (building blocks and Tier 1) may lose their sourcing advantage as the competitiveness of their supplier plants weakens. The cluster could ultimately disintegrate, putting nearly half a million jobs at risk in the Netherlands alone with far reaching consequences for the Dutch economy.

Figure 5. Initial impact on employment in the NL chemical industry by product category (2012, # jobs)



Source: CBS, Deloitte analysis

Relief might come from a number of mitigating factors, but these are not certain and may take years to materialise. Margins in the European chemical industry, though lower than in the Middle East and US, could at least be maintained by a combination of higher global

demand and restrained capacity expansion in China and the Middle East. Or the ratio of European naphtha to US ethane prices - now at an all-time high - may drop over time and narrow the margin gap between Europe and the US (see insert).

### Potentially mitigating factors

First, the European chemical industry could be saved by higher global demand in combination with restrained capacity expansion. For ethylene this would keep the expensive Asian plants in business as the marginal players, leaving European margins unaffected. With the chemical industry historically growing at a rate of 1.5 times of GDP growth and an IMF forecast of 3.3% economic growth through 2018, demand for chemical products would be 34% above 2012 levels. In this case, the market would easily absorb all announced US capacity. This, of course, would require restraint in additional capacity expansion, not only in the US but also in the Middle East and China. This is plausible for US capacity, as most of its plants are owned by global players that will try not to hurt their plants elsewhere. But for the Middle East, China and Brazil, who take a much more nationalistic view, this is a different matter. With its own shale gas or gas from underground coal, China may even emerge as an additional contender on the global market. And Brazil could further expand in bio-ethanol.

Second, the ratio of European naphtha to US ethane prices - now at an all-time high - may drop over time and push European margins upwards. Most energy analysts, as well as scenario outcomes of the Deloitte World Gas Model, suggest an increase of gas prices in the US, leading to higher ethane prices. As the government is allowing export of US gas and as customers gradually convert to gas, demand will grow. Think of power plants switching from coal, and trains, boats and even cars running on natural gas. More electric cars, supplied by gas fired power plants, will also boost demand. In addition, supply could be restricted because at the current price level many shale gas fields are hardly, if at all, profitable. At some stage they will have to reduce their output. Besides higher gas prices, the naphtha-ethane price ratio could drop down due to lower oil prices. Once again this is a matter of supply and demand. Supply will increase with a record number of oil industry investments and the emergence of shale and tight oil. And, at least in the West, demand for oil is dropping as vehicles, the main consumers of oil, are getting ever more energy efficient.

# Policy measures needed to reinforce the 2030-2050 strategy

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The trend toward more global competition is not new and was already identified in the VNCI Vision 2030/2050 study. Nevertheless, it concluded that the outlook for the Dutch chemical industry is very positive. Although additional low-cost competition from the US is not fundamentally changing this picture, more competition than anticipated does warrant a response by the industry itself and by policy makers.

For the industry this means a stronger emphasis on all four of the VNCI's strategic objectives.

The first strategic objective, "ensuring a tightly integrated physical network of chemical plants", remains critical to drive down cost, protect returns on capital, and attract investments. Physical integration reduces transport costs and enhances the value of by-products. Ensuring the superior technical performance of plants will maintain cost and resource efficiency. It makes sense to complete the propylene pipeline system currently being constructed. And, likewise, to build the planned CO<sub>2</sub> and NH<sub>3</sub> pipelines across the ARRRR region to discourage the closing of plants and avoid a chain reaction of further shutdowns.

With the rise of shale gas based ethane crackers strategic objective number two, "flexibility to use a wide range of feedstock", is increasingly relevant too.

- Because ethane crackers create an imbalance in the chemical industry (they generate less C<sub>3+</sub> products than naphtha does), they stimulate on purpose production of bio-based C<sub>4</sub> products and aromatics. With European ethylene costs higher than those in the US, it may become the preferred launching continent for bio-ethylene derivatives.
- Also, with other continents very much focused on hydrocarbon feedstock, Europe has a unique opportunity to be a first mover in recycled materials.
- Finally, the sector could consider investing in flexible naphtha-ethane crackers and be the first to process C<sub>2</sub> and C<sub>3</sub> rich shale gas from European sources, if and when available.

Strategic objective three, "a leading innovation ecosystem", is equally essential as this helps to further drive down cost and develop new products and services. A fair amount of these new products should be on the Tier 3 and conversion levels of the chemical supply chain. They will be least impacted by the new competition and could support a shift of the Dutch chemical industry toward end markets. Enhanced collaboration in the value chain between big corporations and small and medium enterprises is essential. Current strengths still allow the cluster to be world class at the intersection of agriculture, biology, life sciences, and chemistry.

Needless to say, "a clear regulatory framework", the fourth and final objective, is also fundamental to a thriving chemical industry in the Netherlands.

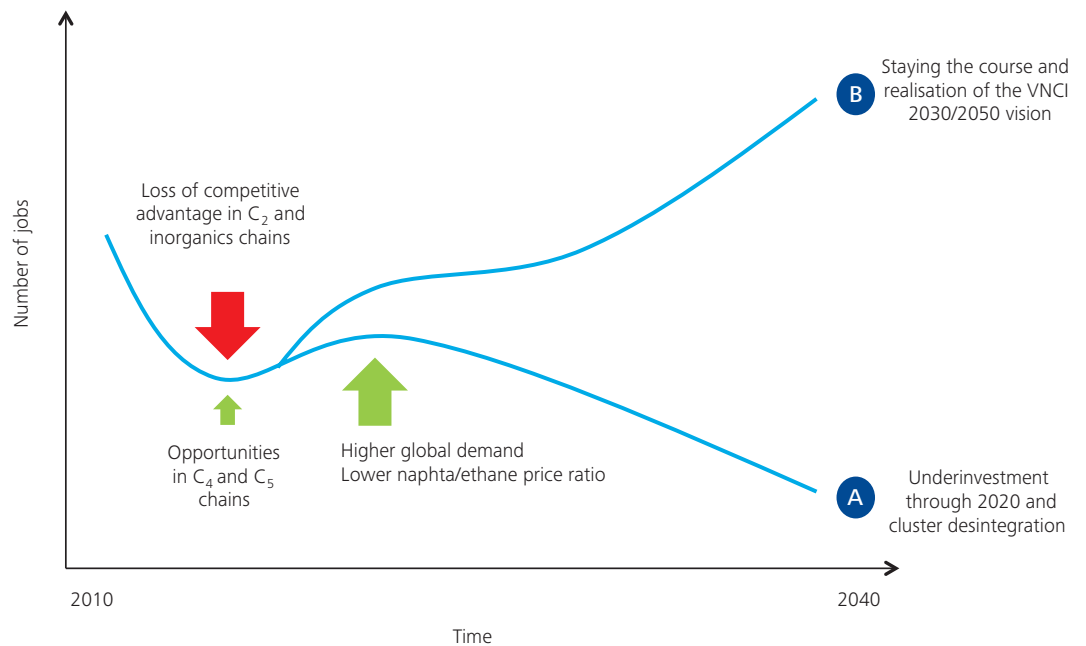
Because most of the industry strategies will only materialise on the long term, they need to be supported by short term policies that allow the industry to weather the storm. Policy instruments should be aimed at avoiding underinvestment in assets and innovation, loss of key players and cluster disintegration. These could range from subsidies and allowing additional tax write-offs for investments (in cluster integration and for bio-based and recycling plants) to a transition away from current European gas supply contract prices.

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**"Sector strategies should be supplemented by short term policies that prevent underinvestment and the loss of key cluster participants"**

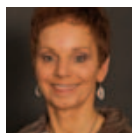


Figure 6. Potential futures for the Dutch chemical industry



Together, these measures can prevent an initial loss of competitive advantage in the C<sub>2</sub> and inorganic chains that would trigger structural underinvestment and a gradual disintegration of the cluster as whole (trajectory A in figure 6). Instead (trajectory B), the sector can stay the course, continue to invest as it has always done in the face of more global competition, and use higher global demand and better naphtha prices to accelerate its development toward the VNCl vision for 2030/2050: a world leading chemical cluster and Europe's hub for feedstock, production, research, and development.

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# Appendices

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A. Background Information

B. Interviewees

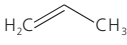
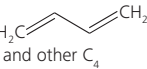
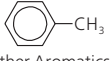
C. Steering Committee

D. Reference Material

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# Background Information

## Appendix A1. Overview of building blocks

Building block	Structure	Production process
Methanol (C <sub>1</sub> )	H <sub>3</sub> C – OH	<ul style="list-style-type: none"> <li>Methane is converted in Syngas, which reacts over a catalyst to produce methanol</li> </ul>
Ethylene (C <sub>2</sub> )	H <sub>2</sub> C=CH <sub>2</sub>	<ul style="list-style-type: none"> <li>Steam cracking of Naphtha</li> <li>Steam cracking of ethane</li> </ul>
Petro-chemicals	Propylene (C <sub>3</sub> )	 <ul style="list-style-type: none"> <li>Steam cracking of Naphtha</li> <li>On-purpose dehydrogenation of propane</li> <li>Production at refinery in FCC and splitters</li> </ul>
	(Iso )Butene Butadiene (C <sub>4</sub> )	 <ul style="list-style-type: none"> <li>Steam cracking of Naphtha</li> </ul>
	BTX (C <sub>6+</sub> )	 <ul style="list-style-type: none"> <li>Steam cracking of Naphtha</li> <li>Refinery reformer</li> </ul>
Inorganics	Ammonia (NH <sub>3</sub> )	<ul style="list-style-type: none"> <li>Methane is converted in Syngas, The hydrogen reacts with nitrogen from the air to form ammonia via the Haber-Bosch process</li> </ul>
	Chlorine & C.Soda (ECU)	<ul style="list-style-type: none"> <li>Electrolysis of salt water</li> </ul>

Source: Deloitte Analysis

## Appendix A2. Examples of products from building blocks

	Building blocks		Tier 1		Tier 2		Tier 3
Petro-chemicals	<b>Methanol</b> (C <sub>1</sub> )		Acetic acid Formaldehyde Methyl amines MMA MTBE		<b>Formaldehy. resin</b> <b>Methylamine</b> <b>Phenolic resins</b> <b>Polyacetal resin</b> Vinyl acetate		<b>Amino resin</b> DDSA <b>EVA co-polymers</b> Paraformaldehyde Polyvinyl acetate
	<b>Ethylene</b> (C <sub>2</sub> )		Ethylene dichloride Ethylene oxide <b>HDPE</b> <b>LDPE</b> <b>LLDPE</b>	Perchloroethylene <b>Polyethylene</b>	Ethanoamines Ethoxylates Ethylene glycol Glycol esters Glycol ethers	PET Polyacetal resin Polyethylene glycol Polyols Vinyl chloride	<b>Antifreeze</b> <b>PET containers</b> <b>PET film</b> <b>PET resins</b> <b>Plasticizers</b>
	<b>Propylene</b> (C <sub>3</sub> )		Acrylate esters Acrylic acid Acrylonitrile Butanol Isobutanol	Isopropanol <b>Polypropylene</b> Propylene oxide	Acrylamide <b>Acrylic fibers</b> <b>Acrylic resin</b> Adiponitrile Fibers	Glycol esters Polyols Polyether polyols Propylene glycol Surface coatings	<b>Adhesives</b> Antifreeze <b>Epichlorohydrin</b> <b>De-icing fluids</b>
	<b>Butadiene</b> (C <sub>4</sub> )		2,6 NDC HDMA Isobutylene Isoprene Polybutadiene	Polychloroprene SB copolymer	<b>ABS resin</b> Polyisoprene		<b>Nylon</b> <b>ABS resin</b> <b>Latex</b> <b>Nitrile Rubber</b> <b>SBR</b>
	<b>BTX</b> (C <sub>5+</sub> )		Aniline Cumene Cyclohexane Dinitrotoluene Ethylbenzene Nitrobenzene	Styrene Para-Xylene Ortho-Xylene Meta-Xylene	Acetone Adipic acid Caprolactam Divinyl benzene DMT Phthalic acid	EPS MDI Polystyrene TDI Phenol Phthalic anhydride	<b>Amino resin</b> <b>Aramid fiber</b> <b>Epoxy resins</b> EPS Bisphenol-A Diocetyl phthalate
Inorganics	<b>Ammonia</b> (NH <sub>3</sub> )		Acrylonitril Ethylenediamine Methyl amines Nitric acid	Ureum	<b>Caprolactam</b> Methylamine Ammonium nitrate Ammonium salts	Melamine Polyacrylonitril <b>Fertilizer</b>	<b>Amino resin</b> <b>Nylon 6 &amp; 66</b> <b>Polyurethane</b> <b>Nitrile Rubber</b>
	<b>Chlorine &amp; C.Soda</b> (ECU)		Perchloroethylene Chloric acid Phosgene Glass		Vinyl chloride MDI TDI Isocyanate	<b>Polyurethane</b>	<b>Bleach</b> <b>Epichlorohydrin</b> <b>Polyvinyl chloride</b>

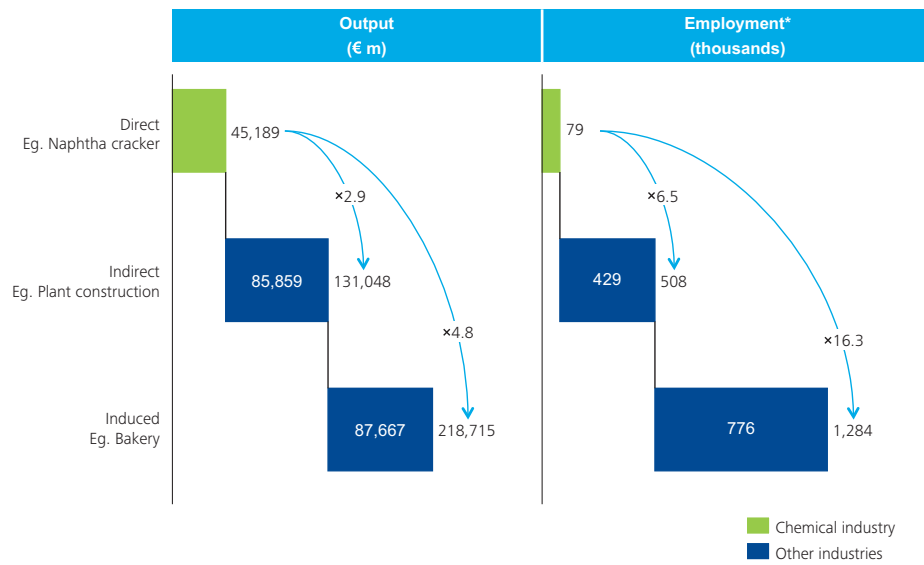
Note: Not a comprehensive list

Source: Deloitte Analysis

Products in **blue**: Traded globally, except when waterborne

Products in **bold**: No further chemical processing, Downstream processing via physical means

### Appendix A3. Multipliers input-output analysis



\* Multipliers are calculated for chemicals and pharmaceuticals and multiplied for employment of chemicals and converters  
 Note: Multipliers are generally used for calculating small differences and may overstate the realistic effects due to underlying assumptions

Source: OECD, Deloitte analysis

# Interviewees

- Heidi Beers (Teijin Aramid)
- Paul Booth (Sabic)
- Frank Choufoer (OCI Nitrogen)
- Sjoerd Gaanderse (ExxonMobil)
- Melt de Haas (Arkema)
- Gerard van Harten (Stichting Regiegroep Chemie)
- Mette Houthoff (Akzo Nobel)
- Willem Huisman (Dow)
- Bertjan Lommerts (Latexfalt)
- Jaap Oldenziel (Air Liquide)
- Connie Paasse (Shell)
- Ton Runneboom (BioBased Economy)
- Chiel Schoevaars (PQ Silicas)
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- Rob Kirschbaum (DSM)
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