A Paradigm Shift :
Supply Chain Collaboration and Competition in and between Europe's Chemical Clusters

Results of the EPCA Think Tank Sessions organized and sponsored by EPCA

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NOTE ON COMPETITION LAW

Competition law, both at national level and at EC level, regulates – among other things – agreements between companies that have the purpose or the effect of restricting competition.

Whilst in itself cooperation between companies to enhance supply chain efficiency and, more broadly, to develop competitive industry clusters does not give rise to competition law concerns –and may indeed help to reinvigorate competition– the existence and nature of such cooperation may be misinterpreted or not fully understood by competition authorities, or indeed may be open to abuse.

For this reason it is important when considering any form of cooperation to ensure (i) the compatibility of individual strategies with competition law and (ii) that these strategies are described and communicated in a clear way that limits any possible misunderstanding as to their nature and intent.

Broadly speaking, it can be observed that the key objective of rules against anticompetitive agreements is that companies should act independently. This of course does not mean that any form of common action is excluded. It does, however, imply that where cooperation is envisaged, the intention should not be to dampen rivalry between firms. It is therefore important that the efficiency or competition enhancing intent behind cooperation be clearly identified at the outset. Moreover, the concrete effects on competition of cooperation should be carefully weighed up. Do the increased efficiency, improved customer service and/or technological advances promised by a certain cooperative strategy outweigh the possible loss of rivalry between firms working together on a project?

Clearly, the compatibility of specific cooperative agreements with competition law ultimately requires a case by case approach. However, the following general observations can be made. Generally

speaking, competition authorities will be more concerned about:

- "Horizontal" cooperation than "vertical" cooperation;
- Cooperation involving (even exchanges of information on) key parameters of competition such as price or output;
- Cooperation between players in concentrated sectors or cooperation involving many players in a sector.

In addition to assuring themselves that a particular course of conduct is indeed compatible with competition law, companies must also ensure that their assessments are carefully documented. Rigorous documentation and document retention policies are therefore key. Clear records must be kept, for example, of the reasoning behind strategies adopted and any meetings concerning them, the assessment of the effects of those strategies and why the company considers them to be compatible with competition law. Paper trails clearly showing the good will and intentions of the companies involved in cooperative agreements are important elements of evidence in the event that breaches of competition law are alleged at a later date.

Finally, it is emphasized that – in accordance with competition law – **the present report** is not intended as a "shopping list" or set of recommendations to industry, but **aims to identify the great efficiencies that can be derived from the development of efficient supply chain management and strong economic clusters more generally. Ultimately, it is up to each company to decide individually upon its own best business strategy.**


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1. MANAGEMENT SUMMARY

With the attention of the chemical industry focused on exploiting the low cost feedstocks in the Middle East and the growth markets of Brazil, Russia, India, China and South East Asia, this report provides a timely reminder to policy makers, chemical companies and logistics service providers of the significant opportunities for improving business potential in Europe's chemical clusters. Europe is still the largest, most sophisticated global market for chemical products, with a well developed, efficient, highly productive asset base, sound infrastructure, leading edge research and development and significant purchasing power. Provided these advantages are sustained, including continued attention to asset maintenance and operational and supply chain improvements, Europe can remain a competitive force in the global market place, despite what the doom-mongers may say to the contrary.

The EPCA Supply Chain Think Tank reports of 2004 and 2005 concluded that there is a huge potential to be achieved through collaboration between producers, customers, suppliers and service providers to drive out waste and cost. Recommendations were made to:

- Actively promote the conclusions of the Think Tank working groups in order to change attitudes and perceptions of the industry
- Alert entrepreneurial stakeholders to the business opportunities
- Develop research connections with universities and institutions
- Continue with the working group activities where there are areas for further discussion and development

As a consequence it was proposed that the successful Think Tank model be maintained, comprising senior stakeholders and decision-makers, to **study supply chain collaboration in chemical clusters in Europe**. During the first half of 2007, under the sponsorship of the EPCA Board, 53 senior representatives of chemical companies, logistics service providers, public authorities and institutions, together with researchers from INSEAD, engaged in this study. The Think Tank was chartered to test the conclusions from previous think tanks, identify working examples of cooperation (successes as well as opportunities for improvement and missed opportunities), develop ideas to overcome constraints and stimulate future supply chain collaboration initiatives, using the examples of **Tarragona and Antwerp/Rotterdam/Rhine-Ruhr (ARRR).** Although each of the components of ARRR are clusters in themselves, the integration through pipelines, waterways, rail and roads as well as the intensity of the exchanges between them encouraged the Think Tank to explore this as one mega-cluster.

The work of the Think Tank has culminated in the production of this report.

There is general agreement that, whilst progress has been made – and case studies illustrating this view are included in the report –, **there are both opportunities and threats for the future growth and added value of the clusters which will require the attention of public policy makers and senior management in the industry.** Much of the cluster development to date has been driven by individual rather than collective initiatives. The long-term health of a cluster requires adequate infrastructure and sustainable mobility, but also a strategic view on supply chains. To achieve the latter, **more attention should be paid to creating the right conditions for successful end-to-end supply chain collaboration.** Whereas the integral supply chain perspective has become a successful reality in sectors like consumer electronics and automobiles, it has barely surfaced in the chemical industry.

The Think Tank discussions showed that the **concept of chemical clusters,** with the associated dynamics and supply chain value proposition, **receives increasing attention on Board meeting agendas and by senior management, but a paradigm shift has not come true yet.** Despite the fact that some 8-10% of total industry turnover is spent on supply chain and logistics activities, representing more than 35% of total value-added, many investment and operational decisions are taken remotely, without necessarily exploring all the supply chain opportunities within the cluster.

It is generally acknowledged that supply chain excellence can deliver lower unit costs, higher capital productivity (ROCE), improved service and reduction of carbon emissions. With capital investments in the chemical industry often having a lifetime of 30-40 years, it appears prudent to ensure that such supply chain benefits and the associated competitiveness can be obtained over the life of the project. This report explores and illustrates how these benefits are being achieved through cluster arrangements, but, more important, how many opportunities still remain unexploited. Recommendations are made on how this can be improved it being understood that decisions must be taken by each individual company in full compliance with competition rules.

Research by INSEAD, conducted through interviews with key industry leaders and subsequently discussed inside the Think Tanks, **has identified many drivers, as well as blockers, which impact cluster growth.** These are discussed in detail in the body of the report, and the reader is urged to explore the interviews and Think Tank results in Chapter 4. On the basis of these results the Think Tank has derived **four recommendations for companies acting in the clusters.**




Information sharing is key.

The interviews have shown that many opportunities to benefit from chemical clusters are missed because each cluster stakeholder (producer, Logistics Service Provider (LSP) or authority) has only a partial view of the flows processed. Compared to chemical clusters in the rest of the world, it is surprisingly difficult to obtain even basic aggregate information on European chemical clusters. Consequently, initiatives to build cluster-wide infrastructure solutions or even merge shipments from different companies are very difficult to undertake. Without a certain level of structured and available information accessible to all partners, firms will value investments in the cluster with a higher risk or might even invest in the wrong alternative. Thus, to ensure that the competitive forces still work to the benefit of all cluster members, information sharing is key and should go beyond exchanging forecasts between business partners. Clearly, any information exchange must be done in full compliance with competition rules.

A flexible discussion platform is required to organize information sharing and coordinate cluster initiatives.

Considering the constraints of the chemical industry with respect to competition law as well as the fact that firms operate independently, we recommend the

creation of a flexible discussion platform to coordinate the information gathering at a supply chain level and to create common knowledge. This platform should be opened to producers, LSPs and authorities (state, region, port/cluster authority) who have the power to exchange ideas and opinions on the basis of the information gathered.

Take actions to solve current cluster issues.

The value of the cluster platform will be demonstrated as soon as actions start to be launched under its initiative. The platform will be an especially important communication channel when it comes to discussing ways to improve cluster performance. Infrastructure shortages or congestion problems are topics that have to be solved collaboratively, taking into account the complexity of the interdependencies between stakeholders in the cluster. For the ARRR mega-cluster, a working group should be dedicated to the harmonization of the legislation and supply chain practices between companies and the three countries. No platform currently exists that brings companies together to address such issues.

The paradigm shift on collaborations has not taken place.

Despite the various examples provided in this report, the study has shown that a significant gap between words and facts still exists when it comes to collaboration. Although producers are very knowledgeable about the benefits of going beyond arm's length relationships with LSPs, the interviews highlight the limits in practice. Frequent tendering practices with limited information sharing reduces planning visibility for service providers and results in a high cost position for producers.

This report is a demonstration of confidence in the future of the European chemical industry, but urges policy makers, local authorities and industry leaders to be alert to the opportunities and to the need for effective lean logistics and efficient supply chain economics to help sustain this competitive advantage. Although individual companies will continue to pursue their own self-interest, the report urges the establishment of local chemical industry platforms, represented by all stakeholders, to explore these opportunities in more detail.

Leveraging these supply chain opportunities through intensive collaboration within and between clusters will go a long way to ensuring the continued competitiveness of Europe's chemical industry.

2. INTRODUCTION

2.1 European Chemical Industry – A Major Force under Threat?

From food packaging to pharmaceuticals, the chemical industry plays a dominant role in today's national and global economies. Developing and sustaining a local chemical industry, able to compete on a global scale, has both economic and political importance as the chemical industry supplies the full spectrum of Europe's manufacturing industry with intermediate products.

In 2006 the European chemical industry comprised more than 30,000 firms, directly employed 1.9 million workers, and generated 2% of Europe's gross national product (Source: Eurostat, 2007). Recent studies performed in the Rhine/Ruhr region indicate that one job in the chemical industry creates three additional jobs in the chemical-related sector.

Since 1990 the European chemical industry has been growing at an average rate of 2.8% per year, outstripping the European manufacturing industry which has grown by 1.6% in the same period. At the end of 2006 the industry had delivered a positive trade surplus of € 41.0 billion, up by 6% compared with 2005.

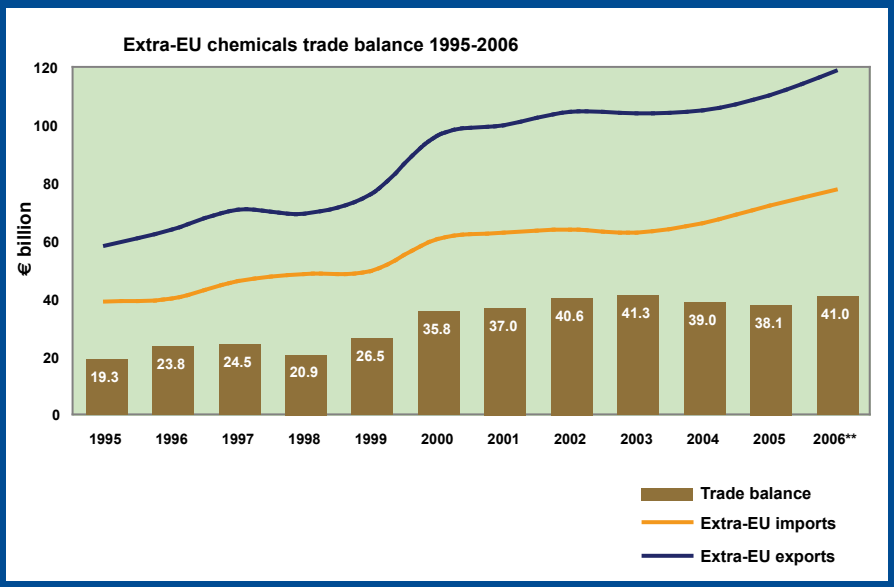

Figure 2-1 Extra-EU chemicals trade balance (Eurostat, 2007)

Therefore, the European chemical industry has been, and will remain, a leading factor in economic growth, warranting specific attention from policy makers.

Despite these positive numbers, there are signals that the growth and export potential of the European chemical industry could be under threat. Agricultural chemicals and fibers have experienced negative growth, the trade surplus for organic chemicals has declined in the face of increased import flows from Singapore and Saudi Arabia, and despite a strong performance from polyolefins, huge new petrochemical capacity in the Middle East will inevitably impact demand for European sourced production.

European companies have of course contributed to the development of competing clusters closer to emerging markets (China/India) and cheap feedstocks in the Middle East. Although much of the new production is expected to find a home in Asian markets, there is a concern that European competitiveness will suffer as companies prefer to invest scarce financial resources in growing regions, and allow the European asset base to become obsolete. Up-to-date manufacturing assets as well as efficient and reliable logistics networks are a prerequisite for remaining competitive in global markets.

2.2 Clusters & Competitiveness

An Arthur D. Little study from 2005 – *The Staying Power of Europe's Chemical Industry* – compared the production costs of Europe's chemical sites to the US, India, China, and the Middle East. Whilst the report acknowledged that Europe may be expensive, the surprising conclusion was that it still remains one of the most competitive regions in the world. The study challenges the hypothesis that significant relocation of European-based chemicals manufacturing operations is likely to happen in order to serve developing and developed markets at reduced cost.

The study conducted both a qualitative and a cost based assessment of the operating environment in which a chemical company can deliver value. The four factors determining the quality of the environment were demand conditions, technological advancement and innovation, environmental regulations, and **the formation of clusters.** With the exception of environmental regulations for which the report underlined that "governments must improve cooperation with companies to develop environmental efficiency at low administrative cost", all other factors are well established in Europe, including the presence of **strongly integrated clusters.**

The report observed that Europe enjoys the benefit of a limited number of strongly clustered areas. With raw materials being the main input to the chemicals industry, their immediate availability through ports, refineries, and pipelines is of prime importance, as well as the opportunity to develop derivative products at the lowest possible logistics cost.

It should be clear that **the continued global competitiveness of European chemical manufacturing is closely linked to the efficiency of its clusters. Chemical clusters are all about the supply chain at work.**

The port and pipeline infrastructure facilitates upstream supply chain operations and economics. The high level of integration and interconnectivity between the cluster participants creates significant opportunities to benefit from efficiencies through reduced transportation intensity (i.e. lower freight costs, reduced risk from the movement of hazardous products, reduced emissions), more effective utilization of assets, and efficient use of working capital.

The inevitable tension between competition and collaboration has probably limited the full exploitation of these opportunities in the past. However, there is evidence of an increasing willingness to explore the scope and benefits of collaborative relationships, as a way of raising the bar on performance, without negatively impacting competition.

In addition, notwithstanding the fact that Europe has well-established and effective clusters in place, supported by highly sophisticated logistics service providers and supportive public authorities, further benefits would be obtained by engaging all stakeholders in enhancing the linkage between clusters.

In this context EPCA took the initiative of conducting a more in-depth study of European chemical clusters.

2.3 The EPCA Study

Since European manufacturers cannot differentiate themselves through a cost advantage on feedstocks (versus Middle Eastern producers), the integration of energy and intermediate raw materials as well as supply chain efficiencies represent key drivers for competitiveness. Previous studies from EPCA and CEFIC have shown that 36% of the value added created by chemical companies can be spent on transforming, storing, and moving products.

The EPCA-CEFIC Think Tank Reports issued in 2004 and 2005 concluded that a huge potential can be achieved

through collaboration between "customers, suppliers, service providers and, occasionally, competitors, to drive out waste, and hence cost". The estimated accumulated potential in Europe from a range of proposed measures was up to € 15 billion.

The key recommendations suggested in these reports as "next steps" were centered on capturing supply chain collaboration opportunities, in various forms. The 2004 report explored pooling of resources, enhanced use of multi-modal and multi-user terminals (hubs), and further exploitation of swaps and pipelines. The 2005 Report specifically encouraged more collaboration and information sharing to achieve improved asset utilization.

Consequently the successful Supply Chain Think Tank model (comprising senior stakeholders and decision-makers representing producers, service providers, public institutions, and academia) was maintained in order to explore the opportunities offered by Europe's chemical clusters in terms of supply chain efficiency and to identify to what extent cluster development can contribute to Europe's long term competitiveness. Specifically, the study would test the conclusions of the previous think tanks, identify working examples of collaboration as well as missed opportunities, develop ideas to overcome blockers and constraints and stimulate future supply chain collaborative initiatives.

The scope of the study, represented in Figure 2-2, is therefore at the interface between supply chain topics and cluster theory.

The Think Tank study was limited to an empirical investigation of two principal clusters; ARRR (Antwerp, Rotterdam, Rhine, Ruhr) and Tarragona. Although traditionally the ARRR cluster has been viewed as separate individual clusters, the degree of interdependence, integration and infrastructure linkage encouraged EPCA to consider this as one mega-cluster. The ARRR group reflected this approach.

Following a brief generic presentation of chemical clusters and a more detailed description of the target clusters in chapter 3, the results of interviews conducted in the ARRR and Tarragona clusters will be presented in chapters 4, including numerous case studies illustrating successful cluster-driven collaboration. The comparative governance structure of each cluster and the impact on cluster development will be reviewed in chapter 5, followed by conclusions and recommendations in chapter 6.

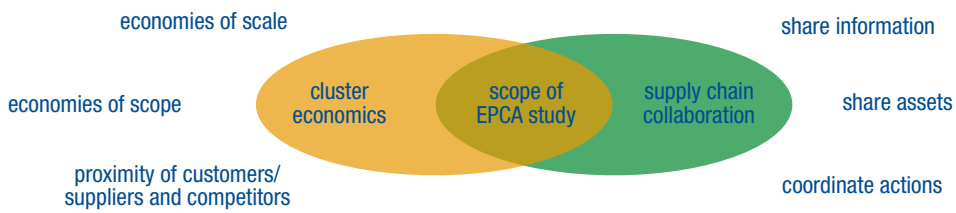

Figure 2-2: Scope of the EPCA study

3. PRESENTATION OF THE ARRR AND TARRAGONA CHEMICAL CLUSTERS

3.1 Definition of chemical clusters

Links between a specific industry and a geographic location can be easily observed in the economic map of the world. For example, financial services are related to the city of London, fashion to Milan and Paris and high-technology electronics to Silicon Valley. The chemical industry could be associated with the area of Rotterdam, Antwerp and the Rhine/Ruhr region, strongly sustained by the presence of 3 important ports (the 2 seaports of Antwerp and Rotterdam and the inland port of Duisburg) and by the dense network of logistics interconnections in place.

The phenomenon of regional industry concentration was explored by Alfred Marshall as early as the 1920s (Marshall, 1920) with respect to the progressive concentration of firms making and machining steel around Sheffield. The attention of the economic and political sphere on this phenomenon has continuously increased since then, due especially to the recognition that such networks would constitute an ultimate source of competitive advantage for an economy (Porter, 1990).

These localized industries that combine a high specialization with an unusual competitive success in a particular field and a specific geographic location represent what Michael Porter described in the 1990s as “clusters” (Porter, 1998). According to more recent research (de Langen, 2004), **a cluster is defined as a “geographically limited concentration of mutually related business units, associations and public or private organizations centered on a specific economic focus”.** This definition will be extended in the following chapters to match the specificities of the chemical industry.

A chemical cluster, like other industrial clusters, is characterized by a high concentration of manufacturing companies and service providers operating in the chemical business. But the cluster population consists also of associations and public or private organizations that participate in and are co-responsible for creating a vibrant environment in terms of productivity, innovation and creation of new businesses. For example, in the chemical clusters examined by the Think Tank the relevant port authorities attract new investors in the area and offer strategic land positions for specific business development in addition to dealing with traditional port activities.

In the manufacturing stage of the value chain, the products of a company are the inputs for the manufacturing process of a company further downstream in the value chain. In addition, chemical companies tend to outsource industry-related services and therefore attract waves of third party investments in warehousing, transportation, general services, waste treatment and disposal, as well as a full range of utilities.

This interaction and interdependence between the firms in a cluster creates complementarities, synergies and a combination of skills and incentives that is hard to reproduce by competitors operating on an isolated basis. This aspect is the real strength of a cluster and explains why many governments, especially in Europe, are attempting to promote the formation of local clusters.

Figure 3-1 shows how chemical companies are integrated into the materials flow system from crude-oil to ethylene and propylene and the C4 cut between BP's Gelsenkirchen sites and the companies located in the ChemSite-Marl Chemical Park in Germany.

While the interaction between companies operating in subsequent stages of the value chain is almost essential for each company's success, the same might not be true for companies operating in the same stage of the value chain. Companies operating in the same product or business segment in the cluster could choose whether or not to collaborate.

However, the fact of being located in a cluster offers unique opportunities for collaboration, even between rival firms. **Optimizing capital investments, increasing the average utilization of assets, swapping capacities and materials and exchanging information are only a few examples of collaboration opportunities that can successfully take place in a cluster.** The geographical proximity of firms within the cluster and the possibility of having frequent face-to-face interactions represent an ideal trigger for developing this kind of collaboration initiative.

C4-Cut interactions in the Rhine/Ruhr cluster

BP's Gelsenkirchen refinery obtains crude-oil feedstock via the crude-oil pipelines from Rotterdam and Wilhelmshaven. The refinery transforms this crude-oil into a range of products, amongst them naphtha, which is used as feedstock by the 2 crackers owned and operated by BP in Gelsenkirchen. These crackers produce, amongst others, ethylene, propylene and the C4 cut, which are feedstocks for chemical companies.

Sabic Polyolefin located in the Gelsenkirchen site, uses ethylene and propylene from the crackers. BP's sites are also connected to the ARG ethylene and the Rhine-Ruhr propylene grids to evacuate what is not consumed locally.

The C4 cut is used as feedstock for the production of a range of chemical products produced by several chemical companies located in the ChemSite-Marl Chemical Park.

CLUSTER

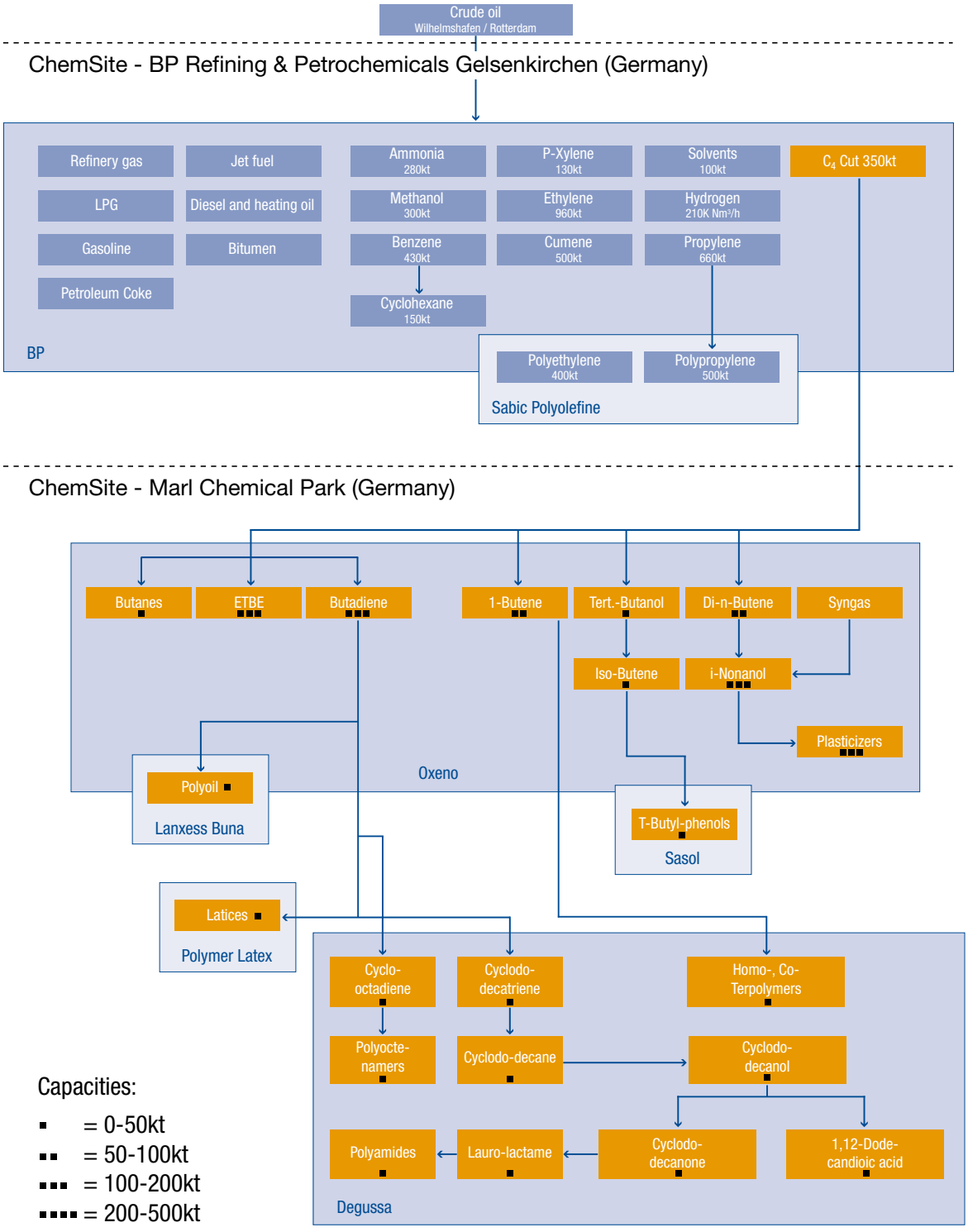

Figure 3-1 C4-Cut interactions within the Rhine/Ruhr cluster

3.2 Presentation of the ARRR and Tarragona clusters

On the basis of the previous EPCA reports, the Think Tank decided to investigate to what extent firms actually benefit from the supply chain optimization opportunities provided by chemical clusters. For the sake of consistency, the Think Tank decided to limit its scope to Northern Europe (i.e. Antwerp, Rotterdam and Rhine/Ruhr - ARRR) as well as Tarragona (Spain), leaving other significant clusters out of the analysis.

In the following subsection, the historical evolution and uniqueness of each of the clusters mentioned will be described.

Figure 3-2 Main chemical clusters in Northern Europe

3.2.1 ARRR Cluster

Though Antwerp, Rotterdam, and the Rhine-Ruhr separately form clusters as defined in Section 2, the Think Tank decided to consider the whole of the region as one mega-cluster, hereafter referred to as ARRR. Indeed, the integration, interconnectivity and product flow between the individual areas justify this approach notwithstanding the fact that ARRR is spread out over three EU member states.

The ARRR mega-cluster is the largest interconnected chemical production cluster in the world in terms of production throughput. The mega-cluster is also the most integrated chemical production region in the world. The main subclusters include the port areas of Antwerp in Belgium, of Rotterdam in The Netherlands, and two major inland areas – Rhine/Ruhr in North Rhine-Westphalia (NRW) and the Ludwigshafen-Mannheim-Karlsruhe area.

A number of "satellite" clusters are interconnected with these sub-clusters. These include Terneuzen, Geleen/Sittard, Feluy and Frankfurt. These satellite clusters have in common that they are highly dependent on the subclusters in order to be successful, as they lack the manufacturing depth to be self-sufficient. The interconnec-

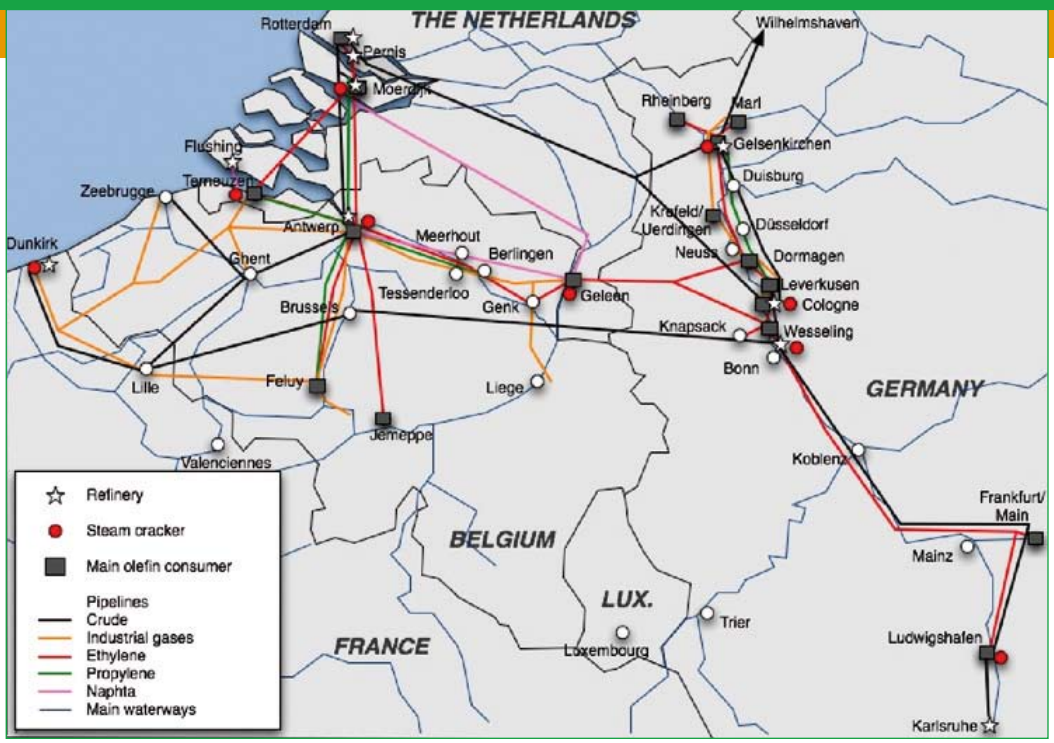

Figure 3-3 Overview of cluster interrelationships

tions between the subclusters and surrounding satellite clusters include pipeline, waterways, rail and road, enabling a sophisticated and highly efficient supply chain management.

The Antwerp/Rotterdam and Rhine/Ruhr clusters are connected via ethylene pipelines passing through the SABIC satellite cluster in Geleen. The propylene pipeline connection between both regions (EPDC project) has not taken place for reasons mentioned in Section 4 (see caselet in Section 4.1.4).

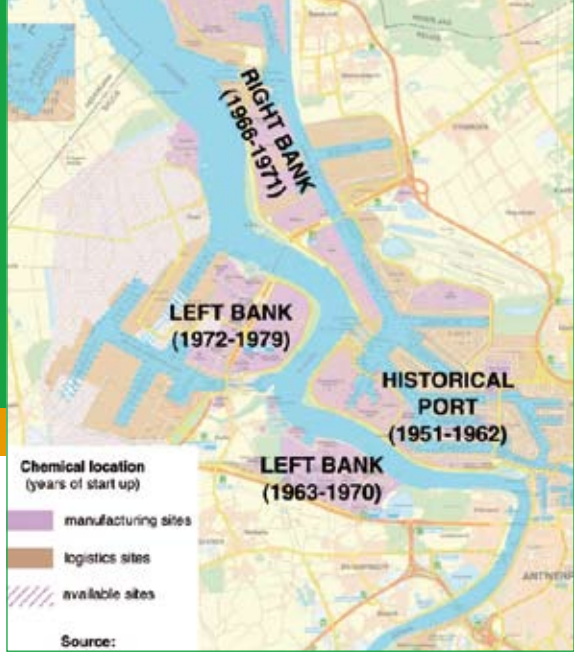

Figure 3-4 Port of Antwerp - geographical overview

Antwerp subcluster

The Antwerp chemical cluster, located in the Port of Antwerp, covers more than 3,650 hectares along the Schelde River. Antwerp strongly developed as a classical trading port in the 19th century, and the petrochemical industry only emerged in the 1930s with the construction of two refineries. Chemical production in Antwerp really took off after the Second World War when two additional refineries and the first ethylene oxide production facility started in 1951 at the Marshall dock.

Between 1951 and 1963, the first series of investments in downstream refinery products emerged on the right bank (Figure 3-4), leading to the extension of the historical docks up to the Zandvliet lock, and to the opening of the Boudewijn lock. Joint investment in two steam crackers and corresponding ethylene processing capacities (at the time 500K tons) in 1963 clearly made the Port of Antwerp an increasingly chemical-focused cluster. By that time, Union Carbide Belgium and Amoco Fina had already opened up their factories in the port in order to exploit the by-products of the refineries. 1963 was also the year when the left bank of the port began to be exploited by Bayer Rubber (at the time Polysar Belgium), subsequently followed by five chemical multinationals by 1970, among others 3M and Exxon Mobil (at the time USI Europe).

The right bank kept growing between 1966 and 1971 with major investments from BASF (1966), Bayer, Monsanto and Solvay (all 1967) and Degussa (1970). The growth dynamics of BASF's integrated Antwerp site attracted Air Liquide which in 1971 signed one of the first co-siting agreements in the Port of Antwerp. The remaining areas were leased step by step in 1972 to Dow-Halterman, Rhône Poulenc (at present these facilities are owned by Katoen Natie) and Bayer, followed by Aqualon in 1979.

The cluster experienced a growth phase between 1979 and 1987 without significant new settlements. Subsequently, during the period between 1987 and 2006, the port of Antwerp benefited from the arrival of additional manufacturers such as North Sea Petrochemicals (Shell/Borealis), INEOS Phenol (at the time Phenolchemie), as well as, from 1999 onward, Japanese companies (Kuraray, Nippon Shokubai and Tokyo Kasei Europe).

The Port of Antwerp encompasses a wide range of the chemical value chain, as illustrated in Figure 3-5.

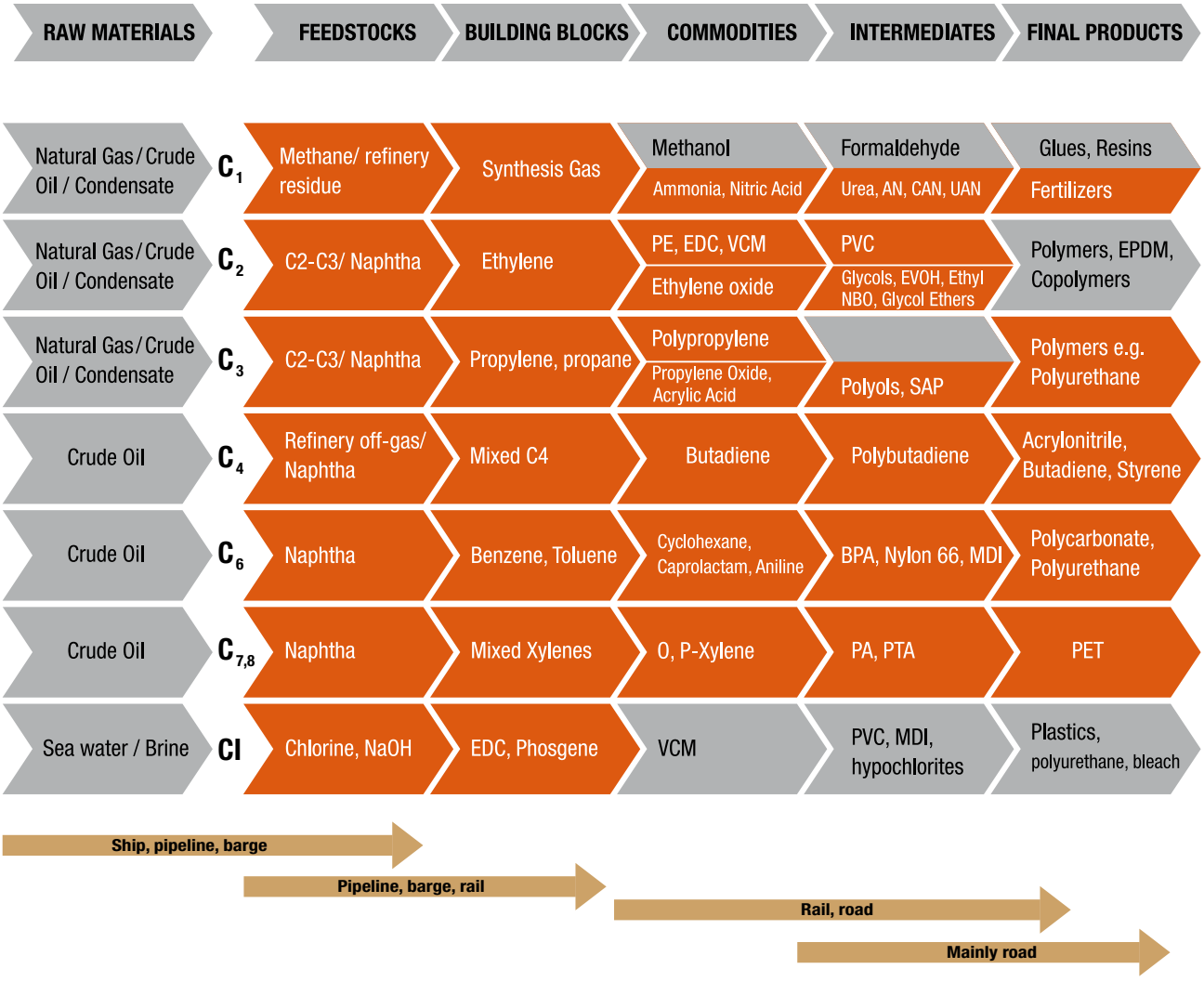

Figure 3-5 Value chain of the Antwerp cluster (red items are produced, grey items are not produced, in the cluster)

Rotterdam subcluster

Rotterdam, initially a fishing village in the 15th century, was already a significant gateway to the European hinterland before the rise of the industrial revolution, due to regular trade lines to Asia and South America (for tobacco and spices). Fuelled by the rise of the German steel industry in the Ruhr region, Rotterdam became through its access to the Rhine River the port of choice for importing ores for the German factories and exporting steel products. In order to cope with higher traffic and heavier loads, access to the port was improved by a new channel ("Nieuwe Waterweg") and the port was extended stepwise towards the sea.

After the First World War, with the growing use of automobiles, oil became a strategic resource for armies (oil had replaced coal during the war), industry and society. Oil had to be imported from other world regions and Rotterdam quickly became the biggest European port of oil imports.

The oil refineries of Shell and Caltex (Texaco) started the cluster just after the Second World War. In the sixties, crude oil pipelines to refineries in Germany and Antwerp were commissioned. This decade also saw the first big wave of chemical investments: Dow, Akzo, ICI (now Hexion), Esso Chemicals, Kemira and Arco (now Lyondell) all set up their plants. Since the petroleum trade continued to grow tremendously quick in the sixties, shipbuilders had to increase the capacity of their vessels. However, the new "mammoth" tankers were not able to enter the existing port infrastructures. Consequently, the Europoort zone was built to the west of the port; it was 20 meters deep and had three additional refineries. The logistics facilities kept pace with the construction of several tank storage terminals, working both for the industry and for companies using them as entry or exit points for Europe. Barges, railways, trucks and pipelines took care of the transport to and from the hinterland and within the port area.

Over time, the port kept on growing westward with more chemical plants and service companies, and the decision was taken to extend the port by reclaiming land from the sea. This gave birth to the Maasvlakte in 1973 (Figure 3-6). In the nineties, several co-siting agreements were set up with industrial gases and combined heat and power producers (e.g. Eastman with Air Products and Eneco, ICI/Huntsman with Air Liquide and Eneco).

As land became scarcer in the port in the last few years, more and more co-siting initiatives took place between chemical plants and tank storage companies, especially in biofuel production (BioPetrol

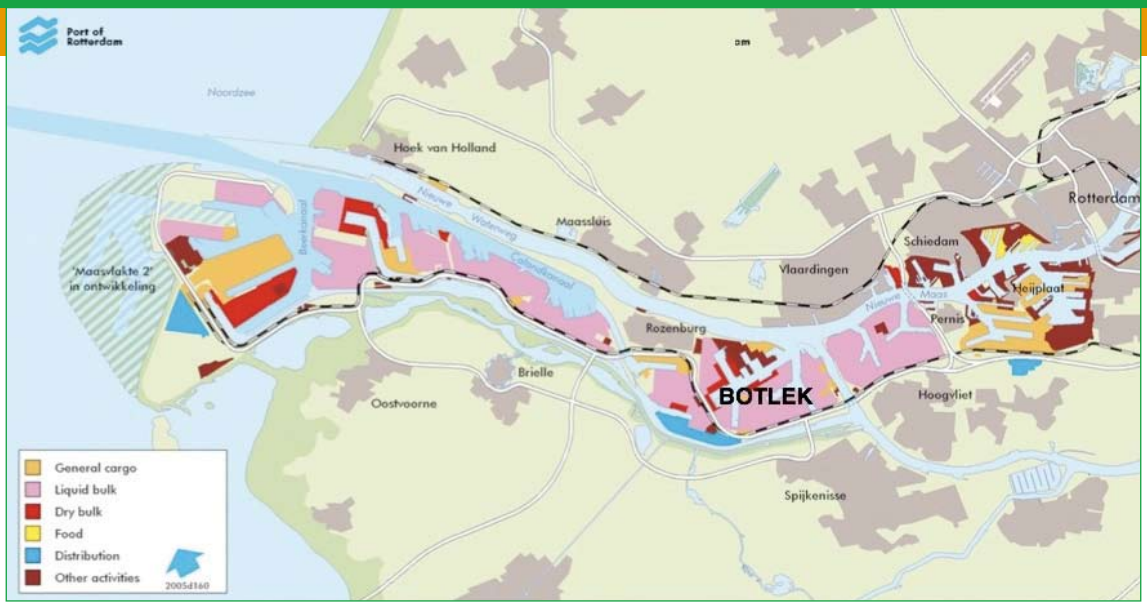

Figure 3-6 Port of Rotterdam - graphical overview

at a Vopak terminal, Dutch Biodiesel at Argos and When Biofuels at Koole).

The oil and chemical cluster within the Port of Rotterdam now comprises an extensive combination of crude oil refineries, chemical plants, industrial gases production, tank storage terminals, pipeline connections and all kinds of service companies. **In total it covers 2,865 hectares, representing 60% of the available land in the port, with an emphasis on raw materials processing and base chemicals manufacturing (Figure 3-7) (pag 26).**

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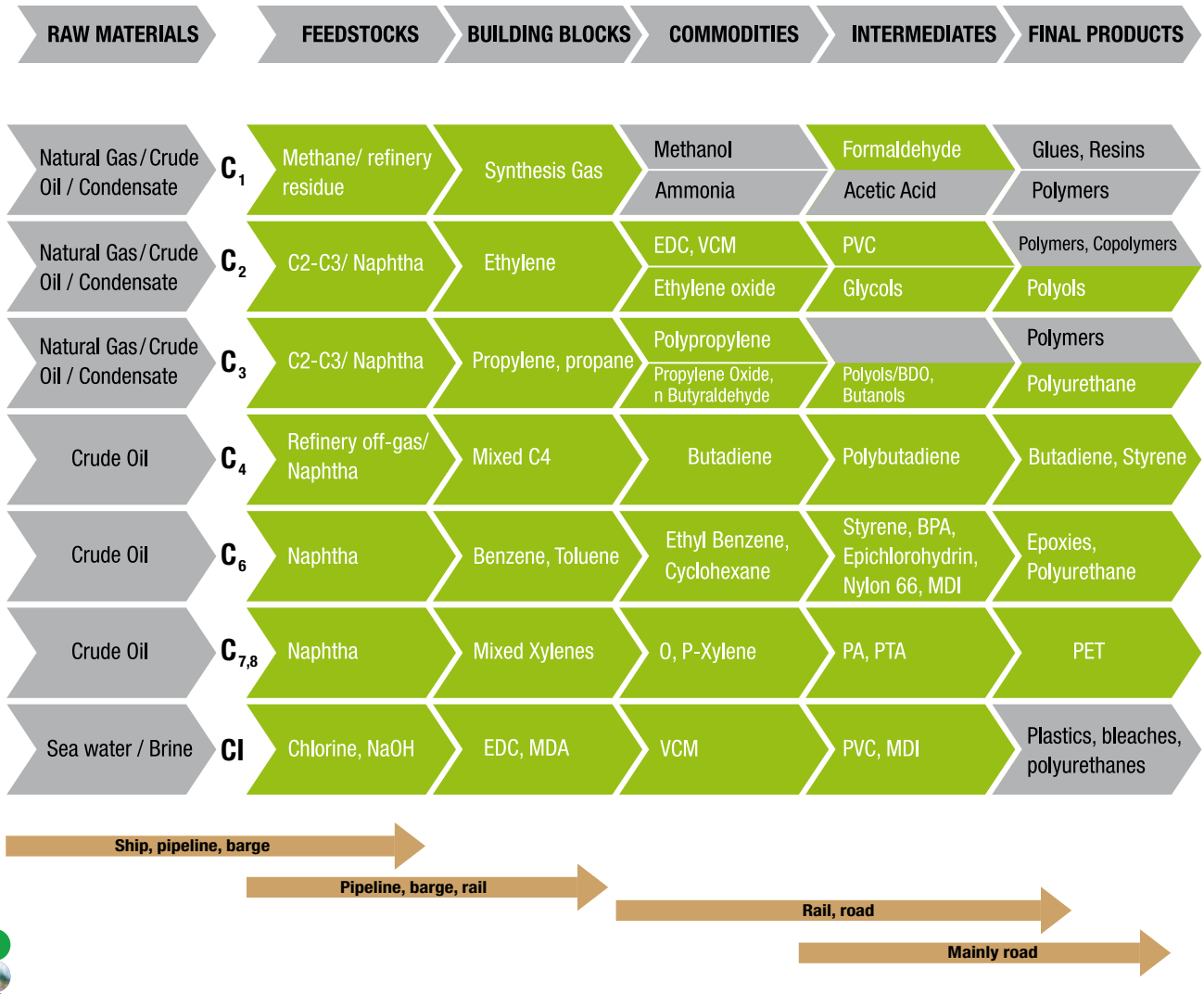

Figure 3-7 Value chain of the Rotterdam/Moerdijk cluster (green items are produced, grey items are not produced in the cluster)

Rhine-Ruhr subcluster

The German state of North Rhine-Westphalia is the base of two major chemical centers: the Ruhr region (ChemSite cluster) in the northern part and the Rhine area (ChemCologne cluster) in the southern part. Together these chemical regions form the Rhine/Ruhr cluster. They are well connected by road, rail, pipeline and waterway, with Duisburg as the largest inland port in Europe. With 720 km of waterways, 180 inland ports and 8,000 km of railways, the region is connected to both the raw material import centers or feedstock production sites (Rotterdam, Antwerp, Wilhelms-haven) and the German and Eastern European hinterland.

The chemical industry in the Rhine/Ruhr cluster emerged in the 19th century with the exploitation of the neighboring coal reserves of the Ruhr. In a similar fashion as in Antwerp and Rotterdam, the development really took off after the Second World War when the former chemical group IG Farben was broken down into several units and petrochemical manufacturers installed refineries and steam crackers in the cluster (Rheinische Olefinwerke GmbH in Wesseling, EC Erölchemie in Worringen). This helped the cluster to maintain its long-term competitiveness by replacing the declining lignite and anthracite reserves by oil as an input for the chemical cluster.

Most of the chemical sites were run by one user only (single user sites) until the mid-1990s when chemical majors started to reorganize their product portfolio. In the course of structural changes in the chemical industry in the Rhine/Ruhr region, traditional chemical industry sites with single users were transformed into integrated multi-user sites (chemical parks), where many users benefit from shared material flows and infrastructure, making efficient joint use of all the facilities available. The utilities as well as the site management are mostly still performed by the initial user of the site (site operator). This structural change has created new opportunities, as each site is now even more focused on attracting complementary partners (manufacturers, LSPs, research centers) to create additional synergies within the chemical parks.

In the late nineties, some manufacturers of the cluster decided to merge their efforts in attracting new companies, triggered by the vision of the “opened chemical cluster” idea. The ChemSite initiative was created in 1997 as a public-private partnership between the German state of North-Rhine-Westphalia and chemical manufacturers in the Northern Ruhr region promoting the attractiveness of the region. Hüls AG (now Degussa), which has been operating in Marl one of Germany’s biggest sites since 1938, founded ChemSite together with, among others, Veba Oel (now BP Refining &

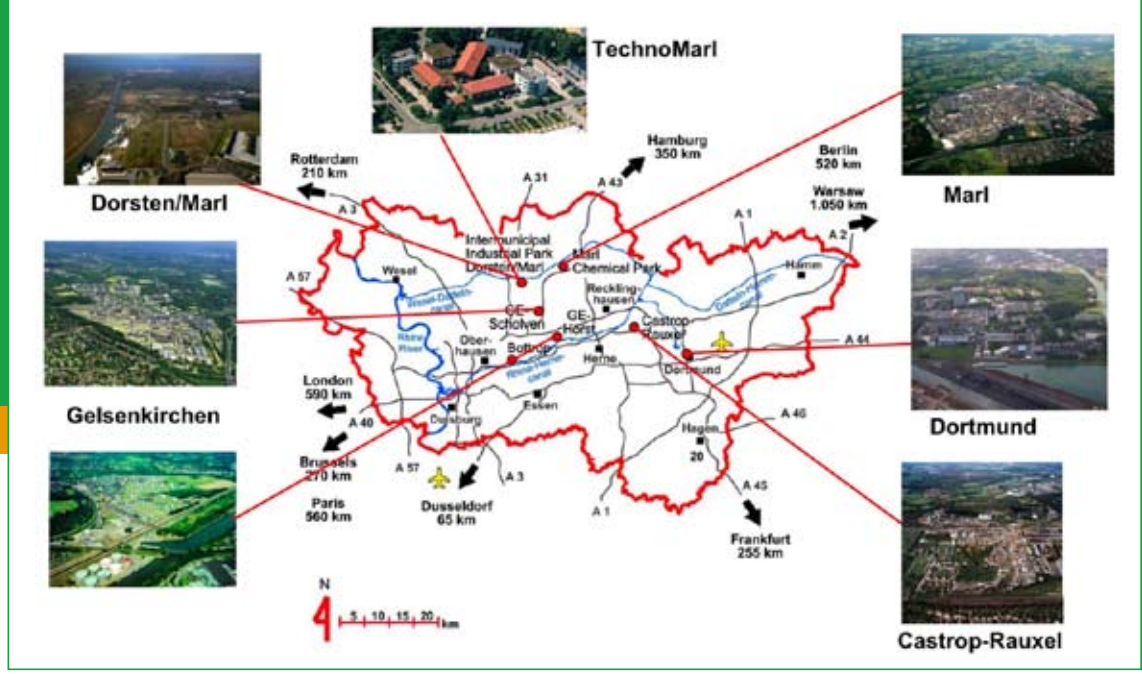

Figure 3-8 ChemSite cluster - graphical overview (source ChemSite, 2007)

Petrochemicals), Rutgers Chemicals, DSM (now SABIC) and the state of North Rhine-Westphalia. Since then, the ChemSite initiative has successfully extended to the whole Ruhr region.

Figure 3-9 ChemCologne sites (source ChemCologne, 2007)

ChemSite currently promotes 7 sites, from the fully integrated petro-chemical cluster operated by Degussa to the research focused cluster of TechnoMarl. All chemical parks and sites are situated very closely together in the Ruhr region. With a total area of 1,400 hectares, these locations offer about 240 hectares for the relocation of new companies.

ChemCologne represents the counterpart of ChemSite for the Cologne/Leverkusen/Bonn region with the biggest producers in terms of volume being Bayer and its spin-offs, as well as Degussa. The range of its 150 members spans classical manufacturers, logistics service providers and authorities; it also includes universities. Like ChemSite, the sites represented (Figure 3-9) are promoted with the objective of attracting new investors.

The chemical parks and sites in the Rhine/Ruhr cluster cover the whole chemical value chain with particular emphasis on base and specialty chemicals (see Figure 3-10). This emphasis is key when considering the potential provided by the high density of universities and chemical research centers in the vicinity.

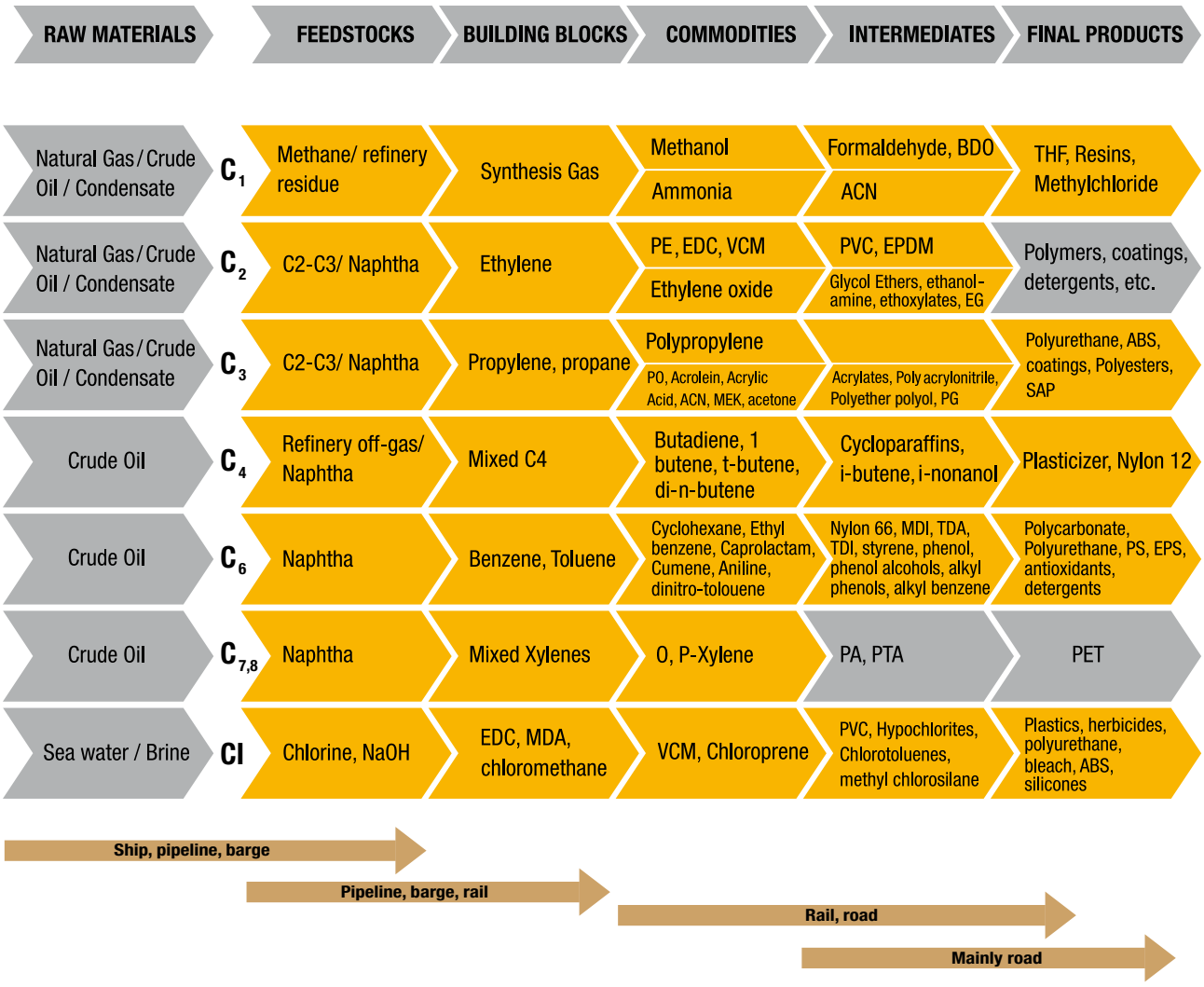

Figure 3-10 Value chain of the Ruhr cluster (orange items are produced, and grey items are not produced, in the cluster)

Rhine Main subcluster

This cluster consists of the Miro (Karlsruhe) refinery and petrochemicals complex, the BASF Ludwigshafen Verbund site, and several smaller chemical sites including Raschig's specialty chemical site in Ludwigshafen. The cluster receives primary raw materials (crude oil and natural gas) via pipeline and depends on the Miro and other European refineries for its primary feedstock naphtha. The BASF Verbund site also currently receives naphtha from Antwerp and Cologne via barge on the river Rhine. Other feedstocks and interme-diates are transported by either rail or road.

In terms of the overall volumes, of product the cluster handles over 20 million tons per year raw materials and similar volumes of sales products per annum. The Rhine Main cluster is the most integrated petrochemical, intermediates, polymers and performance materials cluster in Europe with over 200 production units producing more than 8,000 products (including brands and formulated products).

All of the sites in the cluster have highly integrated infrastructure, utilities, service, waste management and logistics systems serving to minimize their environmental impact. Although significant volumes into and out of the cluster are conveyed by pipeline and barge, over 300,000 intermodal units per year are handled in the cluster.

3.2.2 Tarragona cluster

The Tarragona region is located 100 km west of Barcelona, in the north-east of Spain. The petrochemical cluster of Tarragona plays a major economic and social role in a region inhabited by some 500,000 people. **Tarragona is the most important chemical manufacturing cluster in the southern Europe and Mediterranean area.** The global chemical production of the chemical companies in the Tarragona cluster amounts to 18 million tons per year, 25% of which is exported mainly to the Mediterranean area. Approximately 44% of the total plastics production in Spain is produced in the cluster, thus confirming its leadership in the Mediterranean area. The Tarragona chemical cluster is the third largest producer of ethylene in Europe.

The economic success of the chemical area depends on Tarragona Port, which enables the import of raw materials and competitive feedstock for the chemical manufacturing process. The total maritime traffic through the Port of Tarragona amounts to about 35 million tons per year and the petroleum products (crude petroleum, naphtha, fuel oil, propane, crude condensates, diesel) and chemical products represent around 50% with a total of almost 18 million tons per year.

Since the 1960s, thirty-four companies including some major international ones like Bayer, BASF and Dow, and Repsol, Spain's largest petrochemical company, have set up production sites in the chemical cluster of Tarragona.

The cluster configuration consists of several areas (Figure 3-11 Tarragona's chemical cluster consists of a South and a North industrial park linked to the port.Figure 3-11):

North industrial park covers 470 hectares in the municipalities of La Pobla de Mafumet, El Morell, Constantí and Perafort. It is a refinery and cracker based integrated petrochemical complex. The main players are Repsol and Dow Chemical Iberica.

South industrial park covers 717 hectares in the municipalities of Tarragona, Vila-Seca and Reus. It is a multi-company intermediates, polymers and specialty chemicals site including Repsol, Dow Chemical Iberica, Bayer, BASF, Basell, Ercros and Solvay.

In the locations of Flix and Tortosa, about 100 km south of Tarragona, there are other smaller Ercros plants, producing chlorine, formaldehyde and derivatives. Although well interconnected with the cluster in Tarragona, these plants are not part of it.

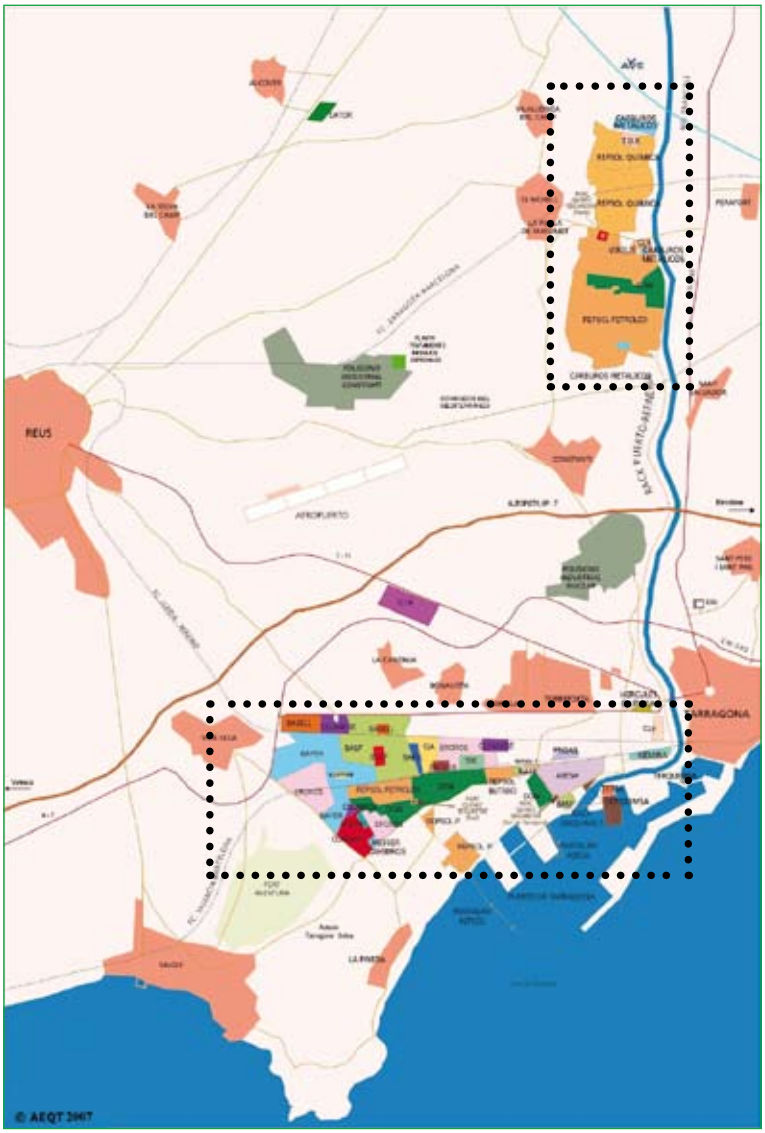

Figure 3-11 Tarragona's chemical cluster consists of a South and a North industrial park linked to the port.

The main raw materials - crude oil and natural gas - are all imported. Natural gas is imported in the form of LNG and then processed into several gasification facilities along the coast around Barcelona and Cartagena. Natural gas is also provided via the Trans Pyrenean pipeline link Calahorra from Lacq in France, and from the Maghreb-Europe Gas pipeline from Algeria to Spain. Crude oil is provided by ship from various sources to several terminals.

25% of the Tarragona cluster's production is exported. **The value chain, from raw materials and feedstocks to final products is depicted in Figure 3-12.** The value chain of the Tarragona cluster is typical of a refinery-cracker based petro-chemical complex. Since the refinery produces a typical "coastal" product slate, refinery residues are not gasified to synthesis gas, resulting in no production of C1 feedstocks or intermediates in the cluster. Similarly the production of xylenes is also absent from the cluster.

There is a high integration between the companies in Tarragona, as one third of the products are used within the cluster as input to other manufacturing stages. Repsol and Dow, for instance, provide ethylene via a 100 km long pipeline to Solvay for its PVC manufacturing plant in Martorell. Ercros sends chlorine from its plant in Flix both to the Ercros plant in Vila-Seca for the production of EDC/VCM and to the Bayer plant for the production of MDI. Hydrochloric acid is then sent from Bayer back to the Ercros plant in Flix, where, combined with phosphoric rock received by train from the port of Tarragona, it is used for the production of dicalcium phosphate.

The majority of the Tarragona chemical cluster companies are members of the Tarragona Chemical Business Association (AEQT), which is, in turn, part of the national chemical trade association FEIQUE. The main role of AEQT is to lobby the local, regional and national government with the aim of defending the interests of the chemical industry and to maintain and develop the chemical cluster's reputation as a whole. AEQT has participated with the local authorities in several projects, including the case of assuring water supply from the Ebro river, setting up a fire-fighting brigade for all the companies in the cluster, and developing the rack of pipelines from the port to the southern industrial park (Dixquimics).

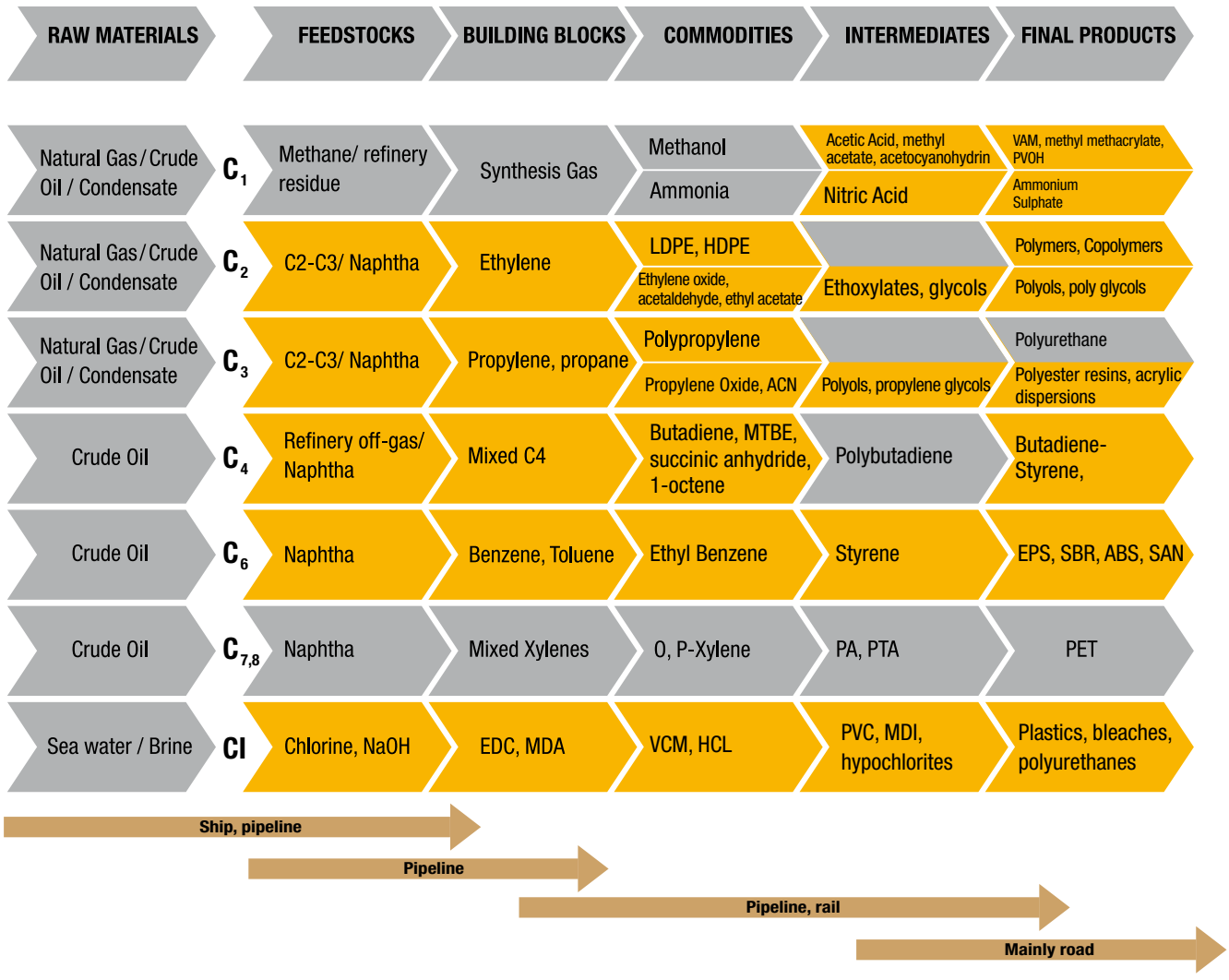

Figure 3-12 Chemical value chain - Tarragona cluster. The products in orange are produced within the cluster, whereas the products in grey are not.

4. INTERVIEW RESULTS

A total of 26 executives from the ARRR cluster and 27 executives from the Tarragona cluster were interviewed by INSEAD researchers. Statistics obtained from the interviews were subsequently discussed in the respective ARRR and Tarragona Think Tanks, as well as in the Steering Committee. This section presents a summary of the results from this process. It is organized around 6 questions concerning the ARRR and Tarragona cluster functioning:
What are the advantages of the clusters?
What are the main disadvantages of operating in the clusters?
What are the obstacles hindering problem solving?
What are the opportunities for horizontal cluster-driven collaboration?
What are the opportunities for vertical cluster-driven collaboration?
Who should lead the ARRR and Tarragona clusters?

4.1 ARRR cluster

The statistics for the ARRR cluster together with the comments and interpretations of the ARRR Think Tank are reported below.

4.1.1 Advantages of the ARRR cluster

For producers, the access to competitive raw materials and feedstocks, proximity of suppliers within the cluster area and existing infrastructure are the main reasons for being in the ARRR cluster (Figure 4-1). Proximity of suppliers and availability of feedstock account together for 44% of the responses stating input costs as being the main advantage of the chemical clusters. Manufacturers develop close physical links with their suppliers to maximize operational efficiency and shorten freight legs, as illustrated in the Rotterdam chlorine case (see below). Although accessibility of the hinterland customer base is vital, the proximity of customers is not perceived by chemical manufacturers as being a significant reason for locating in the cluster, while it is the main driver for LSPs who decide to locate close to their markets. This also indicates that outbound logistics was not considered as a limiting factor when manufacturers decided to locate in the clusters.

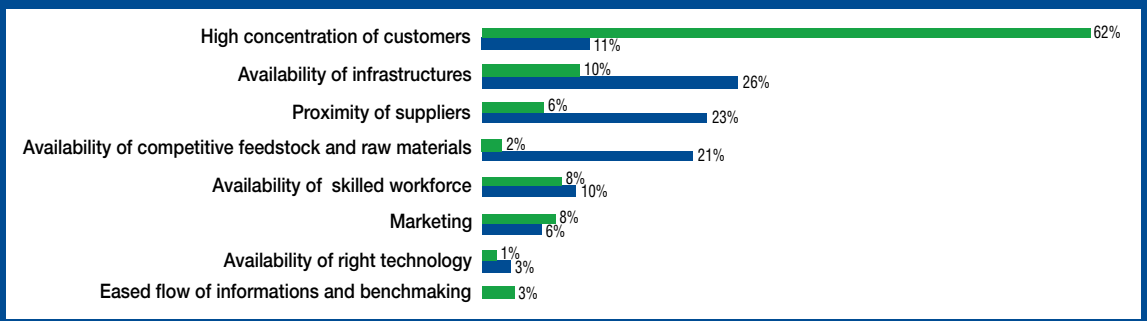

Figure 4-1 ARRR - Benefits of chemical clusters (green/LSPs, blue/producers)

The benefits of co-siting: the Rotterdam chlorine case

Rotterdam is home to one of the most highly integrated and efficient chlorine and derivatives clusters in the world, built around the modern chlorine manufacturing operations of Akzo Nobel in the Botlek part of Rotterdam. Chlorine is supplied by a network of pipelines to a number of derivatives producers in the vicinity.

Shin-Etsu, a Japanese producer of vinyls, has a long-term contract with Akzo Nobel for the supply of chlorine to its ethylene dichloride (EDC), vinyl chloride monomer (VCM) and polyvinyl chloride (PVC) manufacturing processes. The EDC and VCM plants are physically located on the Akzo Nobel site, while the PVC plant is a few kilometers away in Pernis. The connection between VCM and PVC units is by pipeline, leasing one of the multicore pipelines for this stretch (see description of Multicore below).

Huntsman is another important member of the Rotterdam chlorine derivatives cluster, having a long-term chlorine supply contract with Akzo Nobel for its MDI manufacturing operations in the Rozenburg area of Rotterdam. The chlorine that Huntsman uses is returned to Akzo Nobel in the form of gaseous hydrochloric acid, which is then used as an additional feedstock for the EDC/VCM production by Shin-Etsu. This recycling step allows the chlorine molecules to be used twice.

Hexion takes chlorine from Akzo Nobel for epichlorhydrin production and uses it to manufacture a range of epoxy resins at its plant in Pernis.

Tronox also plays a role in the Rotterdam chlorine derivatives cluster. The company manufactures titanium dioxide at its Botlek plant and draws its chlorine needs from Akzo Nobel via a dedicated pipeline link.

These 5 companies have established a highly integrated and synergistic collaborative model enabling optimal production efficiencies and economics to the benefit of all stakeholders, avoiding in addition the highly dangerous above-ground transportation of chlorine. A significant expansion of chlorine capacity has been necessary to support the growing demand amongst the derivative producers.

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The discussion of the Think Tank around these results provided the occasion to review the history of the existing clusters with the participants. The group agreed that there is a virtuous development cycle of a chemical cluster. Companies move to clusters as part of natural organic growth and self interest – not necessarily to consciously exploit the collaborative opportunities and advantages of the cluster. First, manufacturers settle in a region for geographical reasons, looking for upstream supply synergies with other manufacturers. LSPs then settle in the cluster once a critical mass has been reached, ensuring service providers a satisfactory revenue stream mainly from storage warehousing, handling activities and transportation within the cluster, and servicing customers of their customers located outside the cluster. The critical mass also applies to the development of supporting infrastructure like internal cluster pipelines which can only be operated with a sufficient guaranteed throughput. **We observe that LSPs and port authorities often team up to provide attractive infrastructure for manufacturers, reinforcing the cluster dynamics.** The MultiCore pipeline in Rotterdam is a very good illustration of this situation. **It seems that similar actions initiated by producers are rare.**

MultiCore pipeline in the port of Rotterdam: a common infrastructure to the benefit of all

The effective and efficient operation of the Rotterdam chemical cluster depends on the availability of adequate infrastructure. For many years the Port of Rotterdam Authority has played an active role in supporting the creation of optimum conditions for participants in the cluster. Pipelines play a key role in the cluster in moving large volumes of liquids and gases in a safe, environmentally friendly, and cost efficient manner between producers and users. Working in a Joint Venture with Vopak Chemicals EMEA B.V., the Port of Rotterdam Authority has created Multicore, a unique concept for the renting of pipeline capacity (on a variable time and distance basis) for companies in the port and industrial area. This offers an attractive, cost effective alternative to truck transport or inland vessels and barges.

The 20 kilometer long Multicore pipeline bundle (four pipelines with different diameters and constructed of different materials) runs from east to west, straight through the port and industrial area. Further expansion west (between Europoort and Maasvlakte over a distance of 17 kilometers) is in preparation. Oil products, as well as chemicals and gases, can be transported via the MultiCore pipeline bundle.

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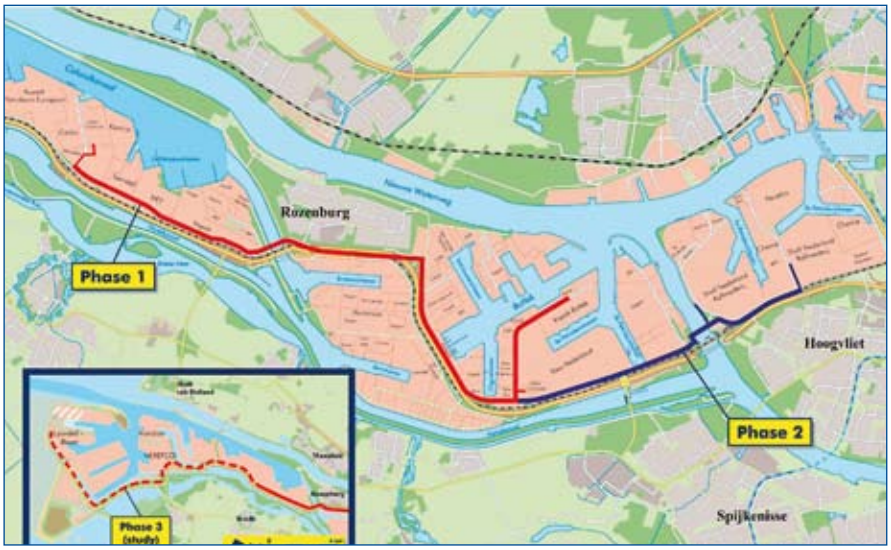

Figure 4-2 MultiCore pipeline concept in the port of Rotterdam

The competition of LSPs benefits the existing base of chemical producers and signals the attractiveness of the cluster to potential new entrants. This positive feedback loop might weaken if the cluster becomes a victim of its own success and starts struggling with bottleneck issues.

Unlike the Silicon Valley cluster, interviewees did not view the availability of skilled workforce and marketing capabilities in Antwerp, Rotterdam and in the Rhine/Ruhr area as a significant advantage compared to the geographical and infrastructure advantages. Nevertheless, the Think Tank discussions pointed out that a skilled workforce is needed today and increasingly in the future.

4.1.2 Disadvantages of the ARRR cluster

As a consequence of the development of the Antwerp and Rotterdam clusters, the tonnage leaving both clusters has grown significantly over the last 15 years (for instance the container traffic in Antwerp increased from 16.5 million tons in 1990 to 80.8 million tons in 2006). **Unfortunately, chemical producers from Antwerp and Rotterdam share their road infrastructure with private users and other industries, thereby creating a bottleneck that the public authorities will have difficulties solving in the short term.**

Manufacturers, LSPs and port authorities need to team up and use the Antwerp and Rotterdam cluster

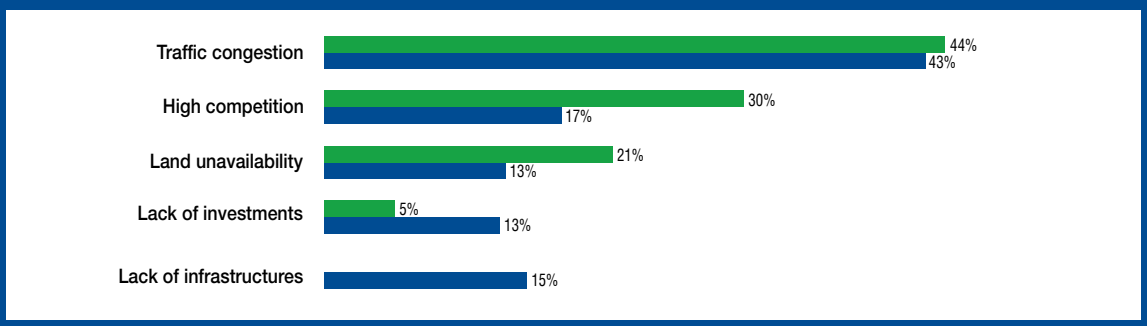

Figure 4-3 ARRR - cluster disadvantages (green/LSPs, blue/producers)

synergies on hinterland deliveries to make environmentally friendly transport modes a competitive alternative to road transport. Indeed, more than 70% of the responses mention congestion stems from the lack of investment in infrastructure in the Antwerp/Rotterdam cluster. The extension of the Port of Rotterdam with the scheduled Maasvlakte 2 (see Figure 3-6) might aggravate the problem if producers are not willing or able to increase the rail and barge portion of their shipments in the near future.

Apart from traffic congestion, manufacturers do not consider land availability or competition as being significant hurdles for operating in the clusters. Competition is considered by the interviewees as being worldwide and not simply limited to the ARRR cluster. Furthermore, the existence of swap arrangements and common capacity investments such as the HPPO plant in Antwerp show that, subject to the respect of competition rules, manufacturers have no problem collaborating when the synergies are obvious and the value proposition is economically and strategically sound.

Apart from traffic congestion, LSPs perceive competition between themselves as a disadvantage of the cluster. This, as mentioned earlier, is the logical consequence of a successful cluster development that has attracted many service providers to the region. However, one LSP mentioned that the size of the market was big enough to allow many LSPs to build sufficient critical mass to work profitably, thus not requiring LSPs to merge their assets. As a result of this fragmentation of the market, manufacturers may have to load and/or discharge parcels from different storage points in the port. This extends the waiting time for the vessels, increases demurrage costs and harms asset productivity. To tackle the asset fragmentation issue, Oiltanking and Stolthaven Terminals, two logistics providers, have teamed up to develop dedicated storage facilities, thereby reducing inefficiencies in vessel loading.

Asset pooling between LSPs in the Antwerp cluster: the Oiltanking/Stolthaven collaboration

In March 2006, Oiltanking GmbH and Stolthaven Terminals BV announced an Antwerp terminal joint venture called Oiltanking Stolthaven Antwerp NV, which will operate as an independent liquid storage provider on the right bank of the river Schelde.

The terminal is located in the midst of the Antwerp chemical cluster and is part of the extensive logistics infrastructure supporting cluster operations. The terminal will be developed as a "Specialty Chemical Hub" for the Antwerp and Rotterdam (plus Amsterdam) clusters, and as a transportation hub to improve the turnaround and utilization of the Stolt chemical parcel tanker fleet.

Parcel tanker operators can face up to 40% of total vessel time in port, moving from one jetty to another. The downside of the cluster may be that there are too many producers and LSPs who have the critical mass to build their own assets, rather than being forced by their small size to explore all the opportunities to share logistics assets inside the cluster.

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The LBC/Ertisa collaboration is another illustration of a logistics provider (LBC) collaborating and setting up dedicated storage assets on a customer's site (Bayer) to serve another customer (Ertisa).

Benefit from cluster synergies via vertical collaboration: the LBC/Ertisa case

In July 2006 the LBC tank terminal group and ERTISA, a subsidiary of the Spanish oil and energy group CEPSA announced their intention to form a Joint Venture to build and operate a tank storage terminal in Antwerp. The first phase of the project would be to build storage for ERTISA products – followed by a second phase for other LBC customers. There would also be facilities for the handling of rail tank cars, road tank trucks, and tank containers. Other value added services, such as drumming and blending, would be built in line with demand.

The terminal will be located at the Bayer site on the right bank of the Schelde river, in the heart of the chemical cluster. The site offers deepwater access to accommodate the largest chemical parcel and product tankers.

The demand for storage was based on ERTISA's increasing production of phenol and acetone in Huelva in the south of Spain, and the need to position product close to its major customers in Northern Europe. This complemented LBC's plans to strengthen their position in the growing Antwerp chemical cluster, extend their relationship with an established customer, and provide existing and new customers with a prime new location for storage and other services.

This development is also in line with Bayer's plans to develop the spare land on their site as a chemical park, and with the process of optimizing the use of services and infrastructure available on the site. This is a good example of cluster-driven collaboration.

CLUSTER

4.1.3 Obstacles to overcoming cluster disadvantages

According to shippers, **the main obstacle to solving congestion issues is the low willingness of the stakeholders to tackle this issue in a collaborative fashion** (55% of the answers, Figure 4-4). **Since manufacturers have outsourced their logistics activities, they do not see themselves taking the lead in developing logistics solutions on a local scale. This point of view is reinforced by the fact that the decision centers for potential investments are often not located in the cluster, which leads to such projects receiving lower attention on the radar screen of a producer's top management** (22% of the answers).

The answers of LSPs are more balanced, but **point out two issues in the current cluster setup. The first is linked to the competition intensity between LSPs, which is fuelled by the producers' practice of breaking down their logistics activities into smaller pieces and granting short term contracts to a set of competing LSPs, rather than exploiting a "total cost to serve" solution.** According to a service provider participating in the Think Tank, the fragmentation of the logistics market is the consequence of the lack of willingness of producers to collaborate with LSPs. Nevertheless, the Think Tank discussions also highlighted the fact that LSPs collaborate voluntarily when their service scope is complementary (e.g., the Pernis Combi Terminal in Rotterdam) or when a producer asks competing service providers to develop a solution together.

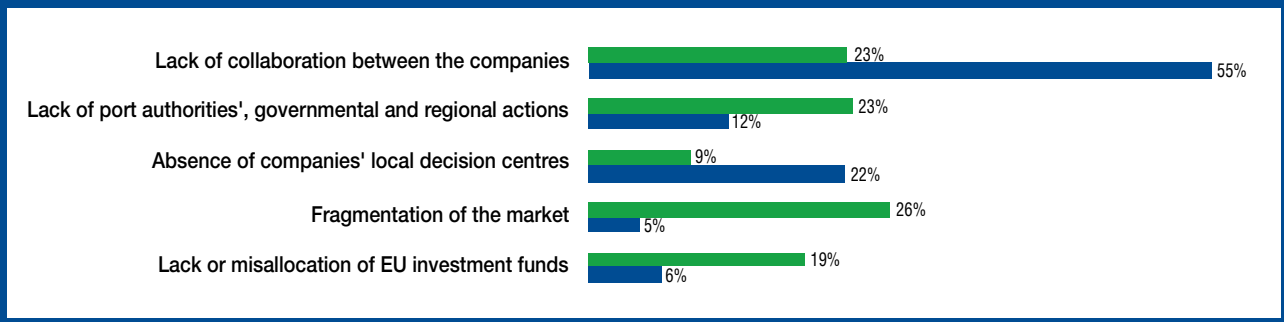

Figure 4-4 ARRR - obstacles to overcoming cluster disadvantage (green/LSPs, blue/producers)

Horizontal LSP collaboration in the Port of Rotterdam - Pernis Combi Terminal

Pernis Combi Terminal in the heart of the industrial port area of Rotterdam was created in 2005 on the initiative of Den Hartogh Logistics, Nijhof-Wassink, MCS (Multi-Modal Container Shipping) and VLS. The project started in 2003 when the LSPs agreed that there was market potential for a Tri-modal service centre in the Rotterdam industrial area, combining road, rail and water. This terminal could be further complemented with warehousing, drumming lines and container storage. The terminal started its operations in February 2006.

Each of the four collaborators has its own specialty to bring to the venture: Den Hartogh Logistics is a bulk liquid chemical logistics specialist, Nijhof-Wassink a bulk specialist, MCS a shipping specialist and VLS a warehouse specialist.

This LSP collaboration offers the Rotterdam chemical cluster an efficient hub and spoke tri-modal solution. Truck, barge and rail combine Sea Port and European Maritime cargo with the European rail and road network, offering the possibility of consolidating Continental and Maritime cargo for distribution into Europe or transshipment to overseas destinations by truck, rail or barge. The drumming and warehouse operations further complement these services.

The current train services have been operating directly to Györ (Hungary) since February 2006 and to Lyon (France) since June 2007, and there is a daily shunt to the main Rotterdam station for outbound services to other destinations. The current barge services offer shuttles to and from the other European chemical clusters.

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The second issue is linked to the fragmentation of the market which leads to the inability of LSPs to obtain a complete picture of the cluster flows. While fragmentation ensures intense competition between **logistics service providers,** the latter **lack the critical size and planning stability to optimize their logistics infrastructure.** In fact, in the current setup, the **Think Tank members were skeptical about whether this fragmentation really benefits producers in the long run.** Producers establish their logistics network by tapping into the independent networks of several logistics service providers. Taking into account the fact that chemical customers follow multiple sourcing strategies, shipments might arrive from different independent channels. The resulting demand variability affects the operating efficiency of LSPs, who need to adapt their capacities ad-hoc at high costs.

A solution could be to develop pan-European networks, but the competition intensity may hamper the development of joint operations of shared assets between LSPs.

4.1.4 Opportunities for horizontal cluster collaboration

Both producers and LSPs agree on the opportunities offered by horizontal cluster collaboration, i.e., cooperation with competitors in order to capture the synergy effects offered by the cluster (Figure 4-5). Each opportunity and its limits will be addressed in the following.

Pooling of logistics resources between service providers could increase the efficiency of the current assets and improve the competitiveness of the cluster as a whole.

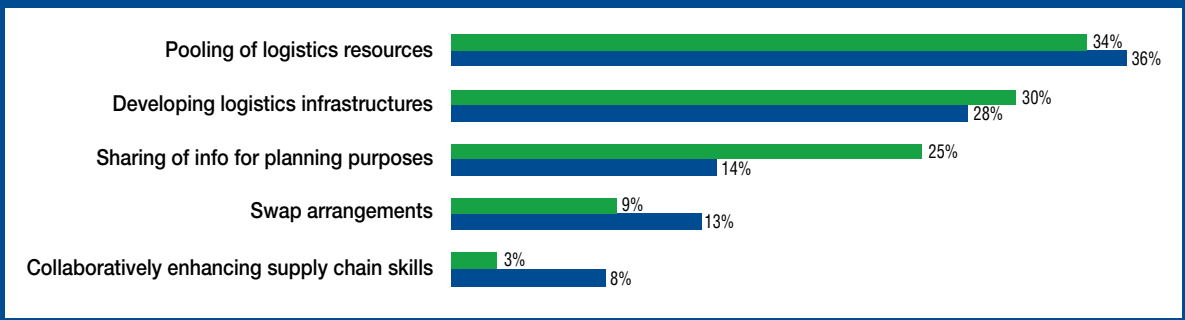

Figure 4-5 ARRR - opportunities for horizontal cluster collaboration (green/LSPs, blue/shippers)

Pooling of logistics assets

Interestingly, the pooling of logistics resources is the most frequent answer for both producers and service providers (35% of the answers). According to the LSPs, the growth of the cluster has allowed them to build their own logistics capabilities separately. In some cases, however, this uncoordinated growth has led to inefficiencies within the cluster. The horizontal collaboration of Oiltanking and Stolthaven Terminals is an example of LSPs consolidating assets in order to correct inefficiencies related to jetty fragmentation.

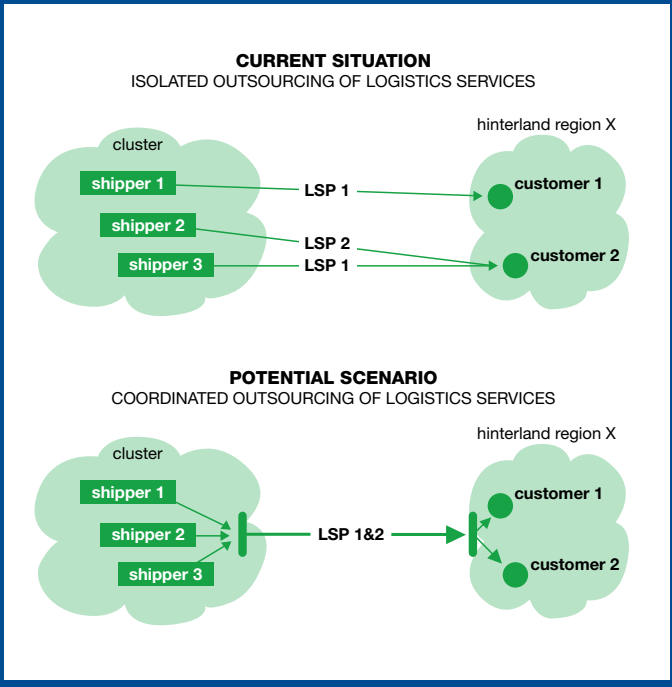

Figure 4-6 Isolated tendering cannot take advantage of cluster opportunities

As mentioned previously, producers follow a contradictory strategy with respect to the cluster opportunities. Producers expect LSPs to be able to collaborate in order to optimize the use of their assets. Simultaneously, they fuel the competition between LSPs by frequently tendering their logistic processes whilst not giving guarantees on quantities. The fact that service providers have currently a very partial and temporary view of the overall cluster flows prevents them to design long-term, sustainable concepts for supplying the hinterland. In a nutshell, manufacturers forego cluster-inherent synergies with respect to their outbound logistics by fragmenting the market and not sharing logistics assets with their competitors.

In the presence of a dynamic but fragmented market for LSPs, **shippers are the main players able to trigger the development of solutions exploiting cluster synergies in distribution logistics.** In this context, one promising opportunity is the ComLog initiative of Bayer Material Sciences, Degussa and Lanxess.

ComLog – Common Logistics Procurement: an example of both vertical and horizontal cooperation

Besides integrating service providers more closely into producer supply chains (vertical cooperation), the cooperation between producers themselves (horizontal cooperation) presents potential for synergies (e.g., by using a common portfolio of service providers, optimizing logistics concepts, and achieving operating efficiencies for all parties involved). When all the parties are located within a cluster the concepts can be more easily developed and the opportunities and benefits more readily achieved.

Based in the ChemSite cluster, Bayer and Degussa implemented an innovative form of horizontal cooperation when they set up a common logistics procurement operation in 2003 called ComLog. Today the partners are Bayer Material Science, Lanxess and Degussa – the latter being represented within the RAG Group by RAG Service GmbH, under which the procurement function has since been centralized.

Operating within a cluster environment leverages the benefits of bundling of demand for logistics services from three manufacturers. As a result LSPs are able to operate on a more efficient scale.

One example that horizontal collaboration can foster vertical collaboration is the strategic partnership between ComLog and the German Railway company Railion. Next to a long term frame contract minimizing operating costs for inland transportation and providing incentives to shift more cargo from road to rail, the contracted volumes allowed the implementation of a ComLog specific single railcar solution.

CLUSTER

Infrastructures opportunities

Consensus also exists about the fact that the development of industry-wide infrastructure would contribute to relaxing the transport bottleneck. From the interviews, the most cited opportunities have been pipelines and multimodal hubs that will be discussed in the following.

For feedstock and commodities in a liquid or gaseous phase, pipelines appear to be the most effective alternative to road transport, reducing risks inherent to the transport of dangerous goods as well as carbon emissions. As the interviews revealed, potential for improvement through pipelines within clusters is limited since already more than 90% of the commodities are forwarded by through them. However, opportunities to link several clusters remain (especially for propylene supply). The main benefits are expected further downstream (intermediates and final products) where the shipment quantities are much smaller (full truckload or less than truckload) and thus shipped directly by truck rather than via multimodal platforms. Multimodal platforms are perceived as a means to reduce the road congestion by merging shipments from different sources, but they require all LSPs to use the same hubs in order to guarantee sufficient loads. Thus, shipments could leave the main production centers via rail or water and be dispatched in smaller loads by road from spokes in the hinterland.

Although clusters might provide the critical mass to make capital-intensive investments such as pipelines or multimodal hubs profitable, horizontal collaboration between chemical manufacturers is not automatically emerging for various reasons. First, there is the need to act in conformity with competition rules. Sharing quantities and destination information between manufacturers is highly sensitive from a legal standpoint. Second, **manufacturers might not be willing to share assets with their competitors if they feel no need to do so** because of their perceived superiority in the market, or if they feel this will effectively eliminate a competitive edge, or barrier to entry. Thirdly, **different manufacturers follow different strategic objectives, making industry-wide investments difficult, although the cluster itself and other stakeholders would benefit as a whole.** The failed EPDC pipeline project provides a good example to illustrate the dynamics in practice and their consequence.

The challenge of multi-company infrastructure investments: the EPDC case

A project to construct a polymer grade propylene pipeline linking several production and consumption sites in northwest Europe had been considered by some companies in the European petrochemical industry for many years. The example of the ARG ethylene line illustrated that this type of line could be a successful way of moving propylene around the industry, with the clear environmental benefits of using pipelines to transport this gas whilst preserving potentially beneficial economics.

By 1999 the industry believed that a substantial European shortfall of polymer grade propylene to supply derivatives was likely to come about in the following years, requiring increased imports from other regions of the world. Consequently, more companies became interested in a pipeline linking European polypropylene manufacturers to the sea and access to polypropylene imports. It was at this time that the EPDC (European Pipeline Development Corp) was created in order to construct the so-called 'U-line' linking Rotterdam/Antwerp with Marl in the North and Wesseling in the South.

EPDC originally comprised 15 industry shareholder companies; by 2005 these had been reduced to 8 as a result of industry consolidation. These 8 companies (INEOS, Westgas, Shell, Sabic, Celanese, DSM, Sasol and BASF) had interests in, and economic benefits from, different parts of the line. All agreed that, once the whole line was constructed, the entire petrochemical industry in Western Europe would benefit in unforeseen ways from its completion.

On the surface, this seems like a real example of industry cooperation leading to improved infrastructure linkage between clusters in Western Europe. However the decision was taken in March 2007 to terminate the full project, although a build of reduced scope, in northern Germany only, may still go ahead.

According to industry experts, the failure of this apparently beneficial horizontal collaboration has several origins. Firstly, the 'lowest cost' objective of the project introduced elements (i.e., a drive for subsidies) which extended the project and, in fact, added cost. To achieve the maximum in subsidies, at least two years was added to the project timeline. Furthermore, the conditions imposed by the authorities to obtain these subsidies resulted in higher costs and restricted flexibility in attracting new investors. As a result costs were 35% higher as a direct consequence of the subsidy conditions – far outweighing the value of the subsidy!

A second reason is that the single project cross-border execution strategy was not in line with existing pipeline construction market realities, as there were no cross-border pipeline and engineering companies. A tailored approach by country had to be adopted which, with hindsight, added complexity and cost.

Thirdly, the business model, which had many shareholder 'givens' or conditions, hindered the project roll-out. The shareholder companies were driven by their 'internal economics': "What's in it for me?" - and not in the first place by an overall general industry or stakeholder value. This had several consequences, but, put simply, each decision taken by EPDC had to be tested against individual company self interest. This lengthened both the process and the overall project time and cost. The shareholder 'givens' thus restricted the EPDC ability to optimally manage the overall project.

Hence the project took too long from inception to decision, leading to increasing costs, particularly in the last two years, as global shortages of raw materials and EPDC contractor capacity impacted all projects. Of course, as costs rose, profitability declined – which led to a unanimous view in March 2007 that the project was not viable.

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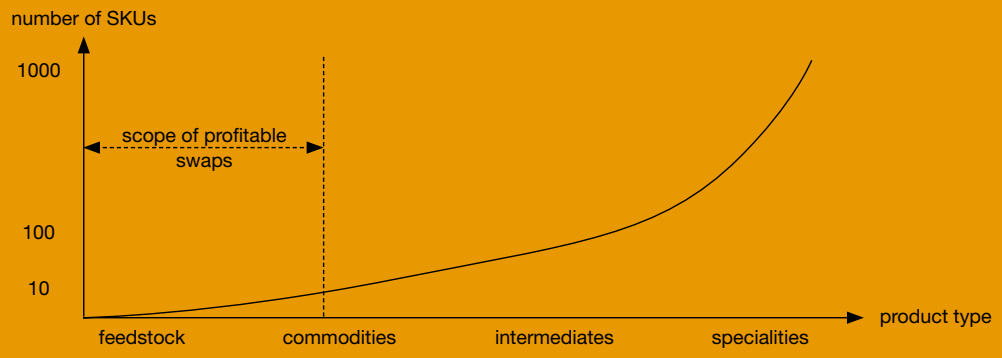

Figure 4-7 Scope of profitable swaps

Sharing of planning information to exploit cluster synergies

Despite the ComLog example, sharing of transport planning information between chemical manufacturers is very critically perceived, especially because of concerns related to competition rules. Moreover, **the joint design of a logistics network could lead to the exchange of strategic information related to the long-term sales plans of competing manufacturers.** For these reasons, **producers consider that LSPs should share planning data in order to exploit the synergies of joint shipments.**

Swap arrangements

Although the manufacturers have cited swap arrangements as examples of horizontal collaboration in 13% of the cases, we observe that **the occurrence** of this answer **depends on the position of the company in the chemical chain and on its competitive strategy.** All interviewees are concerned about compliance with competition rules and companies referring to swaps do this after due examination of competition law effects. Swaps seem to be more common practice for raw materials and feedstock, whereas polyethylene and polypropylene producers are less willing to collaborate in swap arrangements within a local area.

Apart from the increasing number of product variants making a direct swap cumbersome to organize (see Figure 4- 7), polymer commodities manufacturers are reluctant to allow their customers to receive competing products. To cite one interviewee: “you do not want to remind your customer that your competitor can also deliver the same item”. **Swap agreements thus seem to be triggered by the willingness to avoid empty transport legs.** In this context, the most significant savings are achieved through swaps between two different clusters. **Isolated chemical clusters separated from each other seem more interested in swaps than integrated ones.** Therefore, it is not surprising that the potential of swap arrangements is cited more frequently in Tarragona than in the Antwerp/Rotterdam region.

Development of workforce competencies

Finally, companies do not grant the same importance to the joint development of workforce competences as they do to infrastructure topics. **Supply chain skills are not seen as a priority, although the interviewees fear an imminent shortage of skilled workers when the baby-boom generation retires.**

4.1.5 Opportunities for vertical cluster collaboration

Customer/supplier relationships offer opportunities to obtain the benefits of clustered operations. From the Think Tank discussions in 2004 and 2005, it was obvious that **lack of information sharing made it difficult for manufacturers and LSPs to obtain a clear picture of structural network opportunities and benefits from operational planning.** The integration of service providers in the strategic network planning process of shippers is the most frequently quoted opportunity in our interviews (48% for LSPs, 33% for producers - Figure 4-8). This integrated planning has started with some shippers but remains limited to a very small set of logistics service providers.

Concerning inbound and outbound logistics, we recall that this integration might only pay off in the cluster concept if the service provider has already reached a critical mass in the cluster.

To benefit from cluster synergies, LSPs need to have access to the best planning information available so they can efficiently plan their loads and optimize the use of their assets. Thus, service providers perceive a collaborative sharing of data as the main opportunity (35% of answers), while this is not reflected in the producers' answers. From the interviews, we know that **automated forecast exchanges between LSPs and producers (via electronic data interchange for instance) are very rare, and this potentially results in higher transaction costs to the service providers.** Forecasts are generally exchanged on a monthly aggregated basis via spreadsheet applications. Forecast data with higher granularity is either not available due to planning uncertainty or too costly to exchange via automated IT bridges. The CLA initiative between BP Chemicals and major logistics players, organized within the scope of one single legal entity located on the BP site in order to enable access to the best information available, is an exception to the rule.

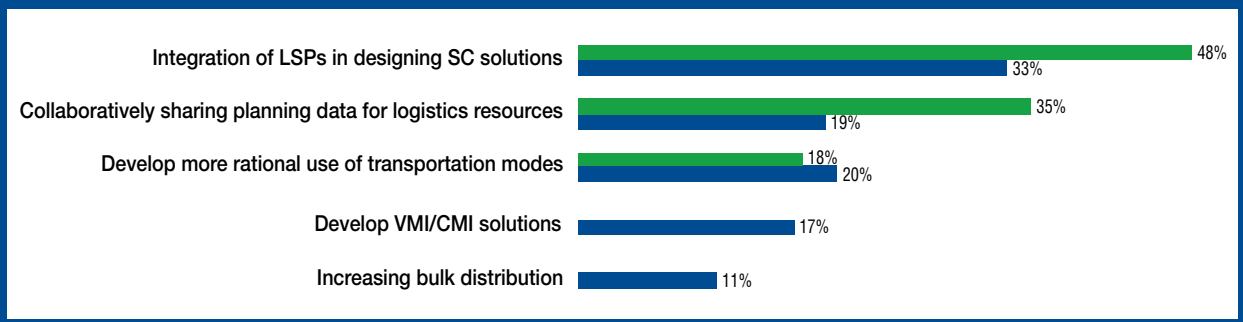

Figure 4-8 ARRR - opportunities for vertical cluster collaboration (green/LSPs, blue/producers)

Joint consortium in the cluster: the CLA initiative

BP Chemicals decided in 1999 to tender all the liquid volumes out of their Benelux storage and production facilities, seeking a Pan-European solution for the transportation of their total volume. In 1999, the whole package was divided between 12 transport companies, who all had their niche market strengths.

To enter the tendering process, 4 companies decided to establish a legal entity with the sole purpose of delivering a one-stop-shop service to BP Chemicals for the complete Benelux liquid package. The legal entity was headed by the following companies: Bertschi AG, Dedijcker NV, Dedecker-Vanriet NV, and VanderLee Transport

This 'natural' alliance between 4 LSPs was enabled by the following factors:

They had trust and respect for each other with a similar background (family owned, own fleet and drivers, high quality standards).

Each company had its own geographical strength and they were therefore complementary partners with subsidiaries spread throughout the ARRR-cluster.

When, in mid 2005, Dedijcker NV stopped its activities in the haulage industry, the three remaining partners managed to absorb its volume without hampering the day-to-day operations.

The success of the Alliance was dependent on a single contract, joint investment in equipment, and a CLA implant in the BP Chemicals office. BP enjoyed the advantage of dealing with one partner, both commercially and operationally, and having joint project teams to work on continuous improvement in the supply chain.

This is an example of cluster driven collaboration with natural alignment, resulting from cluster proximity, rather than being enforced. According to the interviewees, success was heavily dependent on mutual trust and an openness to share information and costs.

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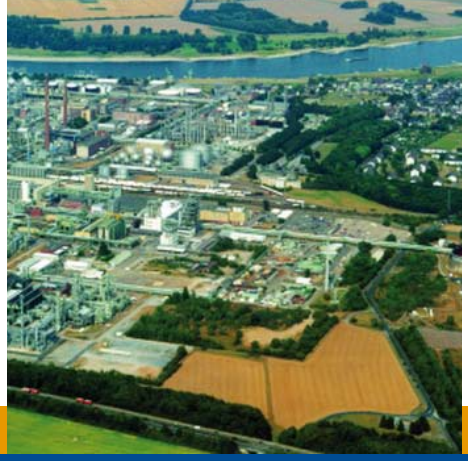

Chemical manufacturers face similar information quality issues with their customers and identify vendor-managed inventory (VMI) solutions more than customer-managed inventory (CMI) as an opportunity to improve supply chain transparency. **Currently, suppliers of chemicals face erratic demand patterns from their customers** and do not have the opportunity to be proactive because of the lack of information shared. **Without reliable forecast data, shippers are not able to optimize their shipments to use the synergies offered by clustered customers.**

The last main opportunity related to vertical cluster collaboration is the development of more efficient ways to dispatch products outside the cluster. Producers agree on the fact that increased bulk shipments would improve the load of the trucks, but in the interviews they also mentioned repeatedly the limits of this approach. First, customers might not want to invest in bulk storage capacities. When it comes to commodities and certainly to specialty chemicals, the quantities to be delivered can be too small to justify bulk shipment, or the material may not be suited for this purpose (e.g. PVC rolls). Although an increase in bulk transport is attractive from an environmental perspective, marketing aspects constrain the expansion of bulk transportation further down the chemical chain.

The shift from road to rail and water-based freight was seen as an opportunity by both LSPs and producers in about 20% of the cases. However, the interviews highlighted the lack of reliability of these transport modes compared to road, as well as the costs of accessibility. Similar to the Rotterdam MultiCore case, a coordinated approach between producers, port authorities and LSPs appears to be necessary, given the significant investments required.

4.1.6 Who should lead the development of the cluster?

The earlier discussions highlighted the need for coordination between stakeholders (producers, LSPs, authorities) to identify and exploit the opportunities offered by chemical clusters. This opinion is shared by all interviewees; none of them answered positively to “we don’t need coordination” (Figure 4- 9).
The question however remains who should take the lead in the identification and exploitation of the opportunities. The interview results are very revealing in the sense that **LSPs state** in the majority of cases (65%) **one focal organization is required to take the lead, but there was no agreement on who that should be. The manufacturers**’ answers are more precise and **suggest industry associations and manufacturers in general take the lead in**

identifying opportunities within the cluster and triggering investments.

The Think Tank provided the opportunity to debate on what a coordinating body should look like and what actions it should be empowered to undertake. With respect to the land ownership structures in the European clusters (apart from ChemSite), "directive" coordination bodies seemed impossible. Port Authorities in Antwerp and Rotterdam or cluster associations like ChemSite are recognized as having a global view of their respective cluster and are therefore partners of choice when it comes to getting a bird's-eye view of their network.

Indeed, cluster leadership does not mean that a company dictates its rules to others. Chemical clusters need participants which are prepared to take the lead on initiatives, in most of the cases driven by self-interest (like the INEOS Ethylene Oxide case), but paving the way for other manufacturers and stakeholders by proving the viability of cluster-driven concepts.

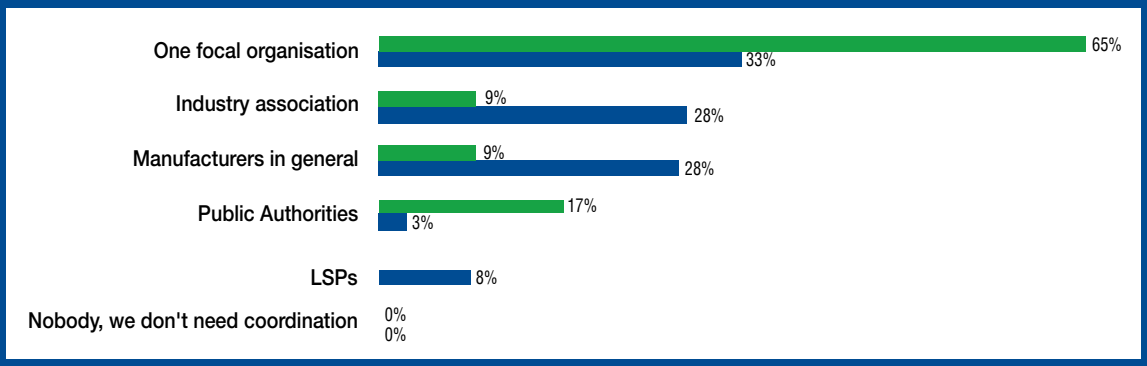

Figure 4-9 ARRR - cluster development leadership (green/LSPs, blue/producers)

Proactive site leadership: the INEOS Ethylene Oxide case

INEOS Oxide has a long history in Antwerp through a series of successive ownerships. In turn it has been Union Carbide, BP Chemicals and Inspec at the Zwijndrecht site on the left bank of the River Schelde. Third party hosting at the 200 ha site has been in place for many years, since BP Chemicals' decision to sell its LDPE assets to Neste and its hydroethoxylates facilities to Union Carbide.

With spare land available, and a strong interest on the part of Ineos to find additional on-site users for ethylene oxide, a highly hazardous product unsuitable for transportation, the site has been heavily promoted to attract investors; especially companies looking to establish an operational foothold in Europe.

Kuraray, the first Japanese chemical company to settle in the Antwerp port area, built an ethylene vinyl alcohol (EVOH) copolymer resin plant in 1999, and has subsequently progressively increased capacity.

Nippon Shokubai followed Kuraray two years later and built a super-absorbent polymers plant on a plot adjacent to the Ineos site. As a result eight parties are now on the site including General Electric, Dow, Praxair, Seppic, Specialty Polymers Antwerp, and Borealis.

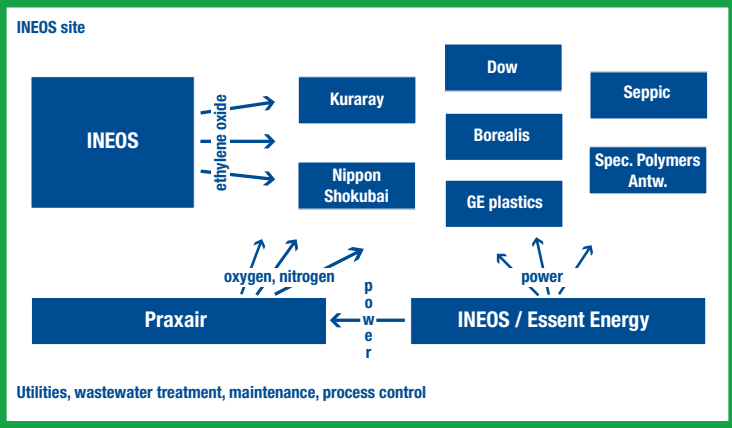

Figure 4-10 INEOS Oxide co-siting concept

The site offers many cluster advantages to new investors: land for production facilities; shared infrastructure; feedstock supply on site as well as by pipeline; utilities; waste treatment; and logistics facilities, including a jetty, a railhead, loading gantries and tank storage. Due to this proactive site management, the ethylene oxide capacity has more than tripled in the last 15 years.

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4.2 Tarragona

The statistics for the Tarragona cluster together with the comments and interpretations of the Tarragona Think Tank are reported below.

4.2.1 Advantages of the Tarragona cluster

The main advantages perceived by the Tarragona producers are the availability of competitive feedstock and raw materials, and the proximity of suppliers. With an import of almost 18 million tons of petroleum products, the port represents the main source of the necessary inputs for the manufacturing processes of the chemical companies settled in Tarragona. The appropriate flow of chemicals from the port to the refineries, the crackers and the storage locations is ensured by a suitable infrastructure.

The Dixquimics pipelines rack, which involved both a high percentage of companies and the local authorities, emphasizes the importance of infrastructure in the Tarragona cluster operations. It also points to the necessity of considering the longer term maintenance and growth of the cluster's and regional infrastructure.

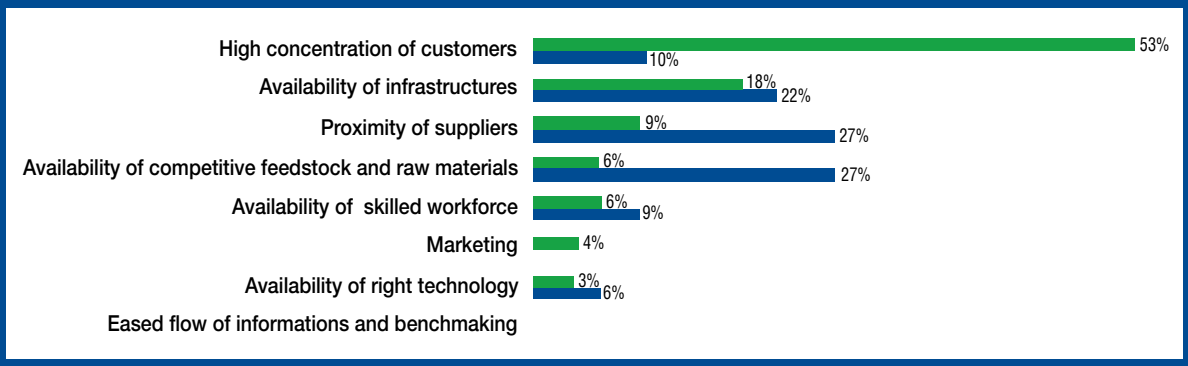

Figure 4-11 Tarragona - Benefits of chemical cluster (green/LSPs, blue/producers)

Dixquimics Pipe Rack

Dixquimics represents the rack of over 60 pipelines connecting the port with the south industrial park in the Tarragona chemical cluster. Several companies use the same pipeline complex for their product interchanges. We can report as an example the case of ethylene oxide, flowing from IQA to Dow Quimica and Clariant, and the case of chlorine, flowing from Ercros to Bayer.

Started in 1998 with the participation of just 5 chemical companies, Dixquimics now involves 16 companies in the Tarragona industrial complex, and moves 1.5 million tons/year of chemicals along a route of about 7 km.

The prospect of significantly decreasing investment costs and unifying all the pipelines into one single legal entity, in order to obtain a simplified authorization process, led the chemical companies to collaborate to embark on this project.

Since its construction, Dixquimics has favored the development of logistics synergies between cluster players. In this respect, the example of Terminales Quimicos S.A. (Terquimsa) handling vinyl acetate for Celanese Chemicals Iberica, S.L. at its port facilities, constitutes an important example. Indeed, due to the Dixquimics rack of pipelines, the previous vinyl acetate road transportation has been completely eliminated and product handling has been completely outsourced to Terquimsa.

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The availability of infrastructure represents a key advantage for the LSPs in the Tarragona cluster. However, the main reason that they were attracted to the cluster is the high concentration of chemical companies, and therefore of customers. This observation is consistent with the progressive specialization of the producers in the manufacturing of chemicals, and their subsequent outsourcing of industry-related services. The presence of the LSPs started 20 years ago. The integration of the LSPs with the producers is gradually progressing, but examples of LSPs co-siting on the land of the chemical producers and engaged in storing, handling and transporting chemicals on a long term basis, are not common yet. The recruitment of well-qualified logistics and supply chain specialists is reported as being quite difficult for both chemical companies and LSPs. This could explain why the availability of skilled workforce is not perceived as a main advantage of the cluster. The promotion of training courses in logistics and supply chain management is unanimously welcomed by the companies in the cluster.

4.2.2 Disadvantages of the Tarragona cluster

The main disadvantage reported by the producers in the cluster is the lack of land availability. The chemical companies claim that, **as the tourism industry has developed in the region, there has been less attention paid to the chemical industry by the local and regional government. The fact that no additional land has been earmarked for future chemical industry zoning has become a serious concern for both the producers and the LSPs**, since land availability plays a pivotal role in the longer term development of the cluster in Tarragona.

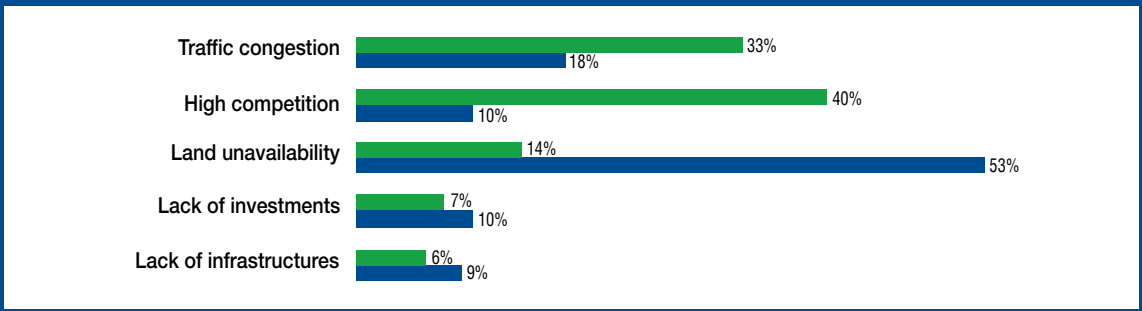

Figure 4-12 Tarragona - cluster disadvantages (green/LSPs, blue/producers)

Land for future growth of the chemical industry in Tarragona is available almost uniquely within the properties of the chemical companies. Indeed the **chemical facilities do not fully occupy the land of many chemical companies, and a substantial part (about 50%) remains unexploited. The Think Tank in Tarragona agreed on the necessity to analyze the feasibility of managing existing unexploited land on a joint/collaborative basis which could enable long term land leases or sales of land to third party investments. The association of chemical companies in Tarragona, AEQT, is not vested with the power of managing the land, but the possibility of broadening and strengthening its role has been the subject of several discussions in the Think Tank sessions.**

However, the chemical companies claim that **the substantial percentage of unexploited land in the Tarragona cluster is also related to the complexity of getting the right authorizations for the development of chemical projects on available/zoned land.** Finally, although showing a lower percentage result, the LSPs are also seriously concerned about the issue of land availability, since land prices in the chemical industrial parks in and around Tarragona have significantly increased over the last few years.

According to LSPs, the main disadvantage of being associated with the cluster is the high level of competition. This may explain the rare cases of horizontal collaboration between LSPs in the cluster. Pooling logistics resources and joint development of logistics infrastructures are not considered as real opportunities by the LSPs. A high percentage of LSPs consider that the trigger for collaboration between them should come from the chemical producers.

Producers and LSPs partly agree that traffic congestion is a disadvantage of the cluster. The traffic congestion issues do not relate to movements within the cluster, but rather to linking Tarragona to its hinterland markets. The distance from neighboring European countries, the specific Spanish rail gauge different from the French one, and national constraints in road transport (e.g. driving bans) are reported by the companies in Tarragona as the main complications in the distribution of the products from the manufacturers to the customers.

The prospect of increasing logistics efficiency triggered for example a collaboration initiative between Bayer Polimeros, S.L. and Bertschi Iberica, S.L., with the objective of developing a container terminal based on the existing railway connection on Bayer's property.

Multimodal Container Terminal

The Tarragona chemical cluster does not have a container rail terminal. Containers to and from the Tarragona manufacturing sites have to be moved by truck to Constantí, where the nearest terminal is located. In 2005 the opportunity of constructing a container terminal for the whole Tarragona chemical cluster led Bertschi Iberica, S.L. to start negotiating with Bayer Polimeros, S.L., which had ample land available, and on whose property a railway connection was already present. After signing the land lease contract with Bayer at the beginning of 2007, Bertschi is expected to complete the project by the fourth quarter of 2008.

The new set-up on the Bayer site will serve the whole Tarragona chemical cluster, with the following advantages:

- road transport to and from the cluster of Tarragona is expected to significantly decrease, due to the proximity, easy access and flexibility of the rail terminal. This in turn would positively impact the carbon footprint;
- distribution costs are expected to decrease, due to the direct transshipment to rail within the cluster;
- a new container storage capability within the cluster would mean that supply chain and production optimizations are possible.

The project of developing the multimodal terminal on the Bayer property will benefit several other chemical producers in the cluster of Tarragona, such as Dow, Lanxess, Ineos, BASF, Repsol, Aiscondel, Basell and Clariant. The vertical collaboration between Bertschi, Bayer and the other producers in the logistics infrastructure on the Tarragona site is expected to create significant synergies between the chemical companies and to enhance the competitiveness of the Tarragona chemical cluster as a whole.

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4.2.3 Obstacles to overcoming cluster disadvantages

The lack of collaboration between companies is perceived by both producers and LSPs as the main obstacle that stands in the way of overcoming the cluster disadvantages.

The prerequisites for any collaboration initiative, such as establishing a fair allocation mechanism, finding the right partner and mutual trust, appear difficult to fulfill. However, the opportunity to share capital investments, mixed with the specific needs of the industry, has triggered several collaboration initiatives within the cluster. The project undertaken by chemical companies and local authorities to recover water for the chemical industry from the urban water treatment plant represents a key example example.

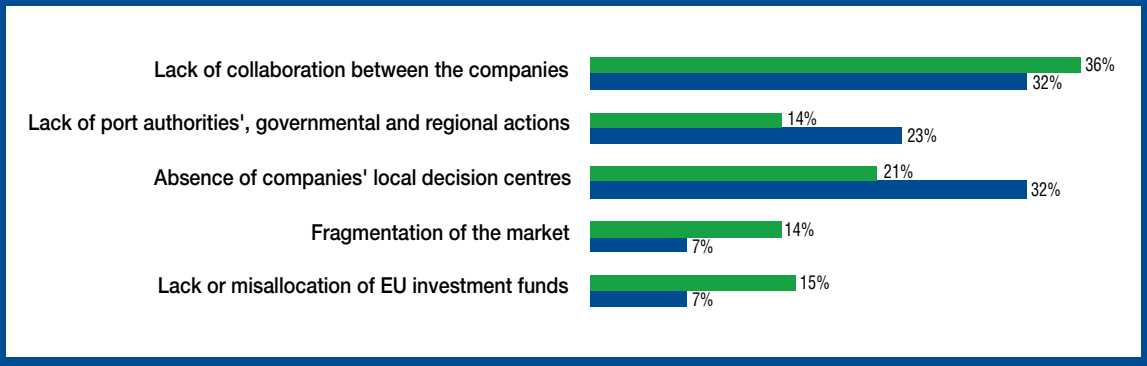

Figure 4-13 Tarragona - obstacles to overcoming cluster disadvantages (green/LSPs, blue/producers)

Water supply in Tarragona

Water shortage is a critical problem along the Spanish coasts, and more generally in the whole Mediterranean area. Tarragona is a location where a combination of different factors, including expansion of the chemical industry, population growth and tourism pressure, has increased water consumption to dangerous limits. The increasing demand for water, with limited natural resources, has even challenged the quality of the water, which has attracted the attention of the Catalan government. In this context, a water pipeline of about 100 km from the Ebro river to the Tarragona area has been constructed. The pipeline, with a capacity of 4 m3/second, was built to provide water for both industrial and urban use, at respectively 60% and 40%.

Since the start up of the line, industry consumption has increased from 0.79 m3/second to 1.05 m3/second. Urban demand has approximately doubled, due to a population growth in the area by 40% from 1990 to 2005. Finally, the increase in tourism has saturated the capacity of the pipeline, especially during the months of July and August.

The need to explore new sources of water led the local authorities to embark in 2005 on a project for recovering water from the wastewater urban treatment plants. The project required an investment of € 25 million and had the objective of reclaiming part of the chemical wastewater intended for industrial use and making it available for urban use. Finally, by using recovered water for the cooling towers of the chemical plants, an amount of 0.57 m3/s of additional water was made available for human consumption.

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Another project that saw the involvement of both the chemical companies and the local authorities is the waste incinerator plant.

Hazardous waste incinerator in Tarragona

The plant for treating all kinds of industrial wastes (including halogen compounds, liquid, solid or slurry) has been located in the Tarragona chemical cluster, between the two main industrial parks, since 1998. The facilities comprise an area for waste reception, an area for waste classification and storage and a treatment area. The total plant capacity amounts to 41 Ktons/year.

The program for special waste management, approved in September 1995 by the regional government of Catalonia, included the need for an investment project for a waste incineration plant in the area of Tarragona, where most of the basic chemical industries are located. The society PTRES was founded in the same year for the promotion of a public tender for the construction, start-up and first two years of operation of the plant.

The plant is certified ISO 14001 and equipped with cutting edge technologies for assuring the proper environmental control. For example, flue gas analyzers measure on line the concentration of several pollutants and the results are sent via radio to the environmental authority and to the town of Constantí. The ground water is continuously controlled through piezometers.

Dioxins/dibenzofurans and heavy metals are checked every two months in the flue gas. This testing generally occurs in Europe no more than once/twice a year.

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The project of unifying the current pipelines that dispose of treated water into the sea represents another example of collaboration that has involved all chemical companies in the cluster.

Treated Water Disposal

The different start-ups of the chemical companies in Tarragona and the absence of a cluster coordinating central body can be consi-dered the causes of the existence of eight pipelines for discharging treated water into the sea.

Two of these pipelines are in the north industrial park and dis-charge water from the crackers, the refinery and the chemical companies into the sea. The remaining six pipelines are in the southern industrial park; one from Asesa inside the port, one from Dow and BASF in the central area of the cluster, and the remaining in the west part of the cluster.

Following the expansion of the port area, the pipelines for the treated water disposal became internal to it. The resulting envi-ronmental concerns required an urgent solution.

This situation has driven all the chemical companies to invest in merging the eight pipelines into a one, with a disposal point twice as far from the shore (from 1800 m to 3600 m) and at an increased depth below the surface (from 22 m to 35 m). All the companies active in the cluster have embarked on this project, with a contribution proportional to the company's rate of treated water disposal.

Starting in mid 2008, the project is expected to reduce the environmental impact of the cluster operation, since moving the disposal point to a location deeper and farther away will improve the dilution of the treated water with sea water.

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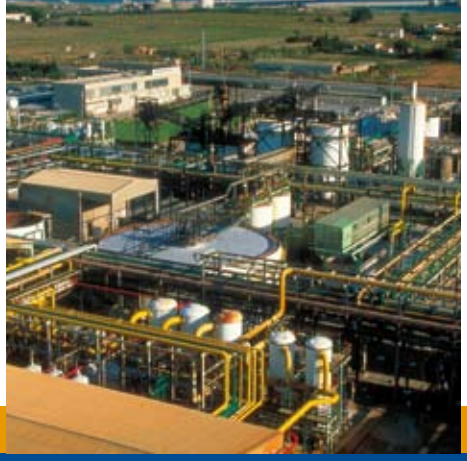
The examples of collaboration reported above **are clearly triggered by the necessity to share capital investments on assets and infrastructure necessary for the manufacturing of chemicals.** However, when the chemical companies and the LSPs address the lack of collaboration as one of the main obstacles overcoming cluster disadvantages, with a percentage respectively of 36% and 32%, they mean something more than sharing capital investments. Both the chemical companies and the LSPs are concerned about the necessity of joint action for defending and developing the chemical business interests and lobbying the regional and local authorities. Indeed 23% of **the chemical companies and** 14% of **the LSPs claim that there is a lack of action and of involvement of public institutions and local/regional governments in supporting further development of the chemical cluster in Tarragona.**



4.2.4 Opportunities for horizontal cluster collaboration

Producers and LSPs have mostly diverging views on opportunities for horizontal collaboration.

Developing logistics infrastructure and pooling logistics resources are considered most important for LSPs, whereas producers consider swap arrangements to be crucial. These results seem to be in line with the perception of traffic congestion as one of the main disadvantages of the Tarragona cluster. As a consequence, LSPs look at opportunities for more efficient logistics solutions, while producers are more interested in promoting swap arrangements, subject to competition law compliance, to decrease the need for transporting chemicals from their sites in Tarragona to distant customers. However, the range of products suitable for swaps is quite narrow and is restricted to base chemicals and commodities. Swap arrangements are possible in general if the two partners are of a comparable market size. The difficulty of finding the right partner, together with the necessity of establishing mutually convenient agreements and the perceived risk of losing market share represent significant obstacles to the further development of swap arrangements.

The willingness to promote operational synergies between LSPs in order to develop more efficient logistics solutions is clearly demonstrated by the case of Pañalon and Transportes Martin, who implemented multimodal distribution services jointly for container assets.

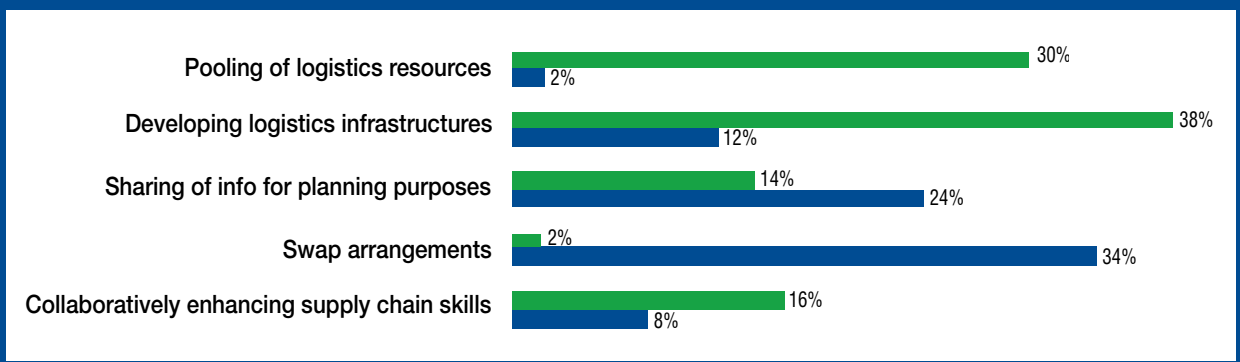


Figure 4-14 Tarragona - opportunities for horizontal cluster collaboration (green/LSPs, blue/producers)

Tradilo Multimodal Transport JV

In the cluster of Tarragona the two companies Pañalon, S.A. and Transportes Martín have been active in transporting chemical products by road for more than 30 years. In Spain, both companies were considered leaders in the market of chemicals transportation.

In 1999, based on the customers' increasing demand and the perspective of its continuous growth over the following years, the two companies decided to join their resources and found Tradilo, S.A. The objective of the new company was to develop a reliable and flexible plan of multimodal distribution services, based in Tarragona.

Tradilo, S.A. has quickly developed, together with shipping companies, a reliable sea "highway", connecting Tarragona with almost all the big ports of the Mediterranean Sea. The link with Italy has proved to be particularly efficient.

Tradilo, S.A. owns 200 tank containers, dedicated to the transport of chemical and petrochemical products, and benefits from the fleets of vehicles of both the two founding companies, amounting to a total of 1,800 vehicles.

Three years after the foundation of Tradilo, the two companies Pañalon, S.A. and Transportes Martín decided again to join their resources and found a new company, Tradilo Inversiones, S.L. The new company is a logistic public platform of 130,000 m2, providing full complementary services to the chemical transportation companies, such as ADR parking, a container platform, a station of 6 cleaning lines, a waste treatment plant and all the administrative services. Tradilo, S.A. and Tradilo Inversiones, S.L. have settled in the industrial park of Constantí. This location benefits from the proximity to customers' plants (the distance between Tarragona and Constantí is about 6 km) and a well developed transport infrastructure network (airport in Reus, port of Tarragona, container railway station and motorway).

CLUSTER

The opportunity of increasing asset utilization rate and sharing handling costs of bulk chemicals led two other companies, Dow Quimica and BASF, to start a joint venture.

TAPP Mooring

In 1998, BASF installed a dock in the Port of Tarragona for the charge/discharge of bulk chemicals. In recent years, this facility was operated at low utilization rates (less than 50% of capacity), creating a sizeable operational inefficiency.

In 2003 Dow was planning to install a dock in the Port of Tarragona (next to the existing BASF dock) for the charge/discharge of bulk chemicals, and the opportunity for the two companies to collaborate was obvious.

BASF sold 50% of the existing dock to Dow, and in June 2006 both companies integrated their respective part of the dock into a new society, TAPP A.I.E. (Terminal de Atraque de Productos Petroquímicos, Asociación de Interés Económico).

The collaboration between BASF and Dow resulted in fully exploiting the capacity of the dock, while sharing equally the related operation and depreciation costs.

CLUSTER

Producers and LSPs agree that sharing planning information is an opportunity for horizontal collaboration. The possibility for producers to collaboratively provide LSPs with planning data for logistics services was explored by the Tarragona Think Tank. **The main obstacle to this kind of interaction lies in the way chemical companies choose their LSPs.** Indeed **it seems that a large part of the demand for logistics services is aggregated by several chemical producers at a company level, and contracts with LSPs are drawn up at headquarters. Promoting more effective integration of local decision makers into central decision making and procurement processes could represent a large opportunity to enhance the efficiency of logistics services.** Indeed LSPs have confirmed that long term contracts, and more reliable and complete planning data from the producers would be crucial for providing more efficient logistics solutions.

4.2.5 Opportunities for vertical cluster collaboration

Producers and LSPs are mostly in agreement on opportunities for vertical collaboration.

Integration of LSPs in designing Supply Chain solutions and collaboratively sharing planning data are considered most important. A tighter integration between producers and LSPs has already demonstrated several benefits, as exemplified by the case of the Repsol and Terquimsa collaboration in the Ammonia Logistics project.

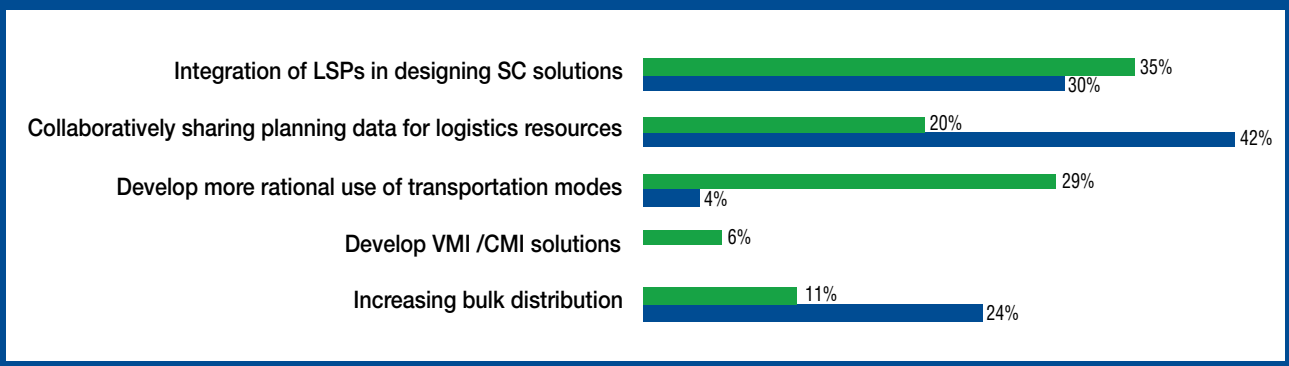


Figure 4-15 Tarragona - opportunities for vertical cluster collaboration (green/LSPs, blue/producers)

Ammonia Logistics: Repsol/Terquimsa collaboration

Before 1999, ammonia was delivered to the Tarragona chemical cluster by sea through the ports of Valencia and Barcelona and from there by rail to the Repsol Química, S.A. manufacturing plants. The absence of cryogenic storage facilities at the port of Tarragona prevented the product from being delivered to the port itself. The opportunity of reducing the logistics costs and increasing the security level of the transportation triggered a collaboration initiative between the companies Repsol Química S.A. and Terquimsa S.A.

By installing a cryogenic facility at the port of Tarragona and by building a 14 km long pipeline from the port of Tarragona to the Repsol chemical plants, the rail deliveries of ammonia have been completely removed.

Ammonia storage and the pipeline have been fully operative since the end of 1999. The project has benefited both parties involved, especially in terms of increased safety, and flexibility of the procurement process. The project resulted then in a consistent release of logistic assets (Rail Tank Cars), up to 1400 RTC/year.

CLUSTER

LSPs are also interested in a more rational use of transportation modes. However, lack of flexibility, limited network access, and poor service quality still prevent chemical companies from choosing rail or water-based transportation modes. In this context, it appears that the export of chemicals from the port of Tarragona could be improved. Insufficient export throughput does not justify regular shipping lines, especially for containers, and many companies are forced to use the more flexible port of Barcelona, which has the disadvantage of being almost 100 km away and therefore of adding unnecessary logistics costs.

4.2.6 Who should lead the development of the cluster?

Producers and LSPs are in agreement that the cluster requires leadership.

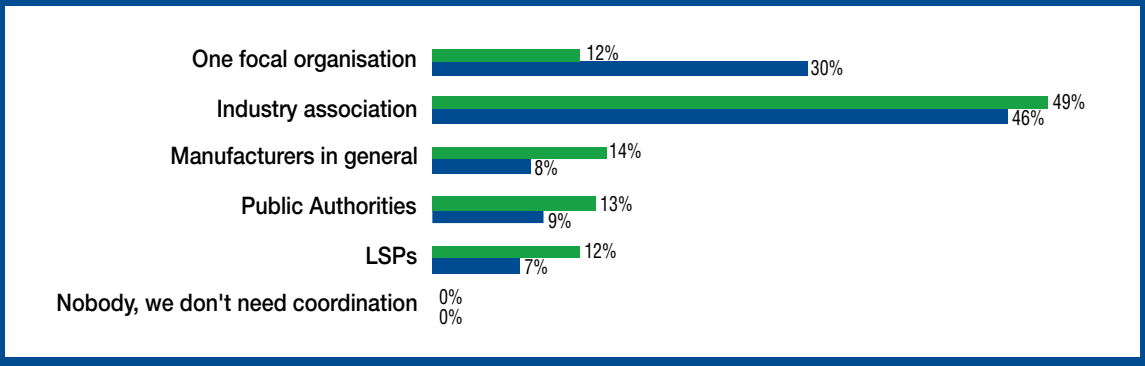


Figure 4-16 Tarragona - cluster development leadership (green/LSPs, blue/shippers)

In order to develop the long-term vision for the chemical cluster in Tarragona, **the think tank focused on the need to investigate the formation of a stakeholder driven model.**

This model would consist of three different tiers:

- LSPs, Producers and Local/Regional authorities on the operational or implementation level
- A newly formed Supply Chain Group and the Port, Road, Rail authorities/ Infrastructure Companies on the coordination level
- A Cluster leader, based on a model to be agreed by the stakeholders

The activities/roles of the various parties in the model would be:

- Supply Chain Infrastructure development and operation is the domain of the Port, Road, Rail or Infrastructure Companies together with the Producers and Local/Regional Authorities
- Supply Chain Integration is the domain of the LSPs, Producers and a Supply Chain Group to be formed (it is anticipated that the SC Group will consist of representatives from all key stakeholders)
- Implementation of the cluster infrastructure, coordination and operation strategies is the domain of the LSPs, SC Group, Producers, Port, Road, Rail authorities, and Local authorities
- The cluster leader (envisaged as a public-private partnership between the stakeholders) is responsible for creating the vision and strategy for the cluster which is then implemented as above.

Defining what decision-making powers this cluster leader would be vested with would be a further step. It emerged from the interviews that **the issue of land scarcity is one of the priorities that the cluster leader would be encouraged to address, since the opportunities of further development for the cluster in Tarragona appear to depend very much on this.**

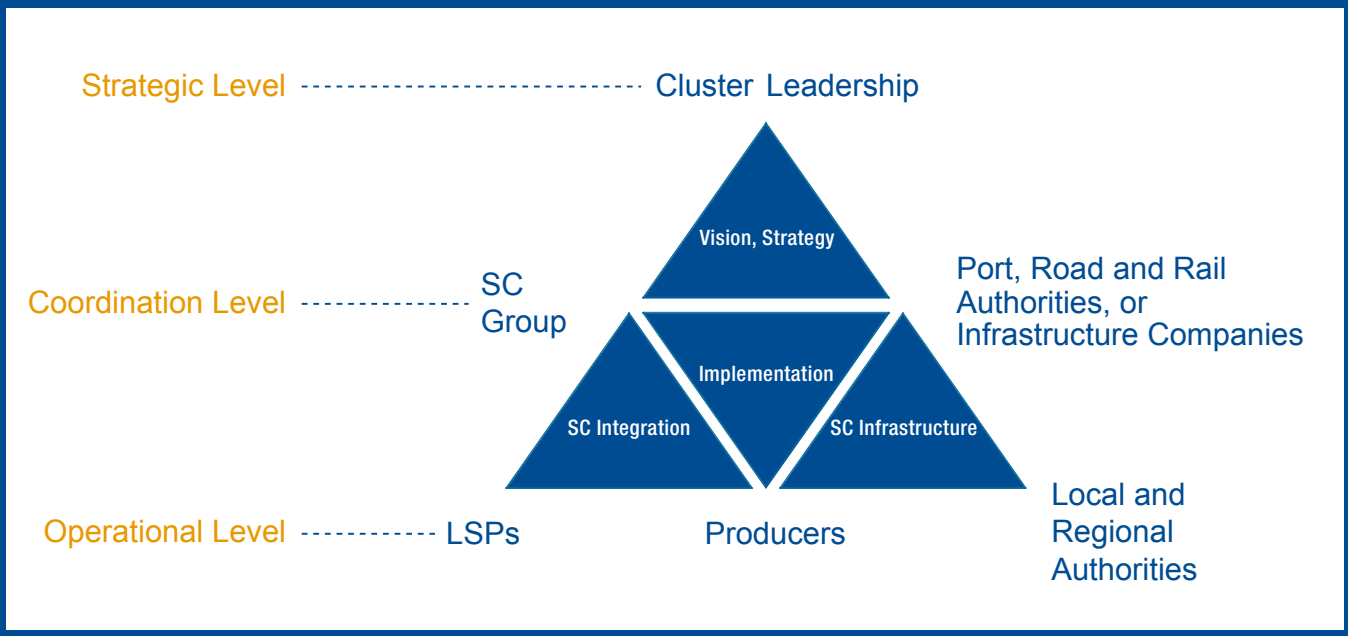


Figure 4-17: Proposed Tarragona stakeholder model

5. COMPARISON BETWEEN THE CLUSTERS IN ANTWERP, ROTTERDAM, THE RHINE/RUHR REGION, AND TARRAGONA

5.1 Raw material and competitive feedstock

The clusters in Antwerp, Rotterdam and Tarragona have developed around their respective ports. Indeed **the port represents the principal access point to raw materials and competitive feedstock for the manufacturing of chemicals.** Significant quantities of crude oil and natural gas find their way to the Ruhr region (ChemSite cluster) via other sources: crude oil via a pipeline from Rotterdam and Wilhelmshaven; and natural gas via the German pipeline network. The Ruhr region, although land-locked, is well-connected to the seaports of Rotterdam and Antwerp due to the nearby river Rhine and the inland waterways. The importance of the necessary inputs for the manufacturing processes within the cluster is underlined by the results of the interviews, where the availability of raw materials and competitive feedstock is considered by almost one third of the companies as one of the main advantages of the clusters.

5.2 Exports

The impact of the port on the economic success of the chemical clusters **is considered fundamental for exports as well. The ports of Antwerp and Rotterdam are extensively exploited for shipping outgoing cargoes. The same does not happen in the port of Tarragona. In particular for containers, the throughput does not reach a sufficient volume to justify regular shipping lines.** It therefore often occurs that companies ship containers from the port of Barcelona instead of Tarragona, thus adding unnecessary logistics costs and contributing to traffic congestion. **Investments in the area could increase the throughput of the port exports and pave the way for the development of more regular shipping lines.**

The Think Tank discussions revealed that **both import and export activities of the clusters made better coordination of legislation on VAT, customs and security between Belgium, The Netherlands and Germany a must for the ARRR mega-cluster. These discussions stressed also the importance of the coordinated development of suitable container infrastructure in and around the clusters as well as from the clusters to the hinterland.**

Figure 5-1 compares the clusters in Antwerp, Rotterdam, the Ruhr region and Tarragona along several critical dimensions, such as the link between industry and government, land ownership, and cluster growth opportunities.

	Tarragona Cluster	Port of Antwerp Authority
Configuration	Port is separated from the chemical cluster but is essential to the economic success	Chemical Cluster is integrated into port infrastructure
Link with government	No partnership with local governments for the cluster development	Appointed by local/regional governments to cooordinate interest in development and operation of ports
Land Ownership	Land is owned by chemical companies and LSPs onsite	Owns part of the land and acts as broker on behalf of local/regional government
Infrastucture & Service	Mostly individual companies with some common facilities and coordinated activities	Common infrastructure coordinated by port utilities and services outsources to third parties
Cluster Growth	Some chemical companies promote their sites for investment	Actively coordinates strategic initiatives with stakeholders in port. Acts as a cluster leader, lobbying government on development initiatives
Investment	Each land owner lobbies local government separately if they wish to invest	Actively promotes cluster to international investors

Port of Rotterdam Authority	Chemsite
Chemical Cluster is integrated into port infrastructure	Chemical cluster consists of 7 industrial sites well connected to the ports of Rotterdam and Antwerp
Local and national government are shareholders of the port	Partnership between local/regional governments and industry and state government
Owns the land and leases it out to private companies. Acts as land broker on behalf of local/national government	Land is owned by industry partners/ owners of the site. Acts as land broker on behalf of the owners of the 7 chemical sites as “one-stop-shop” for new investors
Common infrastructure coordinated by port utilities and services outsources to third parties	Common infrastructure owned and offered and coordinated by site operator (partner of ChemSite). Services are offered by site operator
Actively coordinates strategic initiatives with stakeholders in port. Acts as a cluster leader, lobbying government on development initiatives	Responsible for long-term cluster development strategy in collaboration with shareholders and stakeholders
Actively promotes cluster to international investors	Actively promotes cluster to international investors

Figure 5-1 Comparison between the four clusters in Antwerp, Rotterdam, Ruhr region (ChemSite cluster) and Tarragona along several critical dimensions

5.3 Logistics

The importance of the logistics services offered by the cluster is different in the four areas considered.

In the case of Rotterdam and Antwerp, the ports are responsible for the maritime traffic but are also involved in the maintenance and development of the cluster infrastructure.

In the Ruhr region, ChemSite offers the chemical companies highly developed chemical parks and sites with sophisticated infrastructure, tailor-made services and integrated material supply systems.

The Port Authority of Tarragona has the function of managing the imports and exports of cargo through the port, but is not involved in projects on infrastructure maintenance and development. These activities remain mainly a prerogative of the chemical companies.

5.4 Authorities

The involvement of the local authorities and the regional government in the chemical industry constitutes a further element of differentiation between the four areas.

The Port Authorities of Antwerp and Rotterdam are government-owned corporations, therefore appointed and staffed by the local/regional government to coordinate interest in the development and operation of ports.

ChemSite is a public-private partnership launched by the chemical industry, the state of North Rhine-Westphalia and local authorities in the Ruhr region. It forms an umbrella for all activities in the chemical industry value stream in the region.

Tarragona does not benefit from a specific partnership between local industry and government with respect to chemical operations.

5.5 Land ownership

Land ownership also plays a role in the governance of the cluster as expansion investments can only be performed if attractive land parcels are made available.

In Rotterdam, the Port Authority is the owner of the land. Usually, land in port areas cannot be bought by the chemical companies but is leased for long periods, from 20 to 50 years. The Port of Rotterdam Authority is engaged, together with the Dutch government, in projects for increasing land availability. The project Maasvlakte 2, which involves the reclamation of new land from the North Sea at the western end of the port, is a key example.

Figure 5-2 Land under-utilization due to misaligned incentives

In the case of Antwerp, the land is owned by several stakeholders, i.e. the Port Authority, private companies and local government. The availability of land within the Antwerp port area, both greenfield and on host sites, is the result of a deliberate strategy from the Belgian government and local and port authorities. Since the 1950s, they have called for land clearance on both sides of the river Schelde and have mapped out industrial zones.

ChemSite offers about 240 hectares of vacant industrial land to new companies at a total of seven chemical parks and sites in the Ruhr region. The land is owned by industry partners. The sites vary between fully developed petrochemical, base and specialty chemical, high-technology and chemical processing locations, both greenfield and brownfield sites. New companies can be integrated into the comprehensive materials flow system, can share the infrastructure with other companies on site and can make use of all kinds of services available on site.

In Tarragona the land is owned by the chemical companies. The unoccupied by the chemical companies, which amounts to more than 50% of their land, can only be exploited with their agreement. From the results of the interviews, we see that the lack of land availability is considered the principal disadvantage of the Tarragona cluster: 53% of the chemical companies interviewed in Tarragona have raised the problem of land availability, whereas in ARRR only 13% of the companies interviewed are concerned about this issue.

Figure 5-2 shows a typical case in Tarragona of a chemical company whose owned land is less than 50% exploited.

In addition to owning all or part of the land, the Port Authorities in Rotterdam and Antwerp play the role of land brokers. Subject to the business of new investors, they have the necessary experience to propose strategic locations for the supply of raw materials and the integration of their operations with other cluster players. ChemSite provides a comprehensive “one-stop-shop” for new investors and acts as a land broker on behalf of its industrial partners in the Ruhr region.

In Tarragona there is no central unit that assumes the role of land broker. As owners of the land, chemical companies, and only they, have the right to rent on an individual basis their unexploited land to potential investors.

In Rotterdam and Antwerp, the Port Authorities actively coordinate strategic initiatives with stakeholders in the port. They act as chemical cluster leaders, lobbying the government on development initiatives. ChemSite leads the cluster in the Ruhr region and is responsible for formulating long-term cluster development strategy in collaboration with stakeholders and shareholders. In Tarragona the cluster growth depends on initiatives of individual companies promoting their sites for investments.

In conclusion, **the differences between the four areas can be summarized by the observation that the cluster development is centralized in the case of Rotterdam, Antwerp and the Ruhr region, and decentralized in the case of the Tarragona cluster. The lack of a central coordination body creates some significant hurdles to the further growth of the chemical cluster in Tarragona.** Having said this, **the study still points out the difficulties experienced by all cluster stakeholders in getting information which enables them to obtain a clear picture of the flows and thus identify opportunities.** Given the variety of independent firms acting in the cluster, retrieving and managing cluster-relevant information is a challenge that still needs to be addressed.

The mega-cluster ARRR is decentralized. Discussions in the Think Tank revealed the need for a co-operation platform between the subclusters of Antwerp, Rotterdam and Rhine-Ruhr.

6. CONCLUSIONS & RECOMMENDATIONS

The co-existence of competition and collaboration is a key feature and strength of European chemical clusters. The **competition** within and between chemical clusters benefits all stakeholders. Shippers benefit from a greater range of alternatives to design and operate their networks. LSPs enjoy the advantage of a larger, local market while potential investors benefit from competing cluster authorities investing to further attract new cluster participants. Despite the competitive intensity, **collaboration** is being increasingly recognized as the next frontier to master interdependencies and maximize efficiencies in the supply chain. The many caselets throughout this report are evidence of the fact that supply chain collaborations (recommended by the previous think tank reports) are increasingly being explored. Nevertheless, considering the supply chain issues discussed in this report, we conclude that there is still **significant room for improvement**. This section of the report will make recommendations and propose solutions, which if adopted, will go a long way to ensuring that additional benefits in chemical clusters can be continuously achieved. Clearly, each company will however then have to make its own decision in full compliance with competition rules.

6.1 Manage cluster information to identify opportunities

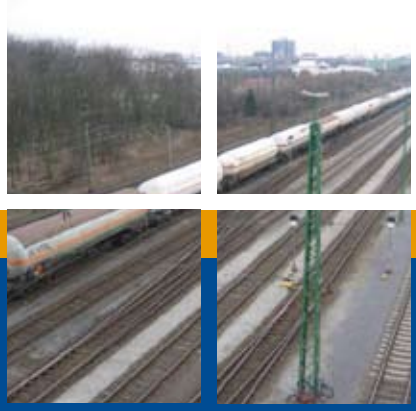
- **Organized information sharing between all stakeholders should be put in place to improve cluster operations.** Information sharing is not simply a case of producers providing forecasts to service providers. The willingness to create broader based knowledge of the capacities and flows in the cluster will create an awareness of the potential efficiencies and will drive market initiatives towards the discovery of more opportunities than are known currently. In many cases, the existing asset base could be much better utilized. Cluster-wide issues such as traffic congestion (Antwerp/Rotterdam, Tarragona) or suboptimal land use (Tarragona) might require significant investments in the future. Authorities, i.e. cluster authorities, national and local governments and the European Commission (DG Enterprise, DG Energy and Transport) are willing to support the chemical industry in this, but require the best information available to value investment proposals that cannot be carried by listed companies. Consequently, **authorities must become partners in the information sharing process and become partners in the development of the European chemical clusters.**

6.2 Provide a platform to discuss cluster opportunities

- All Think Tank participants unanimously agree on the urgent need for the chemical clusters to be effectively managed and to set up an appropriate organization to implement a suitable management system. Operating in clusters is complex considering the interdependencies between manufacturers, service providers and authorities. Information sharing is key to the coordination of actions within the clusters. However, both for the Tarragona cluster and for the mega-cluster Antwerp-Rotterdam and Rhine/Ruhr, no single coordinating body is currently active to support cluster-related information exchange. Therefore, the Think Tank recommends, for Tarragona and ARRR, the creation of a working group bringing all relevant cluster stakeholders together in order to ensure that the recommendations mentioned above become reality. Otherwise, the isolated initiatives will not exploit the benefits of the chemical clusters.
- The decentralized governance of the European clusters (Chapter 5) calls for a working group relying on voluntary participation of manufacturers, LSPs and authorities.

6.3 Take common actions to exploit cluster opportunities

- The ARRR cluster spans three countries that are, despite EU-wide directives, not fully aligned in terms of legislation. Since this lack of harmonization creates unnecessary transaction costs, the Think Tank participants strongly recommend an identical implementation of EU-legislation by the Belgian, Dutch and German states. This encompasses especially VAT harmonization and customs-related as well as security legislation. This can be worked out in the scope of the cluster platform to be created. Over a longer term, this type of co-ordination and harmonization between different clusters could be extended to all chemical clusters in Europe.
- Think Tank participants support the development of infrastructure linking all European chemical clusters so that the European Chemical Industry can effectively continue to compete with other regions in the world such as the US Gulf Coast. The set up of a specific working group for that purpose is suggested.
- More emphasis should be given to the development of appropriate import/export container facilities facilitating massive imports and exports as well as the transportation of the containers to the customers located in the hinterland of the clusters.



6.4 Long-term relationships are more profitable than short-term benefits

The former EPCA reports have been actively promoting long-term collaborations between shippers and service providers for the benefit of both. The Think Tank members acknowledge the progress that has been made, as shown by some caselets in this report, since the first EPCA report in 2004 but the interviews show that there is still a gap between what the chemical industry says and what is practiced. The Think Tank therefore makes the following recommendations.

- **Shippers should develop long-term relationships with selected logistics providers**, allowing them the possibility of fulfilling the collaborative role that producers expect from LSPs (i.e. proactive, forward-looking, flexible and highly competitive). Traditional confrontational relationships between shippers and service providers encourage market fragmentation, with the result that many LSPs are too small to cover a large proportion of a single shipper's demand for logistics services. Manufacturers fuel this fragmentation through frequent tendering rounds and cherry-picking at several suppliers. This competitive intensity often prevents the realization of synergies between LSPs (such as merging shipments in multimodal hubs), and consequently undermines efforts to reduce the carbon footprint in chemical supply chains. Clearly the development of long-term relationships with a limited set of partners provides the opportunity for service providers to develop the logistics solutions producers are seeking.
- In order to convince shippers of the benefits of long-term relationships, **LSPs will have to put greater emphasis on their ability to think strategically and to implement strategy in a pro-active way**. Manufacturers often perceive service providers as operators and do not involve them in their strategic and tactical planning processes. A paradigm shift starts with the design of contracts which give a greater degree of freedom but also higher responsibilities to LSPs. These contracts should however encourage LSPs to pro-actively develop cluster- and Europe-wide services instead of condemning them to react at each tendering round.
- A greater emphasis on **developing coordination skills and high level generalists trained in strategic thinking and planning** is the recommendation to attain this goal for both producers and LSPs.

The European chemical sector has some of the strongest industrial clusters in the world. Its future is bright, provided it manages to strongly build on these clusters, for instance by enabling successful supply chain collaboration. Other sectors, like automobiles and consumer electronics have led the way, and showed that competition and collaboration can effectively co-exist, to the benefit of all stakeholders. However, the groundwork needs to be laid out first. It consists of basics like information exchange, discussion platforms, collaborative end-to-end solution development, and a long-term perspective on cluster development.

7. APPENDIX

Organization of the study

From September 2006 to August 2007, EPCA set up a Think Tank dedicated to two chemical cluster areas in Europe. The Think Tank consisted of a Steering Group and two sub-groups of chemical managers, each dedicated to a specific cluster. The ARRR (Antwerp, Rotterdam, Rhine/Ruhr area) group examined the transnational cluster covering parts of Belgium, The Netherlands and Germany. The other group examined the Tarragona cluster located in the North of Spain.

Each group was composed of representatives of EPCA member companies, designated or invited by the EPCA board, and supply chain researchers from INSEAD, Fontainebleau, France. The ARRR Think Tank meetings took place in Brussels, and the Tarragona Think Tank took place in the offices of several companies of this cluster. The ARRR Think Tank had 7 meetings while the Tarragona members met 6 times, with a high level of attendance.

The first Think Tank sessions contributed to the determination of a relevant cluster charter, to the definition of cluster boundaries and to the issues faced by the clusters. Based on the result of the discussions, INSEAD drafted a questionnaire and interviewed 53 persons, shared between the ARRR and the Tarragona cluster and between producers and service providers. The majority of the persons interviewed were also participating to the Think Tank meetings, while the remaining part was suitably selected among industry experts of the respective cluster. The later Think Tank meetings served the purpose of commenting on both the statistical results of these interviews and the anonymous statements made during them. Together the results and the comments provided a basis from which to discuss the issues raised, understand their origin and find ways to tackle them.

From this process description, it should be clear that the report, at best, presents the collective views of the participating experts. It is neither a scientific document nor a fully representative account of all relevant industry experts. Nevertheless, the process followed was sufficiently rigorous and we are confident that the report does provide a solid baisis for discussion and, hopefully, action.

The Steering Group (SG) had a major role in initiating the process and monitoring the Think Tank discussions. The Steering Group was composed as follows:

- Frank Andreesen (Bayer Material Sciences)
- Hans-Jörg Bertschi (Bertschi)
- Phil Browitt (Agility Logistics Solutions)
- Cathy Demeestere (EPCA)
- Fred du Plessis (ECSPP)
- Antonio Gomis (Repsol YPF), replaced later by Benjamin Palomo (Repsol YPF)
- Paul Gooch (The Logical Group)
- Alfred Heuser (BASF)
- Baptiste Lebreton (INSEAD)
- Paolo Letizia (INSEAD)
- Graham van't Hoff (Shell)
- Luk Van Wassenhove (INSEAD, Chairman)

The two Think Tank groups were composed as follows:

ARRR cluster

- Ronald Backers (Port of Rotterdam)
- Thomas Bode (RAG Degussa)
- Cathy Demeestere (EPCA)
- Johan Devos (Bertschi)
- Hans de Willigen (VOPAK)
- Bas Ensink op Kemna (SABIC)
- Danny Eyckmans (Shell)
- Paul Gooch (The Logical Group, Chairman)
- Margarete Gersemann (ChemSite)
- Bertrand Gyselynck (Total Petrofina)
- Joris Hurenkamp (Port of Rotterdam)
- Eric Janssens (Port of Antwerp)
- Baptiste Lebreton (INSEAD)
- Fabian Leroy (Katoen Natie)
- Paolo Letizia (INSEAD)
- Angela Neu Meij (BASF)
- Susanne Ramp (Hoyer)
- Peter Rose (INEOS Olefines)
- Phillip Schneider (Reederei Jaegers)
- Bernhard Schnittger (European Commission)
- Xavier Van Rolleghem (Port of Antwerp)
- Peter Viebig (Bayer Material Sciences)
- Mark Warner (Den Hartogh)
- Aernoud Willeumier (Port of Rotterdam)

Tarragona cluster

- Josep Andreu (Transport Prats)
- Manuel Arce (Ercros)
- Javier Bort (AEQT, Chairman)
- Josep Maria Chillida (BASF)
- Genoveva Climent (Port of Tarragona)
- José Curado (BASF)
- Fred du Plessis (ECSPP)
- Michael Euler (Schmidt Iberica)
- Antonio Gomis (Repsol YPF)
- Luis Jove (Bayer)
- Erik Klonhammer (Katoen Natie)
- Paolo Letizia (INSEAD)
- Jesus Loma (Bayer)
- Cesar Meler (Repsol YPF)
- Sebastian Mussini (Repsol YPF)
- Juan Carlos Nebot (Bayer)
- Cesar Nunez (Solvay)
- Ed op den Camp (SABIC)
- Josep Pallares (Universita Rovira i Virgili)
- Benjamin Palomo (Repsol YPF)
- Rose-Marie Pype (ECTA)
- Aurora Sanchez (Panalon)
- Jan Schoonbaert (VOPAK)
- Cesar Valdes (Dow Chemical)
- Salvador Vidal Rodriguez (Bayer)

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Definitions

ADR	International Carriage of Dangerous Goods by Road
AEQT	Tarragone Chemical Business Association
ARG	Aethylen Rohrleitungsgesellschaft mbH & Co.KG (Ethylene Pipeline Company – not a strict translation)
ARRR	Antwerp Rotterdam Rhine Ruhr
C4 Cut	Effluent from steam cracking containing Butadiene and Isobutene
CEO	Chief Executive Officer
CMI	Customer Managed Inventory
EPCA	European Petrochemical Association
EPDC	European Pipeline Development Corporation
HPPO	Hydrogen Peroxide Propylene Oxide. A cooperation between Dow, BASF, and Solvay
HSSE	Health, Safety, Security, and Environment
INSEAD	Institut Europeen d'Administration des Affaires
LNG	Liquified Natural Gas
LSP	Logistics Service Provider
NRW	North Rhine-Westphalia
ROCE	Return on Capital Employed
RTC	Rail Tank Car
VMI	Vendor Managed Inventory

Acknowledgments

On behalf of the EPCA Board I wish to express our sincere thanks to the member companies who have delegated senior persons of their organizations to participate in the 2006-2007 EPCA Think Tank on chemical clusters in Europe.

We also are very grateful to all the Think Tank participants who have dedicated time and efforts to generate and substantiate the messages contained in this report. Both the Steering Group members and the participants in the groups of ARRR and Tarragona have done a great job.

Special gratitude goes to Paul Gooch and Fred du Plessis. Their in-depth knowledge of Supply Chain and the Chemical Industry as well as their contribution at meetings supported, together with the input of all participants, the progress of the work.

Our thanks also go to the INSEAD team who handled the interviews and summarized the results so that the Think Tank could focus on understanding what exists and what is lacking in the examined European chemical clusters. With their contribution, the Think Tank could reflect on what we want the examined clusters to be and on how we could get there. INSEAD also drafted this report, for which we are very grateful.

In addition to delivering content, the Think Tank sessions were pleasant and were characterized by mutual respect and fellowship, so typical for the chemical industry. It rapidly became clear during the meetings that European chemical players are not only clustering industrially, but that they are also good at networking, generating through the meetings dynamics of creativity and readiness for a mindset shift from the competition model to other business models integrating a partnership approach.

The many examples in the report show that to some extent collaborative models already exist, as suggested in the 2004 and 2005 Think Tank reports. The recommendations of the Think Tank however also show that a lot remains to be done to optimize supply chain and chemical clustering in Europe in order to safeguard a sustainable and competitive European chemical business community.

So let us all work on turning recommendations into action!

We hope you enjoyed reading this report as much as we all enjoyed making it for you.

Cathy Demeestere
Secretary General EPCA.

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