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SOCIAL ANALYSIS OF A PROPYLENE PIPELINE

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EXECUTIVE SUMMARY

The aim of this study is to analyse the (dis)advantages of the project to both the public and private sector. This analysis will serve as input for Public-Private Co-operation. The (dis)advantages are categorised in the following way: construction of the pipeline, pipeline system in operation and economic impacts.

- Construction of the Pipeline

During the construction phase the project will cause some inconveniences especially concerning land use, traffic and noise. The negative effects concerning land use are less significant because the new pipeline follows existing pipeline trajectories. The negative effects on noise and traffic will be temporary. Moreover, a temporal rise in employment will accrue from construction activities.

- Pipeline System in operation

A realistic assumption is that a substantial modal shift will occur. Statistics show that pipelines are preferred over other modes of transport, in this case barge and Rail Tank Car. Once in operation the positive effects of substitution will dominate, especially in the field of safety, energy use and emissions. This will become even more advantageous as transport flows of propylene continue to grow. The public sector benefits because transport and related pollution as well as energy use will be reduced. Hence, a pipeline system can contribute to improve the quality of life. In addition, the right-of-way caused by the pipeline offers opportunities for ecological corridors or bicycle trails.

Negative effects include noise caused by pump stations, and, at specific times, traffic and noise generated for maintenance purposes. These disadvantages are, however, more than offset by the above mentioned advantages of the modal shift. Another disadvantage involves land use: a spatial zoning will expel some economic and residential activities from the area where the pipeline will be located.

The private sector will also benefit. Reduced safety problems and improved reliability and flexibility (in logistical sense) are among the most important advantages. Furthermore, there is no need to keep large quantities of raw materials in stock.

- Economic impacts.

Employment in the chemical industry in Belgium, the Netherlands and North Rhine Westphalia accounts for about 300.000 people. Basic chemicals as the most important branch of these locations of chemical industry did face high job less in the course of the 1970ies and 1980ies. Recently, basic chemical industry is under pressure again. Where the chemical companies have a choice to improve and use the regional advantages or to source out more and more on a global scale, the public sector has good reasons to strengthen the competitive base of basic chemicals in order to avoid structural upheavals like in the mining sector or steel industry. Further on, basic chemicals are strongly related with materially interlinked downstream activities and they provide an ongoing base for innovations in sectors like special chemicals.

A pipeline – offering propylene in a competitive way - can be seen as crucial for the competitiveness of basic chemicals because basic chemicals are under strong price competition. In this way, the pipeline can be seen as a base for strengthening the competitive position of the region. The impacts of a pipeline will mount, when the pipeline is more than one isolated project but becomes related to further activities to strengthen the regional base for competitiveness and innovation.

There is no viable scientific method to assess and distribute the (dis)advantages over the public and the private sector, so fixing a space for bargaining is proposed. To start with, pipeline investment can always be regarded as a very important investment in a region, especially if that region is facing ongoing restructuring. In this case a public financial support of 20 % of total investment cost (due to EC regional policy) is regular. In the case of this pipeline we may suppose that the social benefits in ecological as well as in economical (employment) respect are higher than in the case of ordinary investments. Therefore 20 % can be regarded as the lowest level for public support.

Because of the stated public benefits, the Dutch approach provides an interesting starting point. Recently, the private sector (i.c. financial institutions) expressed their views on participating in new infrastructure investment. Usually infrastructure projects are not interesting from a financial/economic point of view, because their earning power is less than the investment costs. In order to participate a Public-Private Co-operation is suggested. The private sector should take their share based upon commercial considerations; the rest should be financed by the public sector. The amount of investment accounted for by the public sector is an indicator of the social benefits of the project. In this particular case the public financial contribution accounts for one third of total investment cost.
Summing up, more than one fifth (as lower limit) and one third of total investment costs as upper limit leaves room for bargaining. However, the negotiators should bear in mind that a Public-Private Co-operation is not a zero sum game. As shown before, the public as well as private sector can benefit from the project especially if it is organised as a common carrier. Therefore, a private and public commitment to strengthen the competitive and innovative base of the chemical industry along the pipeline in a co-operative way could be helpful in search of a solution that suits both parties.

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CHAPTER 1 INTRODUCTION

Building a new propylene pipeline between the Benelux, Cologne and Gelsenkirchen has benefits for the chemical industry as well as society at large. This social analysis of the project will try to determine these advantages.

The impacts of the project analysis can be divided into two broad categories: economic and environmental effects. The first category of effects is studied at a sectoral level. As cutting costs is extremely important in this sector where prices are determined on a global market but production cost are determined locally (local regulations, wages etc.), the impact on the competitive position of the chemical industry in North-western Europe is investigated. The research of the environmental effects include energy consumption and emissions, safety, noise and land use. Over the last decade, many efforts have been made in the field of (more) environmental friendly ways of transport. Based upon these recent developments a comparison between the various transport modes will be made.
The results of the research will be summarised in order to get a clear picture of the distribution of benefits which will serve as a base for public-private partnership. Usually infrastructure projects are not interesting from a financial/economic point of view. In practice, their yield doesn't even cover the investment costs. In order to realise this specific infrastructure project Public-Private Co-operation is investigated.

The report starts, in chapter 2, by describing the characteristics of transport by pipeline in general. Bearing these findings in mind, chapter 3 focuses on the Benelux, Cologne and Gelsenkirchen propylene pipeline. In chapter 4 the distribution of the (dis)advantages of the pipeline are summarised. This serves as a framework for public private co-operation.

Given the international scope of the project, the research was carried out by three institutes: the Institute Work and Technology from Gelsenkirchen (Germany), Catholic University of Leuven (Belgium) and Delft University of Technology (the Netherlands). The latter was also leader of the project.

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CHAPTER 2 THE CHARACTERISTICS OF PIPELINE TRANSPORT.

2.1. INTRODUCTION

The spatial dispersion of production and consumption of commodities makes freight transport necessary. As such, it is not a product in itself but a service that enabled society to achieve a high standard of living. However, as the number of vehicles, trains, barges etc. continues to grow, the quality of life is threatened because of some negative side effects.
In this chapter, the (dis)advantages of transport by pipeline are examined. At first, pipelines will be described as a transportation, or in broader terms, a logistical system for the chemical industry. In addition, the environmental performance of the system will be compared with other modes of transport. Ultimately, attention is paid to the impacts on land use during the construction and operation phase.

2.2. PERFORMANCE

2.2.1. LOGISTICS

In the petrochemical industry crude oil is, after several processing stages, transformed into various products. A large share of the output of chemical plants is used by other chemical companies. Basic chemicals like ethylene and propylene are typical examples in this respect.
In order to move chemical products from supply to demand sites, a wide variety of transport modes are available. Due to the large volumes, seagoing vessels, barges, trains and pipelines are preferred. Road transport is not very popular (NEA/Haskoning, 1993; parpinelli TECNON, 1995).

An extensive pipeline network links the petrochemical sector in NW Europe together. The advantages of transport by pipeline to the industry are clear: feedstock and output flexibility along with low transportation cost. Only pipelines can offer a constant availability of feedstock without keeping large stocks. Moreover, handling costs are virtually zero. If available, pipelines will be favoured over other means of transport.

2.2.2. EMISSIONS

Ideally, emissions of sustainable transport match levels which nature will tolerate in the long run. In relation to air pollution and global warming the major emissions are sulphur dioxide, nitrogen oxides, volatile organic compounds and carbon dioxide.

- SO_2 emissions cause soil acidification in sensitive rural areas and damage to buildings, plants, animals and human beings. Sulphates can also cause fog. At the moment, the ecosystems critical load is exceeded significantly. Emissions come from (sulphurous) diesel fuels in railway locomotives, trucks and bunkering oils in ships.
- Nitrogen oxides (known as NO_x) and VOC (Volatile Organic Compounds: hydrocarbons that also contain acid and chlorine) have both human and environmental effects. Down into the human airways NO_x can reach other organs of the human body, whereas VOC can cause allergies and cancer. Environmentally, NO_x can contribute towards acidification of soils, tree damage, changes in ground flora etc. The critical load for NO_x emissions can be described as "significantly harmful" to society and/or the environment. The same goes for Volatile Organic Compounds which are frequently grouped with NO_x as they work together to produce ground level ozone. Roughly 60 percent of European NO_x emissions comes from transport, whereas transport with 44% is the largest single source of VOC.
- Carbon Dioxide (CO_2) is not a toxic pollutant but is a so called greenhouse gas, responsible for more than half of all emissions contributing to global warming. The use of fossil fuels in transport

and generating electricity is the culprit. Transport accounts for roughly a quarter of western European CO_2-emissions. Stabilisation of temperatures below the high-risk limit (2 degrees above pre-industrial levels) can be achieves if global emissions are reduced by 60 per cent in the year 2050.

Obviously, there is a relationship between energy consumption and emissions per transport mode but not as straightforward as one might expect. Therefore, it is necessary to investigate the factors that influence energy consumption and emissions. Superficially, energy consumption per kilometre is determined by factors of a technical nature such as type of engine, vehicle weight, and speed. Besides these aspects, other (operational) factors like occupancy rates, fleet characteristics, and route assignment are important as well.
Moreover, a sound comparison between transport modes should also include the energy used to produce fuel and/or electricity. For example, in order to produce 1 MJ energy of diesel fuel an oil refinery needs 1.067 MJ energy out of crude oil (Rijkerboer et al, 1992). Accordingly, to generate 1 MJ of energy for an electric railway locomotive, a conventional power plant needs 2.64 MJ of input of fossil fuels (CE, 1995). This approach is known as 'well to wheel' and will be adopted in this analysis

Table 2.1: Energy consumption (MJ/tonkm) and emissions (g/tonkm) on a 'well to wheel' basis

	road		rail		barge	pipeline
	lorry	truck/trailer	electric	diesel electric		
energy consumption	1.68	1.20	0.61	0.61	0.60	0.38
CO_2	123	88	43.6	45.2	44	27.2
NO_x	1.40	1.21	0.050	0.819	0.79	0.031
CO	0.35	0.36	0.005	0.070	0.04	0.003
VOC	0.24	0.29	0.001	0.045	0.04	0.001
SO_2	0.15	0.11	0.020	0.025	0.06	0.013
particles	0.08	0.05	0.000	0.018	0.05	0.000

Source: RIVM, 1997

As a result of improved technology, a different picture may emerge in the future. Especially, pipelines and electric railway locomotives will benefit from anticipated, more efficient, power plants with Selective Catalytic Reduction (SDR). Road transport is supposed to become (a bit) more environmental friendly due to strict directives from the European Union. On the other hand, when legislation does not apply (e.g. barge, diesel-electric traction) technological innovations are introduced at a much lower pace.

2.2.3. NOISE

Noise environments and consequences of human activities are usually well represented by median noise levels during the day, night, or over a 24-hour period. These are decibel levels that are exceeded 50 percent of the time, commonly designated by L_{50}.
Noise levels are generally considered low when they are below 45 dBA, moderate in the 45 to 60 dBA range, and high above 60 dBA. Noise levels greater than 85 dB can cause temporary or permanent hearing loss. Various environments can be characterised by levels that are generally considered acceptable or unacceptable. Lower levels are expected in rural or suburban areas than in commercial or industrial zones.

The existing ambient noise levels variations are primarily related to the type of adjacent land use, the proximity of specific noise sources and the time of the day. The primary noise source in the project

area is traffic noise from the major streets and freeways serving the subject area. Secondary noise sources include noise from industrial operations, noise from commercial and institutional activities and residential noise.
The typical L_{50} ambient noise levels during day time are estimated to vary from 55 dBA in residential areas to 80 dBA in the heavy industrial areas and immediately adjacent to a roadway with substantial heavy truck usage. Night-time ambient levels in urban environments are about 7 dBA lower than the corresponding average daytime levels.

Construction of the proposed pipeline will result in increases in existing noise levels for short periods of time as construction passes by a particular receptor along the route. The noise from construction could disturb adjacent land uses. This would be a short-term impact, but it is potentially significant.

Potential sources of noise from pipeline operations are:

- Pump stations. They are considered to be the biggest noise sources along the pipeline. Due to the anticipated modal shift, a decrease of tonkilometres for other transport will represent the gains. Moreover, noise from pump stations is concentrated in specific locations, and therefore easier to manage.
- Inspection tours. The primary noise sources associated with inspection are the transportation vehicles and aeroplanes used by inspection personnel. In comparison to the ambient background noise, the noise generated from the vehicle trips would be negligible. This noise impact would be averse, but not significant.
- Maintenance operations. Although, principally, performed at the pump station sites, maintenance work would also sometimes take place along the pipeline. Noise sources may occasionally involve equipment. The net increase in noise levels would be less than for pipeline construction and would occur only at a few locations along the pipeline for a short period of time. This impact would be adverse, but not significant.

2.2.4. SAFETY

The safety of transport of hazardous material is defined in three different ways:

1. A probabilistic approach, dealing with risk as a combination of probability of an event and its consequences. This approach applies Individual Risk and Group Risk as parameters.
2. A deterministic approach, focussing on crisis management and contingency planning issues, expressed in critical size scenarios, fire fighting capacity and medical support requirements.
3. A spatial zoning approach, expelling other activities from the area where the transport of hazardous material takes place.

As a part of the risk control policy in The Netherlands, comparisons were made between transport modalities. In general, no preferential modality could be identified. (VROM, 1996). However, comparing pipelines with other modes of transport shows two fundamental differences:

- Pipelines have different systems characteristics. Pipelines are dedicated systems which do not apply a separate means of transportation, have centralized flow control systems and are spatially confined to underground applications. Pipeline systems are private property with specific consequences to risk management and organisational issues. They fit in with quality assurance and environmental policies of major companies. Consequently, the exposure to risk and the mitigation of the consequences differs from the other modes of transportation.
- The probability of risk of pipelines is relatively independent of the extend of the flow, where in other modalities, a near linear relation exists between accident probability and movements per unit transport. Pipelines are especially profitable, if a major flow is maintained with a high risk potential. Consequently, if a considerable growth is anticipated, pipelines are preferential to accommodate this growth.

A specific comparison between modalities is desirable if a specified route has to be analysed in combination with vulnerable objects alongside the route. Such a comparison should include all handling activities at transfer points, all batch sizes and unit cargo per means of transportation.

2.2.5. LAND USE

The determination of the level of impact for pipeline construction and pipeline operation on land use is different; the operational impacts are considered to be potentially significant, but construction impacts are found to be less than significant. Construction impacts on existing land uses are considered to be less than significant because construction disturbances are short-term and temporary and therefore will not have any long-term impacts on the sensitive receptors in the vicinity.

Project construction activities may result in daily disturbances of dust, equipment emissions, possible odours, noise, traffic congestion, limited parking, access detours, and utility disruption to land uses adjacent to the pipeline route.

In order to reduce short-term construction impacts, local measures will be necessary. It is assumed that the proposed project includes implementation of these measures. Development of the proposed project may result in intensification of the land use by adding to existing infrastructure along the pipeline, but the overall impact is still considered to be less than significant.

Due to the possibility of night-time construction, there is a potential for significant light and glare impacts. These impacts will be short term and temporary, but it could affect residents adjacent to the construction areas depending on the portion of the pipeline constructed at night.

After the pipeline has been installed, all lands affected by construction activities will be cleaned up and rehabilitated. Well-proven design and construction measures will be used in all areas to minimise environmental effects and to satisfy commitments to regulators and landowners.

The pipeline will be buried for its entire length except for above ground facilities, such as compressor stations. Therefore land use disturbance caused by the pipeline generally will not exceed about 30 m in width. Negative aesthetic impacts are also expected to be less than significant. The proposed project will not alter existing natural viewsheds in the project area. There will only be short-term and temporary visual impacts associated with the presence of construction equipment at the project site.

Disturbances caused by a pipeline are considered more or less significant for each type of land use in the event of:

- Conflict with general plans, policies and regulations.
- Permanent preclusion of a permitted use on nearby property or long-term disturbances that diminish the quality of a particular land use.
- Permanent or long-term pre-emption of a recreational use or temporary pre-emption during peak use season.
- Long-term loss or degradation (extending beyond the construction period) of the recreational value of a mayor recreational facility.
- Conflict with established recreational, educational, religious or scientific uses of the area.
- Conversion of prime agricultural land to non-agricultural use, or impairment of the agricultural productivity of prime agricultural land.

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CHAPTER 3 A NEW PROPYLENE PIPELINE IN NW. EUROPE

3.1. INTRODUCTION

The need for a propylene pipeline in the ARG-area will be examined in this chapter. In depth research in the nature and interdependencies of the petrochemical industry is the basis for 3 scenarios: disintegration (no pipeline), stabilisation (pipeline) and innovation (pipeline plus). Next, the impact of the new pipeline on society will be described. The anticipated modal shift is the basis for assessing the reductions in emissions. Safety aspects will be dealt with in the last paragraph.

3.2. CHEMICAL INDUSTRY IN THE NETHERLANDS, BELGIUM AND NORTH RHINE WESTPHALIA

3.2.1. POSITION IN THE WORLD

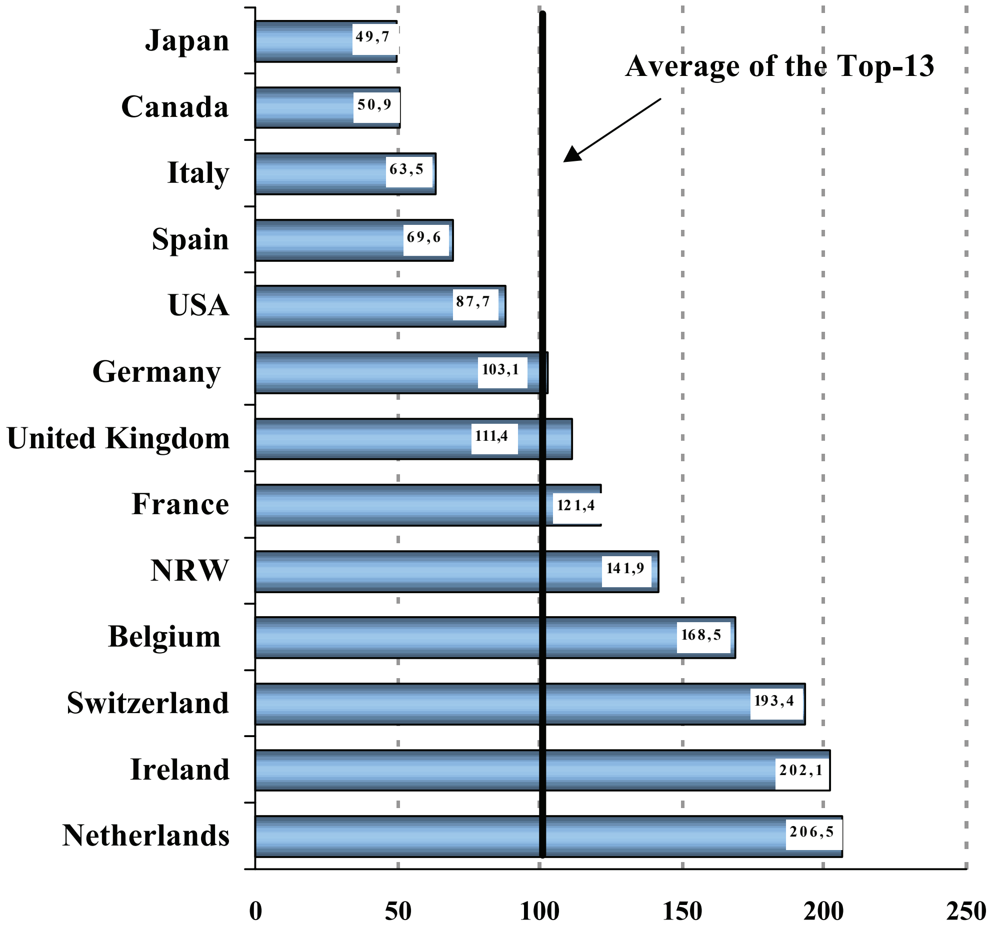
The chemical industry is one of the world's most important industrial sectors. Its importance can be attributed to its great share in the economic life as well as to its linkage with the other sectors. It supplies virtually all sectors of the economy and forms a virtual link in the value chain of every other industry. Plastics for packaging and durable goods, chemicals for electronics, active ingredients and performance materials for life sciences, consumer goods and automotive applications are just to name a few.
Furthermore, the chemical industry is one of the most R&D intensive industries and the innovations in the chemical industry keep opening up new fields of application and pave way to progress and innovation in other high-tech-industries like microelectronics, aerospace, telecommunications, car industry, biotechnology, material technology or medicine. It is also crucial for an integrated environmental strategy focusing on far reaching savings in material input and processing.

The chemical industry is a huge business in the world economy. The world chemical production in 1998 is estimated at 1.233 billion euro, nearly double size of the world market for information technology (including office equipment, electronic data processing equipment, software and services; 718 billion euro). Chemical products represent 12% of world exports of manufactures. A geographic breakdown of world trade for chemical production shows that three regions account for more than two third of the total chemical output: Western Europe, North America and Japan. With an estimated 357 billion euro, the EU chemical industry is the world's leading producer of chemical products and accounts for nearly one third of estimated world production. The USA and Japan are responsible for 28% and 15% respectively.

The chemical industry is one of the EU's most international, competitive and successful industries with a wide field of processing and manufacturing activities. Within the EU manufacturing industry, the chemical industry ranks first in terms of value added and second in terms of sales just behind the food and beverage sector. Furthermore, chemical industry accounts for 11% of manufacturing sales, 10% of value added in the EU. Throughout the EU, some 39.000 companies employ a total staff of about 1,7 million or 7% of the overall workforce in the manufacturing industry.

In the EU, Germany is the most important chemical producer in Europe, followed by France, the UK and Italy. Together, those four countries produce 67% of EU chemical output. Including the national industries of Spain, Belgium and the Netherlands this share would rise up to 89%. Belgium and the Netherlands are important producers of chemicals in Europe, particularly when the relative size of the countries is taken into consideration. The figure 3.1 highlights the degree of export specialisation of the Netherlands, Belgium and NRW reflecting a strong market position in the world.

Figure 3.1: Export specialisation in the leading 13-exporters in the world in 1998



Source: CEFIC, OECD; own calculations

The indicator[1] shows the extent to which a country‘s exports are specialised in a particular industry relative to the average of the all countries (in this case 13) under consideration. It is defined as the share of the exports of the chemical industry in the country‘s total manufacturing exports, divided by the share of the total chemical industry exports in the total manufacturing exports of the all countries. By definition, the average value of the indicator is 100. Accordingly, values greater than 100 indicate that the country‘s exports are relatively specialised in that industry.

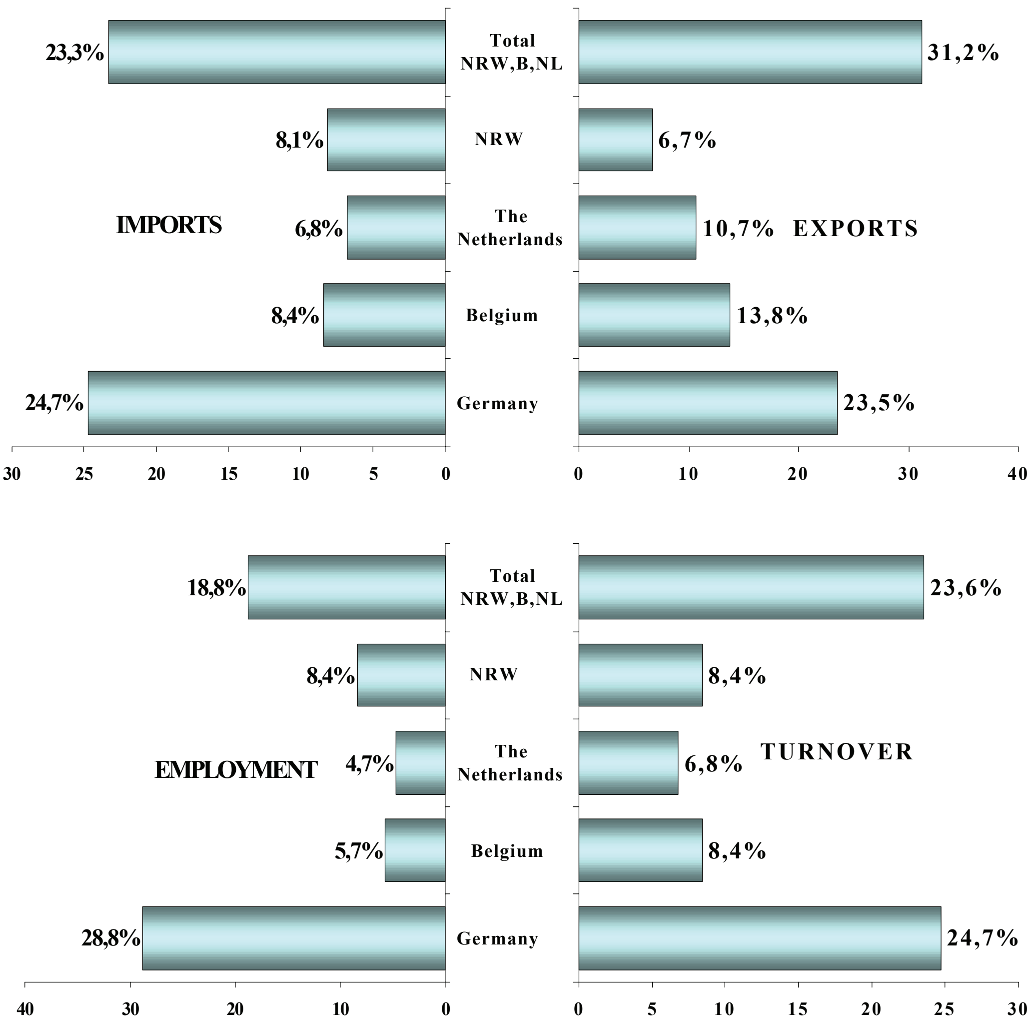
Taking other indicators into consideration, the market position of the Netherlands, Belgium and NRW in the world chemical production might be more apparent. The Dutch chemical industry is in the seventh place in terms of turnover in the EU and holds the ninth place in the world rankings**.** Belgium stands in the ranking before the Netherlands and has the fifth place in EU and seventh in the world. Accordingly, with a share of 8,4% of the total EU turnover in the chemical industry NRW would

[1] OECD: Science, Technology an Industry Scoreboard 1999

have the sixth place in the EU and eighth place in the world.

As shown in the following figure, the industrial performances of NRW, the Netherlands and Belgium on its own and taken together indicate a very strong competence in these locations compared with the chemical industry performance in the EU.

Figure 3.2: The relative Position in the European Chemical Industry.



Source: CEFIC, VCI, LDS 1998

Whereas NRW, Belgium and the Netherlands taken together account only for 11,7 % of the population of the European Union (15 countries), their chemical industry generate 23,6% of total turnover and is responsible for 18,8% of employment and 31,2% of the exports. In terms of export volumes they would even leave Germany behind reaching the first ranking in the EU. They account together for 23,6% of total turnover and would reach the second place after Germany in the EU and fourth place in the world demonstrating their strong position in the chemical industry in Europe as well as in the world.

Table 3.1: Share of the chemical sector in the European Union in 1998

	Turnover		Employment	
	In millions of euro	% of the EU	In thousands	% of the EU
Germany	95.186	24,7	484.600	28,8
Belgium	32.316	8,4	94.966	5,7
The Netherlands	26.084	6,8	79.100	4,7
NRW	32.421	8,4	141.094	8,4
NRW+BEL+NL	**90.821**	**23,6**	**315.160**	**18,8**
EU (15)	385.326	100	1.679.800	100

	Exports		Imports	
	In millions of euro	% of the EU	In millions of euro	% of the EU
Germany	62.055	23,5	37.914	17,7
Belgium	36.414	13,8	28.945	13,5
The Netherlands	28.338	10,7	19.378	9,0
NRW	17.624	6,7	8.986	4,2
NRW+BEL+NL	**82.376**	**31,2**	**57.309**	**26,7**
EU (15)	263.619	100	214.471	100

Source: CEFIC, LDS 1999

3.2.1. The Structure of Employment

As to the number of engaged, the chemical industry in these three countries has a dominant position in the total manufacturing industries.

Table 3.2: The Structure of Employment in the Chemical Industry

	Employment	Turnover in billions euro	Share in the Industry	
			Employment	Turnover
Belgium	94.966	32.316	*14,6%	*22,1%
The Netherlands	79.100	26.084	*9,5%	*16,3%
NRW	141.094	32.421	9,8%	14,5%
Total Employment	**=315.160=**			

*) 1997

The majority of employees are highly qualified in all three locations. The percentage of high school graduates or further qualified workforce is in comparison with the manufacturing industries in general over the industry average As known, the existence of well-trained workforce in this sector is very important, since only through qualified workers new products and production processes can be developed and consequently, market share would be gained.

Whereas the European chemical industry is dominated by small-and medium sized companies, the structure of firm size shows in NRW and in the Netherlands a little bit different picture. In NRW, the chemical industry is dominated by the great enterprises with more than 500 employees. These firms with a share of 13,5 per cent of all chemical enterprises in NRW employs more than 75 per cent of all workers in NRW and generates over 73% of the turnover in the chemical industry[2] There are over 420 companies, of which 301 are employing over 20 workers. Only 5,7% of the sites employ more than 1000 workers.

The Netherlands has more than 600 chemical companies, of which 250 has at least 20 employees. Three companies, Shell, Akzo Nobel and DSM are among the largest in this industrial sector. They are responsible for about half of the total turnover in the chemical industry and one third of the employment in the Dutch chemical industry. Companies with more than 100 employees are only 19 per cent, but they employ as of 1995 estimates more than 85,5 % of the workers in the chemical industry
On the other hand, the Belgium chemical industry is characterised by the importance of the layer of small and medium-sized enterprises. Although over 780 companies are engaged in this field, only 1% of the chemical sites employ more than 1,000 people. But they absorb more than one fifth of the total amount of jobs in the Belgian chemical industry. Furthermore, one fourth of the sites account for more than 80% of all jobs and about 75% of the chemical companies count less than 100 workers.

3.3. Sectoral and Geographical Breakdown

3.3.1 Geographic Breakdown of the Chemical Industry

The chemical industry is geographically concentrated. This concentration has its roots in the mid 19th century. The origins of concentration did depend on the neighbourhood of related industries (textiles, colours), on the access to raw materials and on the availability of labour and water (energy, transporting, processing, waste management). When chemical industry shifted to a petrochemical base in the course of the 1950s, petroleum supply and the nearness to international ports like Antwerp, Rotterdam or Hamburg became important too. Geographical concentration rose because chemical industry is characterised by a high level of joint production (Kuppelproduktion), that means, the different steps of the production chain are strongly interconnected and depend on each other. With another word, end- or by products of one company are the raw materials for another company.

Because of this high and standing level of concentration the importance of chemical industry differs from region to region. In NRW, Leverkusen, Wuppertal, Krefeld, Cologne, Erftkreis, Düsseldorf, Neuss and Recklinghausen (including Marl) are the most important locations in absolute terms (more than 6000 people employed). In relative terms, that means that the share of employment in the manufacturing is overall more or less the same. Nearly one third of 40 biggest companies have their headquarters in NRW.

[2] For Germany the same structure is observed: in 1995, 11,6% of the companies are employing 70% of the all workers in the chemical industry and are generating 70,3 of the total turnover.

Table 3.3: Geographic Breakdown of chemical industry in NRW 1998

Region	Employment	Share of employment. in manufacturing
Leverkusen	n.a.	more then two third
Düsseldorf	11.173	23,6
Krefeld	9.519	32,9
Cologne	8.659	12,5
Neuss	8.626	25,6
Erftkreis	8.473	33,2
Wuppertal	7.832	20,4
Recklinghausen	6.456	15,6
Rhein-Sieg	3.884	14,0
Münster	3.331	29,8
Unna	3.027	11,2
Gelsenkirchen	2.620	14,6
Duisburg	2.516	5,8
Oberhausen	1.845	18,7
Hamm	1.845	12,1

Source: LDS 1998

The chemical industry in Belgium is very evident in the Flemish Region. Two thirds of the total workforce are employed by the chemical industry in this region. About one fourth of the chemical production activity is located in Wallonia, against more than two thirds in Flanders, the latter being found for over 50% in the Antwerp port area. Brussels, with only a small percents of the production activity, is characterised by the presence of many headquarters and R&D, administrative, financial and commercial services, which represents 10,9% of the employment in the chemical sector. Starting with Antwerp, one of the most important petrochemical centres in the world, chemical industry is lined up along the length of the Albert Canal, the Rupel, and the river Scheldt. Although these three regions in Belgium have each their own specific characteristics, their economic interdependence remains very close. A large number of chemical companies are established in two or even three Regions in order to carry out complementary activities.

The Netherlands is the gateway of Europe for containers and bulk goods as wells as for chemical raw materials. The Port of Rotterdam, together with those of Singapore and Houston, is the largest transfer centre in the world for chemicals. The connection with the rest of Europe is maintained by several transport possibilities and by pipelines.

Table 3.4: Regional Breakdown of employment figures of the total chemical industry in 1998

	Factories	Jobs	Job share in the Region	Job share in Belgium
Flemish Region Total	516	62.760	100	66,1%
Antwerp	163	32,724	52,1	
East Flanders	128	10,539	16,8	
Flemish Brabant	119	9,043	14,4	
Limburg	50	6,269	10,0	
Westflanders	56	4,185	6,7	
Walloon Region Total	221	21,851	100	23%
Hainaut	82	8,348	38,2	
Liége	49	3,595	16,5	
Namur	19	1,503	6,9	
Luxembourg	8	1,471	6,7	
Walloon Brabant	63	6,934	31,7	
Brussels-Capital Region	209	10.355	100	10,9%
Total Belgium	**946**	**94.966**		**100**

Source: Fedichem 1998

Figure 3.3: Major locations of the chemical industry in the Netherlands: Number of Firms

1)	Rijnmond	50 Firms
2)	Amsterdam	25 Firms
3)	Limburg	25 Firms
4)	Zaandam	20 Firms
5)	Gröningen	15 Firms
6)	Delfzijl	12 Firms
7)	Arnhem	10 Firms
8)	Dordrecht	10 Firms
9)	Enschede	10 Firms
10)	Oorsterschelde	10 Firms
11)	Bergen op Zoom	5 Firms

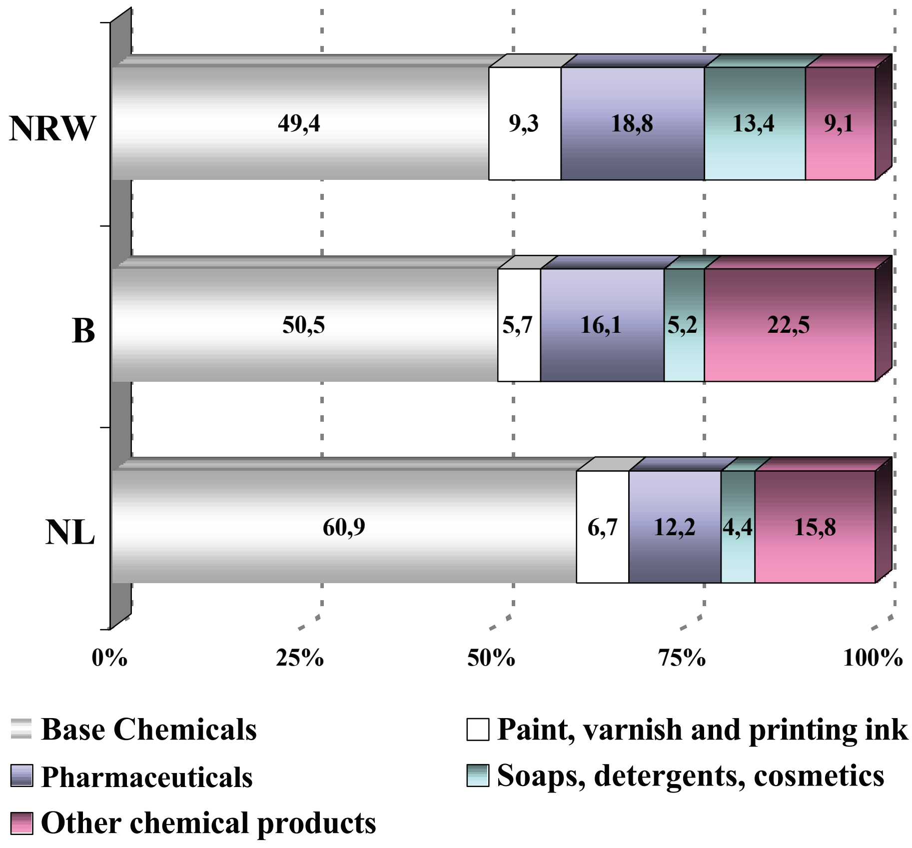
Source: Netherlands Foreign Investment Agency 1999

3.3.2. A SECTORAL BREAKDOWN: FEATURES OF SPECIALISATION

The chemical industry is actually an industrial branch of very heterogeneous character in which the main activities consist of transforming materials into diverse substances, giving them new physical and chemical properties. For these activities, the chemical industry employs raw materials from the petroleum, mining and extractive industries such as oil, minerals, metals and certain industrial products. The major share of the chemical products (33% on the European average) are further processed within the chemical industry itself. In other words, the chemical industry is its own largest consumer. In many instances, it is only after several processing stages that the product go outside consumers. Mainly basic chemicals require further treatment within the chemical industry itself in order to be converted into downstream chemicals. The big industrial consumers of chemicals are the metals, mechanical and electrical industries, textiles and clothing ,wood and paper and the automotive industry.

In statistical terms, basic chemistry, paints, varnishes; pharmaceutical products; soaps, detergents and cosmetics are the most important subbranches. Focusing on the impacts of a pipeline we look at basic chemistry. As to the definition, there are problems, because the production of basic chemicals is strongly integrated with downstream activities. For our purposes, nevertheless, it makes sense to concentrate on the statistical units differentiating between organic and non-organic chemicals.

Figure 3.4: Sectoral Breakdown of chemical industry in NRW, Belgium and Netherlands 1998, Turnover by subsector



The basic chemicals sector is characterised by the production of large quantities, by high entrance costs as far as investments in fixed assets and production orientated research are concerned. In general terms, we can say that basic chemistry's share in the chemical industry in NRW, in Belgium and in the Netherlands is over average compared with chemical industry in Germany or in Europe. The dominant position of the basic chemistry is connected with the location advantages resulting from the ports and refinery, from traditional production structure and related competence.

Within the basic chemistry in Europe, the petrochemicals industry represents more than two-thirds of the basic chemical sector and a quarter of the total chemical industry turnover. The petrochemical industry is defined as the industry that uses raw materials derived from oil or natural gas to manufacture products such as primary petrochemicals, ("first generation"): olefins (ethylene, propylene, butylene, butadiene, acetylene), aromatics (benzene, toluene, xylenes, naphthalene), methanol and synthesis gases (used for further synthesis of ammonia, methanol and "oxo" alcohols), petrochemical intermediates: vinyl chloride, acrylonitrile, cyclohexane, ethyl benzene, styrene, phenol, etc. and petrochemical products: plastics, synthetic fibres, solvents, surface active agents, additives, synthetic rubber, fertilisers and agricultural chemicals.

The petrochemical industry is concentrated mainly in Germany and the Benelux countries, which hold 27% and 25% of the Community's olefin cracker capacity of ethylene production, respectively, followed by France, the United Kingdom and Italy, with 18%, 15% and 12%. The EU is a major player in the world market for primary petrochemicals, being the largest producer of butadiene and benzene and the runner-up to the USA for the production of ethylene and propylene. At the end of 1997, there were 50 steam crackers operating in Western Europe, with annual capacities of 20 million tonnes. Total European production of propylene in 1997 amounted to 12,6 million tonnes. Among the derivatives of propylene, polypropylene accounts for 51,4% of demand for propylene[3].

Basic chemicals are transported via roads, railways, ships and pipelines. They are especially well suited for transportation by pipeline. There is for example a multi-pipeline route between Rotterdam and ports situated along the Schelde River, as well as a pipeline system for transporting ethlene between Rotterdam and Ruhr area. 80% of the basic chemicals produced in the Netherlands are processed by the chemical industry itself in order to manufacture intermediate and semi-finished products.

[3] APPE Activity Review 1997-98

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3.3.3. THE CHEMISTRY TRIANGLE THE NETHERLANDS, BELGIUM AND NRW

3.3.3.1. Trade Flows within the triangle

The chemical industry is of great importance in the economies of these three locations. In terms of export volumes, the chemical industry is the second largest industry in the Netherlands and Belgium and the largest industry in NRW. In all these three, the trade in chemical industry generates a positive trade balance. It is one of the most global industry sectors. Looking at the export/turnover ratio would make this evident. Over 80% of the chemical products produced in the Netherlands are exported. This ratio is for Belgium over 64% and for NRW only 54%.

The structure of the geographic breakdown of trade flows shows that the European Union accounts for the huge share of the total exports. For Belgium the major trade partners are Germany, France and the Netherlands totalling up to 60% of Belgium's intra-Europaen exports in chemicals. The European Union accounts for three quarters of the total imports of chemicals in Belgium. Within the EU, especially the neighbouring countries are the main trade partners accounting for 47,8% of the total imports of chemical products in Belgium. Germany and the Netherlands together accounts for 29,8% of exports and 32,8% of imports of the chemical products in 1998.

Similarly, the Netherlands and Belgium are among the most important trade partners for NRW. Belgium and the Netherlands dominate the imports with a share of 16% and 15,5% respectively. NRW exports are, however, directed to other European countries and to the USA. By this way, it becomes evident that the Netherlands and Belgium are responsible mainly as supplier for the chemical industry in NRW. As to the trade structure of the Netherlands, over 71% of the exports and 76% of the imports in the chemical industry take place within the European Union. Germany and Belgium belong to the main trade partners.

Figure 3.5: Most important trade partners in the chemical industry, NRW

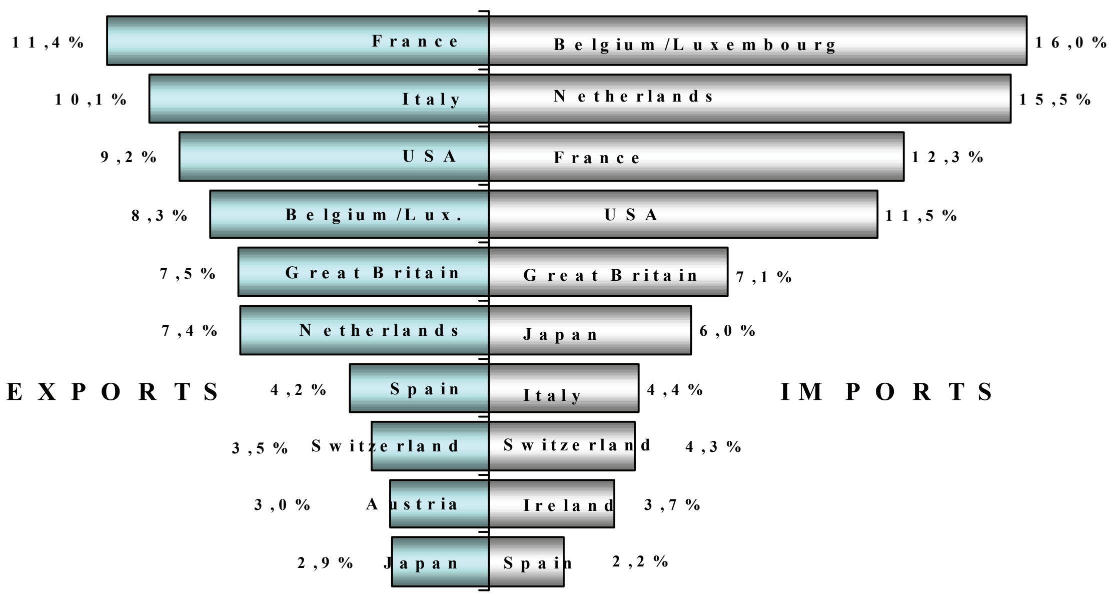

Figure 3.6: Most important trade partners in the chemical industry, Belgium

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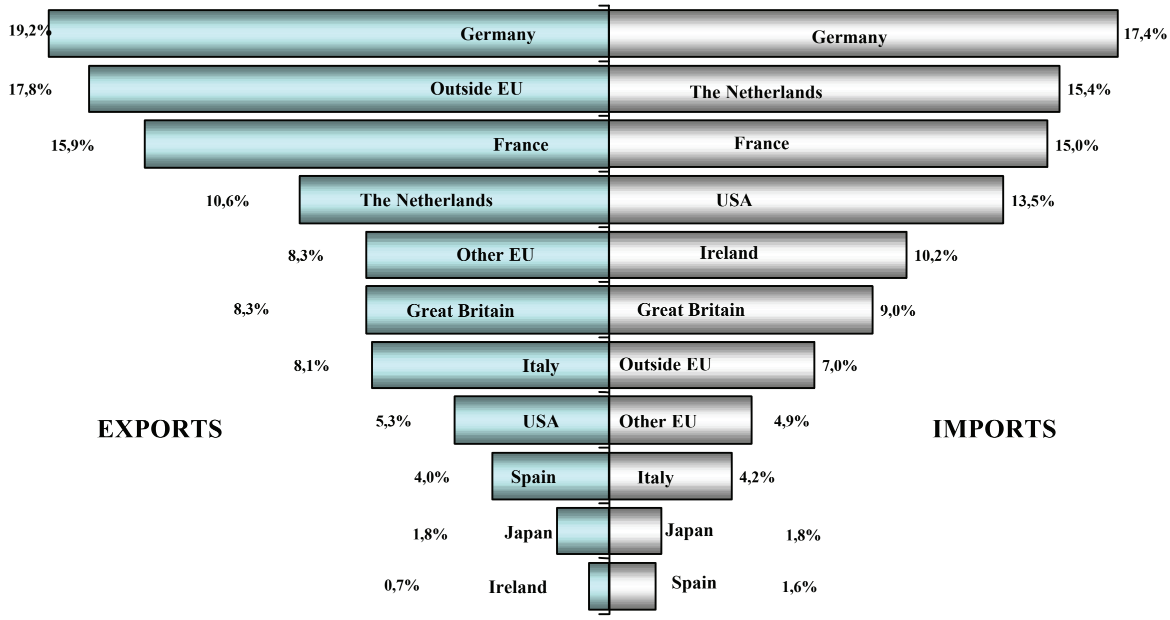
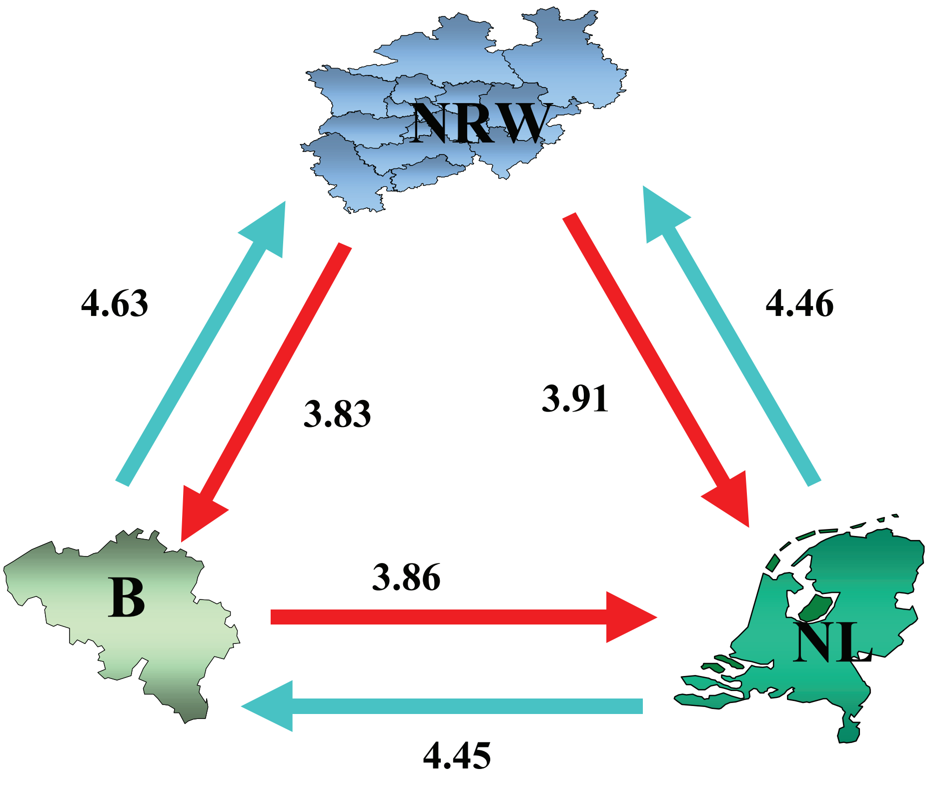


These regions are connected with each other in many aspects with a long standing and dense relationship. The dimensions of the connections cover all the fields of activities. From the point of NRW: Belgium and the Netherlands are the most important suppliers of chemical products in NRW: one fourth of chemical imports in NRW stems from Benelux. Related to NRW exports the evidence is less impressive: one eight of exports are leaving for Benelux.

Figure 3.7: Export and Import of the chemical products within the triangle Netherlands, Belgium and NRW in 1998 (billions of euro).



Source: LDS 1998, Fedichem 1998

The figure is quite different if we look at single products. Two third of NRW's imports for olefine (ethylin, porpylene, butylen, butadien) origin in Benelux, the share in exports is about 60 %.

Table 3.5: NRW imports and Exports in Olefine (in 1998)

	Imports (in 1000 Euro)	Exports (in 1000 Euro)
Belgium	3.233	14.876
Netherlands	14.135	5.985
Total NRW	25.587	33.267

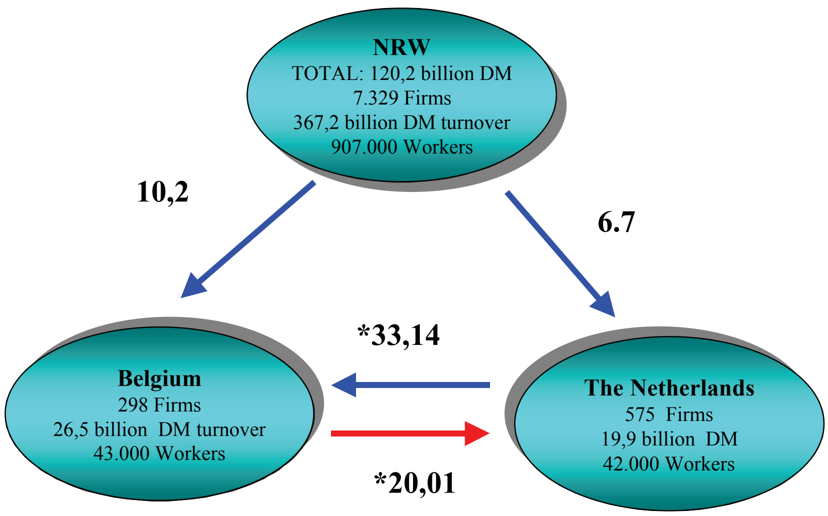
3.3.3.2. FDI-flows

In terms of Foreign Direct Investments these regions are intertwined to a great extent. In Belgium and in the Netherlands, foreign direct investments play an important role in the national economy as well as in the chemical industry. Since 1960's, a characteristic of the chemical industry in Belgium has been the substantial amount of foreign investments it has attracted. During the last 40 years, chemical companies with foreign capital accounted for about three-quarters of the total investments achieved by the sector in Belgium. These same companies represented two thirds of the total chemical employment.

In the Netherlands, 6804 foreign-owned companies are operating and employing 394.900 workers in 1998 in the overall economy. Over 60 % of investors stems from the Western Europe and 27% from the USA. Hence, the Netherlands is the number eight recipient of foreign direct investments in the world. Foreign companies in the Netherlands account for approx. 20% of industrial production and 21% of employees and nearly one fourth of industrial investment. Of the Fortune top 300 (industrial giants) nearly 50% have an affiliate in the Netherlands; 30% of the total number operates a manufacturing plant that account for 10% of the Dutch industrial employment. 1.159 German firms with 51.000 workers are operating in the Netherlands. For Belgium amount these figures to 10.000 workers and 281 firms.

In general, direct investment flows abroad give an indication of the international orientation of a country. The amount of inward investment is a reflection of the attractiveness of an economy as a location. Equally, a steady flow of outward investments shows the strength of an economy that is generating surplus resources. Ratios of investments to GDP provide a measure of the relative scale of international activity of a country. This ratio amounts to 5,65% in the Netherlands, 3,31% in Belgium and 1.58% in the Germany. It is interesting to note that the Netherlands and Belgium are not only investing abroad, but also they are very attractive for foreign investments. In relation to the GDP, the ratio of received investments amounts for Belgium to 59,1%, the Netherlands to 36,2%. For Germany it is only 6,6%. Although NRW is a strong investor abroad, but it receives only very small amount of foreign direct investments. The following figure shows the investment flows between NRW, Belgium and the Netherlands.

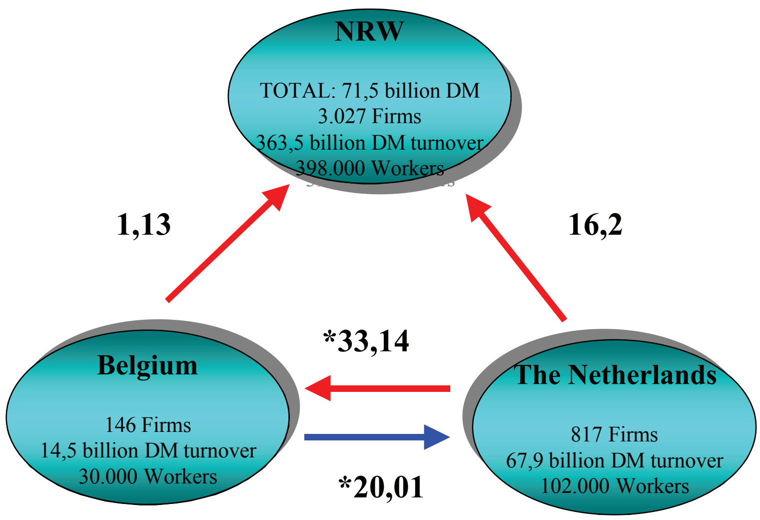
Figure 3.8: Foreign Direct Investments between NRW, Belgium and the Netherlands in 1997, Outward Position in billions of DM



*) 1995

As of 1997, the stock of FDI from NRW to all countries reached 120,2 billion DM. 8,5% of which has flown to Belgium and 5,6% to the Netherlands. 298 firms in Belgium and 575 firms in the Netherlands stem from NRW.The inward flows to NRW are less impressive. As shown in the following picture, only 71,5 billion DM has been in NRW invested. From the total of all direct investments in NRW, only less than 5 % are directed to the chemical industry.

Figure 3.9: Foreign Direct Investments to NRW in 1997, Inward Position in billions of DM



*) 1995

Only 1,5% of the all foreign direct investments are coming to NRW from Belgium. For the Netherlands this rate amounts to 22,7%. Hence, the Netherlands is one of the biggest investors in NRW. Belgium has 146 firms and the Netherlands 817 firms engaged in NRW. The chemical industry NRW investments abroad amounted to 26,1 billion DM in 1997.This makes 21,7 % of all investments. In return, NRW received only 4,4 billion investment for the chemical industry in 1997, which makes only 6% of all foreign direct investments in NRW.

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3.3.3.4. Chemical industry facing restructuring – trends and options

As shown in the previous section, the chemical industry has a central position in terms of employment, trade balance and value added within the economies of the Netherlands, Belgium and NRW. The chemical industry accounts for 315.000 workers employed and various locations depend heavily on the chemical industry. Further, like no other regions in Europe, the Netherlands, Belgium and NRW are closely connected with each other in various spheres of the economic activities, especially those relating to the chemical industry. As to the chemical industry, they have a similar industrial structure, which is characterised with a predominant position of the production of basic chemicals accounting for more than half of the total turnover within their chemical industry.

Recently however, basic chemical industry is coming increasingly under stress mainly in two aspects. First, basic chemical products in general are confronted increasingly with a cost competition. The pressure for the chemical industry in the EU as well as in the Netherlands, Belgium and NRW are coming from the new producers in the world scene. Although worldwide new markets for the chemical products are opening up, especially in the Far East, Middle East and South America -it is estimated for example that by 2010 Asia will represent almost 40% of the global demand for chemicals- local factories in these countries are also being set up, that are likely to compete strongly with the European companies, whose cost they can undercut. Asian competitors and Middle Eastern producers expand aggressively their capacity with a view to entering new export markets, including Western Europe. The penetration of these competitors into Europe is happening not just through imports but also through direct investments. As a result, chemical prices are increasingly set on a global basis.

Second, basic chemical industry faces stress resulting from a general trend in restructuring the chemical industry. In this context, four aspects are important to understand the trends regarding the future developments of the production of basic chemicals.

- There is a shift in chemical industry from petroleum base to biotechnology base. The great companies are rationalising and restructuring to reduce costs and reorganising themselves around "life science" as core business. They are concentrating on diversification and turning towards biotechnology based sectors, especially pharmaceutics, agro-chemicals and food processing.
- During the course of the formation of life science companies other branches of chemical industry are sold and forced to reorganise, too. One consequence is a rising concentration in those branches outside of "life-science". The other one relates to the risk that opportunities for innovation in those branches will be eventually neglected.
- Following organisational disintegration, especially basic chemistry runs danger to loosen the ties with the downstream parts of the production chain. Traditional joint production becomes weak and chemical production complexes become to disintegrate. This could be a great problem because benefits from joint production can reduce cost and contribute to the attractiveness of a location.
- Nevertheless, basic chemicals is by no means an old industry. About one fifth of people employed in new founded chemical companies are engaged in basic chemicals (see figure 10), basis chemicals account for further innovations in economic as well as in ecological terms, and not and least, basic chemicals can be a strong base for innovation in special chemicals.

Figure 3.9: Share of the employment in the new established firms in Germany in 1997

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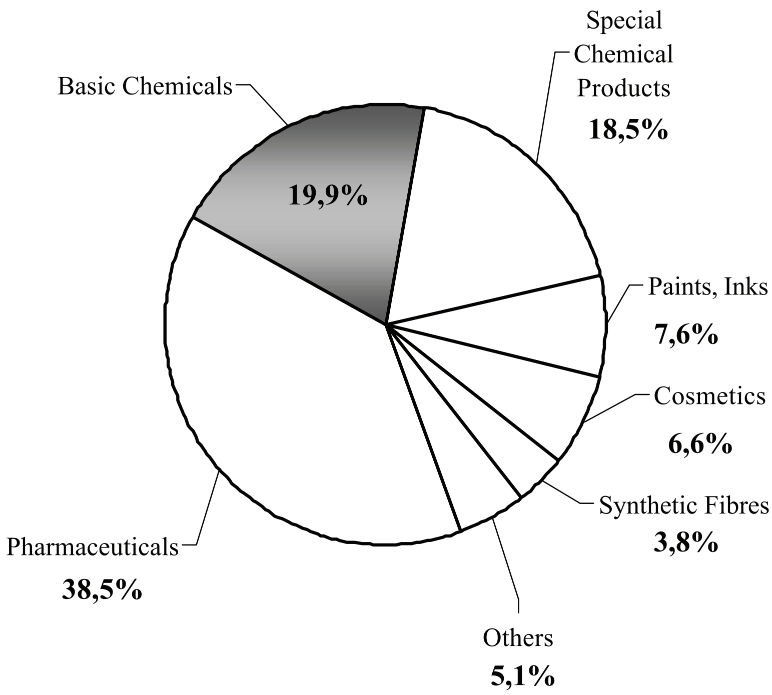

Source: Arthur D Little "Beschäftigungseffekte von Innovationen der deutschen chemischen Industrie"

The result is that basic chemical production is under rising stress and it runs danger not to mobilise its potential in innovation and employment Then the key question is how to stabilise and support innovation in basic chemical industry.

Most sectoral studies suggest that the future of the chemical industry for basic chemicals lies in setting up strategic partnerships between chemical manufactures and supplies of logistic services (transportation, storage and distribution). Excellence in logistic management is one of the most decisive areas of competitive advantage where European chemical companies can reduce costs and create competitive advantages. This goes hand in hand with stronger development and integration of partnerships among the producers.

It has been usually argued that cost-disadvantage of the European petrochemical industry can be traced back to the absence of an extensive pipeline network for the key raw materials like olefins, such as propylene. Such a network exists for example on the Gulf Coast of the United States. The construction of propylene pipeline as proposed would enable chemical companies to improve their cost structure. The companies can, moreover, increase end-consumer satisfaction through improved delivery reliability and service at lower cost. They can simplify internal supply chain and focus more on core business. Flexibility and adaptability would be increased, leading to improved competitiveness and greater profitability. Other benefits would include improved control, decreased safety risks and a more consistent image.

3.3.4. FUTURE SCENARIO'S

Pipeline is thus one of the most strategic possibilities to answer the challenges coming from the new centres of growth. By this way, it would enable the chemical industry in the Netherlands, Belgium and NRW not only to reduce costs but also to attract new companies in line with the downstream processing to settle down nearby, which could lead to emergence of new clusters of production. The existence of infrastructure, opportunities of share utilities, waste disposal facilities are essential for the emergence of such clusters. Apart from logistical and financial advantages, such clusters would pave way to further innovations and progress with a far reaching effects on the growth and new employment in the regions in question.

Basing on these arguments three options (scenarios, but not quantitative ones) can be grouped around the impacts of a pipeline. Of course pipeline is only one, probably a crucial one, and it stands for joint efforts to strengthen the infrastructure for the competitiveness of basic chemistry in the regions.

I: Disintegration (no pipeline)
In this case chemical companies strengthen global sourcing and therefore local materially joint production will gradually loosen. The result is a continuing trend in production and job loss in the core production regions. Agglomeration effects basing on the joint production will be reduced and this will accelerate the trend in disintegration. First of all, the problem is a social one. Companies have the choice between disintegration and strengthening of the local productive base. From a regional point of view the decision is: is basic chemistry an industry with a future (innovative potentials) or is it an "old" industry like steel and mining. If the first alternative is the case, the task is to support diversification away from basic chemicals. If the second alternative is the case (and there are good reasons for this assumptions) regions ought to support the productive base for basic chemicals.

II: Stabilisation (pipeline)
As mentioned above, pipeline stands for attempts to strengthen the regional base for basic chemistry. A pipeline commits to longstanding and secure support and infrastructure. Companies can rely on it and have a stable framework for further expansion in the given locations. Nevertheless, due to ongoing rationalisation, employment will go down moderately even if there is some inward investment. Maybe for the companies there is no significant difference, they have to compare the benefits from the regional productive base with the benefits from global sourcing. But for the regions the difference is crucial in social terms.

II: Innovation (pipeline plus)
In this case setting up a pipeline goes hand in hand with attempts to support regional innovation activities following the pipeline, the ChemSite concept. In this case the pipeline is basic for the infrastructure and it can be seen as a base for further innovation. Companies could benefit from synergies and agglomeration advantages if the use the regional base for innovation, following inward investment and improved innovated infrastructure. In this case, employment could be stable, maybe growing in a moderate way.

Without any doubt, facing employment aspects, this third option in the long run is the most attractive one for public as well as for private actors. It could be realised only in the way of a joint activity committed to a strong improvement of the attractiveness of the locations depending on basic chemicals and a pipeline, organised as a common carrier, could be an important starting point.

3.3. IMPACTS ON SOCIETY

3.3.1. MODAL SHIFT

Realisation of the Benelux-Cologne-Gelsenkirchen propylene pipeline will influence the modal split of propylene flows. At this moment the propylene pipeline network consist of two separate networks, one between Rotterdam, Antwerpen en Beringen (Dutch-Belgian part, pipeline section 1-6), and one in the Ruhr-area (German part, pipeline section 9-16). Transportation in between is carried out by barge and/or by train. The proposed project consist of building the missing gap, the Bering-Geleen-Köln section (section 7-8, 135km).

For the Köln-Oberhausen-Scholven-Marl section (section 9-10-11, 120km) there will also be a new pipeline. The existing one has a different standard and cannot be used. In the next table, the present and future propylene flows for each section are presented. Flows are in kilotons.

Table 3.6: Propylene flows (in kiloton) in the ARG-area in 1997, 2002 and 2010

section	distance	from-to	volume		
			1997	HE 2002	HE m 2010
1		Rotterdam-Moerdijk	740	1000	1280
2		Moerdijk-Antwerpen	340	530	530
3		Terneuzen-Antwerpen	300	360	500
4		Feluy-Antwerpen	400	700	1035
5		Antwerpen-Geel	950	1460	2140
6		Geel-Beringen	605	960	1700
7	45	Beringen-Geleen	285	640	1525
8	90	Geleen-Köln	305	585	1165
9	82	Köln-Oberhausen	335	505	715
10	28	Oberhausen-Scholven	435	405	375
11	10	Scholven-Marl	415	515	620
12		Scholven-Herne	55	55	55
13		Oberhausen-Rheinberg	15	15	0
14		Oberhausen-Moers	0	85	80
15		Köln-Knapsack	65	135	595
16		Knapsack-Wesselinck	305	365	665

Source: ARG, 1999.

In 1997, propylene shipments by barge and train between the two networks accounted for 93.4 million tonkilometres. Table 3.7 gives an overview:

Table 3.7: Propylene flows (in kiloton) by barge and train in the ARG-area in 1997.

from	to	volume	distance (km)	present mode
Antwerpen	Geleen	60	120	barge: Albertkanaal-Julianakanaal
Antwerpen	Marl	150	330	barge: ScheldeRijnverbinding-NieuweMerwede-Waal-Rhein
Gelsenkirchen	Geleen	20	200	rtc: Gelsenkirchen-Venlo-Geleen
Köln	Geleen	20	90	barge: Rhein- Maas-Julianakanaal
Köln	Geleen	80	90	barge: Rhein-Maas-Julianakanaal
Moerdijk	Köln	30	265	barge: NieuweMerwede-Waal-Rhein
Pernis	Marl	45	270	barge: NoordMerwede-Waal-Rhein
Wesseling	Geleen	40	90	barge: Rhein-Maas-Julianakanaal

Source: ARG, 1999

As propylene is transported by barge and RTC, but not by trucks, congestion on roads will not be affected. Operation of the proposed pipeline at full capacity will result in a decreasing number of barges on the Waal, Maas and Albertkanaal and trains on the route Gelsenkirchen-Venlo-Geleen.
A Rail Tank Container has a volume of about 75m3. This is approximately 2000 tons of propylene for a whole train. owadays, between Gelsenkirchen-Geleen 20000 ton/year is transported, this is about 10 RTC transports per year (for the present situation). These transports will be skipped when the pipeline is fully in use.
A barge can carry up to 2000 tons of propylene. Full operation of the pipeline will cause a decrease in the number of barges on the Merwede-Waal with 110/year, on the Maas-Julianakanaal with 70/year and the Albertkanaal with 30/year.

The construction of the pipeline will be finished in 2004. By then, about 50% of the quantities will be transported by the propylene pipeline. In 2010, it will be fully operational. Base is the scenario Healthy Europe with a midinland cracker. The amount of transported product will increase by 4.5% per year, 77% between 1997 and 2010.

3.3.2. Reduction of Emissions

In 1997, the total amount of tonkilometres by barge was 89.4 million whereas 4.0 million tonkilometres was transported by rail. Given the emissions per tonkilometer (tabel 2.7) the totale amount of emissions can be determined. Calculations show that emissions from rail and barge amount up to 4.1 ton of carbon dioxide, 71.7 kilogram of nitrogen oxides, 3.7 kilogram of carbon monoxide, 3.6 kilogram of volatile organic compounds, 5.4 kilogram of sulphur dioxide and 4.5 kilogram of particles. In 2010, these figures have increased by 77%.

Table 3.8. Emissions by rail and barge in 1997 and 2010 (in gram)

	1997			2010		
	rail	barge	total	rail	barge	total
CO_2	176000	3933600	4109600	311520	6962472	7273992
NO_x	1120	70626	71746	1982	125008	126990
CO	80	3576	3656	142	6330	6471
VOC	40	3576	3616	71	6330	6400
SO_2	80	5364	5444	142	9494	9636
particles	40	4470	4510	71	7912	7983

If the existing transport flows by rail and barge will be replaced by pipeline a substantial reduction of emissions will be realised. The 1997 emissions would be 1.6 ton lower for carbon dioxide, 68.9 kilogram for nitrogen oxides, 3.4 kilogram for carbon monoxide, 3.5 kilogram for volatile organic compounds, 4.2 kilogram of sulphur dioxide and 4.5 kilogram of particles. For 2010, these quantities can be multiplied by 1.77.

3.3.3. Safety

In the new pipeline system area, not only risk bottlenecks exist at transport nodes and production sites. Especially near Geleen and Cologne, the network capacity on inland shipping and railway must be assessed. The railnetwork capacity in the area is problematic and local railway risk issues exist near shunting areas and at stations, where interference with other transport services may occur. The question arises whether railtransport is capable of accommodating the required growth in traffic flow under the present conditions and network capacity. Although capacity issues do not exist in barge transport, this transport mode deals with risk contour issues as well as a part of the Dutch national policy on risk mitigation.

Additional requirements may be posed on the choice by environmental and safety issues. Such issues arise from two sources:
- a general risk assessment by national policy constraints, expressed in individual and group risk standards
- local issues arising from specific spatial and environmental constraints such as population density and vicinity of housing to the transport system.

Dutch legislation has elaborated these risk issues for all modes of transportation. Consequently, risk based restrictions are posed upon the growth of propylene transport.

Based on the anticipated propylene flow prognoses, the required additional transport capacity can be compared with the potential of each modality to accommodate this demand. The modality capacity estimates are based on the guidelines for external safety during transport of hazardous material (ref).

Rail:
To fulfil the risk standard requirements, a maximum train capacity of 7000 tank wagons per year on the free track is allowed. With a standard unit size of 40 tons, the allowed capacity is limited to 280 kt. For shunt yards a specific risk assessment framework is applied by the PAGE protocol. The PAGE standards indicate that at the Sittard marshalling yard individual and group risk bottlenecks exist. Urban planning and expansion will increase this group risk considerable. The railway track around Geleen accommodates already a substantial amount of hazardous material, while increase of passenger transport is planned.
In conclusion: the present railway capacity could be increased to 280 kt irrespective of other risk capacity claims on the railways, but will only be marginally sufficient to accomodate the intended growth in the various scenarios.

Barge:
The Julianakanaal and port of Stein are used as the main shipping fairway for propylene transport. The canal is a class 5 canal, indicating a maximum vessel capacity of about 1500 tons. According to the Guidelines, propylene transport movements will be restricted to 1350 vessels per year to comply with the risk standards. The overall transport capacity by barge is therefore limited to 2025 kt, not taking into account other barge transport claims in the area.
In conclusion: barge transport has capacity to accomodate the growth partially, depending on other risk capacity claims in this barge transport area.

Pipelines:
A general risk estimate according to the Guidelines indicate that further risk assessment is required. Due to the relatively large pipe diameters and pressures a more detailed QRA is necessary. Also the group risk depends on the population density and distribution in the area. Spatial zoning ciriteria must be assessed and possible local bottleneck identified. No capacity constraints are noted.
In conclusion: combined with the fact that pipeline risk performance is almost independent from capacity, no further risk limitations seem to be imposed on pipeline facility growth in the future. Pipelines are capable of accommodating the growth in propylene transport.

In addition to the risk performance of each modality, a comparison of the risk management structures can be made. Risk management differs widely between the modes. Major differences in risk awareness, risk control strategies and managerial , organisational and institutional differences exist across the modes. Due to the nature of the pipeline sector with high performance private companies, the safety level is very high compared to the other modalities. Contributing factors are:

- The accident rate is low compared to the railway and inland shipping modes, although inland shipping quality has improved considerably over the last decade. In contrast with railway and inland shipping the pipeline sector has a low consequence profile with respect to fatalities and injuries in minor events.
- Safety is an integrated aspect in quality control and monitoring of operational performance within each company, fitting in the safety culture of the process industry
- The existence of a framework of international regulations with respect to design, construction, storage and transfer of hazardous materials which are integral incorporated in company policies.
- A pro-active approach, combining deterministic and probabilistic methods. The centralized flow control in pipeline systems facilitates an event data recording and analysis which does not yet exist in other modes.
- Wide application of ICT developments, supplying a transparent and affluent flow of information and diagnostic potential for process monitoring and control at a network level.

CHAPTER 4 PUBLIC PRIVATE PARTNERSHIP

Extensive pipeline networks for chemical products emerged in NW Europe mainly during the 1960's and 1970's (BIG, 1996). Pipelines for long distance transport of crude oil were among to first to be established, commodities like LPG were soon to follow. As the petrochemical industry continued to grow, a more dense networks for a variety of products appeared. In general, governments do not invest in pipeline systems but water and natural gas. In the past, most pipelines were built by a (petro)chemical company or a joint venture of firms. Nowadays, the chemical sector is sticking to its core business and is not (so much) interested in building pipelines.

Besides the logistical advantages to the chemical industry such as lower transportation costs and increased flexibility, pipelines have advantages to the society as well. As a result of a better competitive position, the downward trend in employment might be adjusted. Moreover, compared to other modes of transport, pipelines offer reduced energy consumption and emissions, lower noise levels, increased safety and no scattered landscape. Of course, some temporal disadvantages during the construction phase occur. Table 4.1 gives an overview of the most important (dis)advantages.

Table 4.1: Advantages and disadvantages of a modal shift towards transport by pipline

	chemical sector		society	
	advantage	disadvantage	advantage	disadvantage
Construction of pipeline (temporary)				
- inconveniences				x
- employment			x	
Pipeline in operation				
- transportation costs	x			
- flexibility in production	x			
- safety	x		x	
- energy use and emissions			x	
- noise			x	
- land use				x
Economic impacts				
- competitive position	x		x	
- employment			x	

In order to evaluate the above mentioned (dis)advantages of the pipeline project, a comprehensive social cost benefit analysis should be carried out (EC, 1998). Basically, the four ways of assessing the costs and benefits of transport are:

- Direct monetary costs

these costs are the easy to calculate as they are quantifiable costs to individuals or companies. Transport tariffs are an example of direct monetary costs.

- Indirect monetary costs

like direct monetary costs, these are quantifiable costs but do not appear in accounts. Loss of output due to fatalities can serve as an example.

- Avoidance costs

this approach can be used for (among others) determining the marginal costs of reducing emissions below a certain level. The Institute of Applied Analysis calculated the polluter's financial liability 1,000 - 2,500 Euro per ton of SO_2 , 4,800 Euro per ton NO_x (and simultaneously VOC). For the propylene pipeline this method can also be used to calculate the costs of removing the bottlenecks in rail infrastructure (marshalling yards).

- Willingness to pay

this approach is applicable if a sum of money makes up for any sort of discomfort. An renowned example is lower house prices due to disruptive noise.

Whatever approach is applied, many choices remain arbitrary. Only (in)direct monetary costs are more or less straightforward to calculate. This leads to the conclusion that, at the moment, there is no viable scientific method to assess and distribute the (dis)advantages over the parties involved.

Recently, a study on investment in infrastructure by the private sector was published (ABN/Amro, 1997). Usually infrastructure projects are not interesting from a financial/economic point of view. In practice, their yield doesn't even cover the investment costs. In order to realise a specific infrastructure project a Public-Private Co-operation is suggested. The private sector should take their share based upon commercial considerations; the rest should be financed by the public sector. The amount of investment accounted for by the public sector is an indicator of the social benefits of the project.

In this particular case the public financial contribution accounts for one third of the total investment cost. The advantages of the project to society are recognised as reduced energy consumption and emissions, lower noise levels, increased safety and no scattered landscape. Moreover, as a result of a better competitive position, the downward trend in employment might be adjusted and the regional base is strengthened. These benefits to society coincide with the aims policy makers defined for pipelines (IPOT, 1999). Hence, the new Benelux-Cologne-Gelsenkirchen propylene pipeline is eligible for government funding.

DRAFT

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ANNEX Calculations in relation to the reduction of emissions

Shipped volumes by barge and rail in 1997

from	to	quantity	distance (km)	tonkm	present mode
Antwerpen	Geleen	60000	120	7200000	barge: Albertkanaal-Julianakanaal
Antwerpen	Marl	150000	330	49500000	barge: ScheldeRijnverbinding-NieuweMerwede-Waal-Rhein
Gelsenkirchen	Geleen	20000	200	4000000	rtc: Gelsenkirchen-Venlo-Geleen
Köln	Geleen	20000	90	1800000	barge: Rhein- Maas-Julianakanaal
Köln	Geleen	80000	90	7200000	barge: Rhein-Maas-Julianakanaal
Moerdijk	Köln	30000	265	7950000	barge: NieuweMerwede-Waal-Rhein
Pernis	Marl	45000	270	12150000	barge: NoordMerwede-Waal-Rhein
Wesseling	Geleen	40000	90	3600000	barge: Rhein-Maas-Julianakanaal
				93400000	

Emissions by mode (1997)

			without pipeline				**with (virtual) pipeline**	
	rail (4 million tonkm)		barge (89,4 million ton)				pipeline (93,4 million tonkm)	
	g/tonkm[1]	total (kilogram)	g/tonkm	total (kilogram)	grand total (ton)	g/tonkm	total (kilogram)	nd total (ton)
CO_2	44	176000	44	3933600	4109,6	27,20	2540,48	2,5
NO_x	0,28	1120	0,79	70626	71,7	0,03	2,8954	0,0
CO	0,02	80	0,04	3576	3,7	0,00	0,2802	0,0
VOC	0,01	40	0,04	3576	3,6	0,00	0,0934	0,0
SO_2	0,02	80	0,06	5364	5,4	0,01	1,2142	0,0
particles	0,01	40	0,05	4470	4,5	0,00	0	0,0

1) mix of electric (70%) en diesel electric (30%) traction

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Shipped volumes in 2010, HE-scenario (+ 77%)

from	to	quantity	distance (km)	tonkm
Antwerpen	Geleen	106200	120	12744000
Antwerpen	Marl	265500	330	87615000
Gelsenkirchen	Geleen	35400	200	7080000
Köln	Geleen	35400	90	3186000
Köln	Geleen	141600	90	12744000
Moerdijk	Köln	53100	265	14071500
Pernis	Marl	79650	270	21505500
Wesseling	Geleen	70800	90	6372000
				165318000

Emissions by mode (2010)

	without pipeline					with pipeline		
	rail (7.1 million tonkm)		barge (158.2 million tonkm)			pipeline (165.3 million tonkm)		
	g/tonkm[1]	total (kilogram)	g/tonkm	total (kilogram)	grand total (ton)	g/tonkm	total (kilogram)	total (ton)
CO_2	44	312400	44	6960800	7273,2	27,20	4496160	4496,2
NO_x	0,28	1988	0,79	124978	127,0	0,03	5124,3	5,1
CO	0,02	142	0,04	6328	6,5	0,00	495,9	0,5
VOC	0,01	71	0,04	6328	6,4	0,00	165,3	0,2
SO_2	0,02	142	0,06	9492	9,6	0,01	2148,9	2,1
particles	0,01	71	0,05	7910	8,0	0,00	0	0,0