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Tactical study E313 – calculating future scenarios for freight transport

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Key logistics drivers

Literature reviewed

A total of 32 references were used as the initial basis for the analytical review (See References). Among the publications selected, four are global in scope, 20 have a European focus and 8 are regionally or country-specific with two of them referring to particular regions in Europe and 4 of them to countries outside Europe (USA, Japan and Australia).

The majority of studies analyze the effect of social, technical, economic and political trends in the transport industry as a whole. This is especially true for the European studies that are concerned with the effects of mode shift and mode split policies. However the studies that develop scenarios for a particular sector of the transport industry have a land-based emphasis (road/ rail), as can be observed in the work developed by McKinnon and Woodburn (1996), Dalla Palma R. *et al.* (2001), Sauer (2002), Matzos *et al.* (2003);(2004) and OECD (2006).

The literature reviewed takes different approaches to developing future scenarios and it considers several time frames for the analysis. However, several of the European projects analyzed together with a considerable number of papers take 2020 as the time horizon. For example, the work performed by Singh (2004), Banister D. *et al.* (2000a), Dalla Palma R. *et al.* (2001), Bertrand G. and Rood J. (2000) as well as projects like Scenes take 2020 as the appropriate time perspective.

In terms of approach, some of the documents opt for a purely qualitative analysis while others use forecasting techniques combined with qualitative assumptions and analyses of certain factors like policy to develop future scenarios.

Qualitative approaches

In the qualitative approaches, coherent stories about possible future scenarios were constructed based on the interpretation of how certain forces and trends (key drivers) could evolve and determine different future socio-economic and operational realities of a region, a country, an industry or at a global scale. In the work developed by Bertrand G. and

Rood J. (2000) for example, different economic and market factors together with considerations over security matters as well as the geopolitical situation of Europe are combined to develop four different scenarios over how Europe will be structured in 2010 and 2020.

In the same line, the Queensland Department of Transport and Main Roads developed in 1999 four different scenarios of how people, goods and services could be connected and moved in 2025, if different considerations were taken into account, for instance, including among other population levels, economic growth, urban development and infrastructure investment.

On the other hand, economic, transport and maritime outlooks like the ones performed by the OECD (2007) and the Institute of Shipping Analysis, Göteborg *et al.* (2006) as well as the analysis performed over the evolution of shipping (Grammenos (2002)) focus on establishing a specific image of the sector's future or business they are analyzing based on key economic, political and market data rather than developing a set of possible scenarios.

Quantitative approaches

Quantitative approaches are diverse and used in several different ways. Some of the projects try to forecast traffic flows, energy consumption or mode split taking into account different economic and political factors as it is the case for SCENES(2002), the work developed by Banister D. *et al.* (2000a) and OECD (2006) over the future demand for road and rail infrastructure. Quantitative work has also been developed to try to assess the long term impact of transport policy over economic, environmental and social implications as it is the case in the ASTRA project (2000) or the work presented by Matzos *et al.* (2004) that consider the effect over future energy consumption of transport if the policy measures of the White Paper of the European Commission are implemented.

Summary

Table 1 *(Key drivers*), presents a summary of the most frequently quoted/identified key drivers in the literature for the area that was being analyzed, paying special attention to the literature referring to the transport sector. An organization's strategy often leads to unexpected advantages and opportunities resulting from the complex interplay with macro factors (Singh (2004)). Therefore, to predict the future of logistics and distribution, it is not sufficient to focus only on the likelihood of macro factors. One also has to consider the emerging concepts that will dominate the future logistics and distribution and the practices of this sector that in return will influence the macro factors.

As can be observed from Table 1 *(Key drivers),* the key drivers were classified as macro and industry factors. Macro factors are those likely drivers of future changes that will affect all sectors of the economy, while industry factors are those drivers that relate to key strategic or operational shifts within the sector.

Table 1: Key drivers

KEY DRIVER	TYPE OF FACTOR	REFERENCES	TIMES CITED
Economic growth / GDP growth / Income per capita	Macro factor	Accenture (2001); Akashi O. (2006); Bertrand G. and Rood J. (2000); Bleijenberg A. (2002); De Ceuster G. (2007); European Commission (2007b); Eijkelenbergh P. *et al.* (2004); Grammenos (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); Jensen (2007); Matzos *et al.* (2004); Matzos *et al.* (2003); OECD (2007); OECD (2006); Scenario Study Team (2006); Singh (2004); Institute of Shipping Analysis, Göteborg *et al.* (2006); Timms *et al.* (2005)	19
Environmental Policy and pricing externalities	Macro / Industry factor	Akashi O. (2006); Banister D. *et al.* (2000b); Banister D. *et al.* (2000a); De Ceuster G. (2007); Dalla Palma R. *et al.* (2001); Eijkelenbergh P. *et al.* (2004); Institut für Wirstschaftspolitik und	17

		Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); Jensen (2007); Matzos *et al.* (2004); Matzos *et al.* (2003); Ministerio de Fomento de Espańa (2004); OECD (2006); Sauer (2002); Queenland Department of Transport and Main Roads (1999); Scenario Study Team (2006); Singh (2004)	
Policy measures	Macro / Industry factor	Banister D. *et al.* (2000a); Bertrand G. and Rood J. (2000); Bleijenberg A. (2002); De Ceuster G. (2007); Dalla Palma R. *et al.* (2001); Eijkelenbergh P. *et al.* (2004); Grammenos (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); Jensen (2007); Jespersen and Nielsen (2003); Matzos *et al.* (2003); OECD (2006); Queenland Department of Transport and Main Roads (1999); Singh (2004); Institute of Shipping Analysis, Göteborg *et al.* (2006)	16
Production and distribution patterns	Industry factor	Akashi O. (2006); Banister D. *et al.* (2000b); Banister D. *et al.* (2000a); Bleijenberg A. (2002); Grammenos (2002); Institut für	14

		Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); Jespersen and Nielsen (2003); Lemoine and Skjoett-Larsen (2004); Leleur *et al.* (2004); McKinnon and Woodburn (1996); McKinnon (2002); Nielsen *et al.* (2003); Singh (2004)	
Technological developments including transport and fuel technology	Macro / Industry factor	Accenture (2001); Akashi O. (2006); Banister D. *et al.* (2000a); De Ceuster G. (2007); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); Jensen (2007); Matzos *et al.* (2004); Sauer (2002); Queenland Department of Transport and Main Roads (1999); Ringland (2004); Scenario Study Team (2006); Singh (2004); Timms *et al.* (2005)	14
Infrastructure policy and developments / Quality of transport services	Industry factor	Akashi O. (2006); Dalla Palma R. *et al.* (2001); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Jespersen and Nielsen (2003); Ministerio de Fomento de Españ́a (2004); OECD (2006); Sauer (2002); Queenland Department of Transport and Main Roads (1999); Singh (2004);	11

		Institute of Shipping Analysis, Göteborg *et al.* (2006);Timms *et al.* (2005);	
Global trade / trade patterns	Macro factor	Akashi O. (2006); European Commission (2007b); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); Jespersen and Nielsen (2003); McKinnon (2002); Nielsen *et al.* (2003); OECD (2007); Scenario Study Team (2006); Singh (2004); Institute of Shipping Analysis, Göteborg *et al.* (2006)	11
Energy and oil prices	Macro / Industry factor	De Ceuster G. (2007); European Commission (2007b); Grammenos (2002); Jensen (2007); Matzos *et al.* (2004); Matzos *et al.* (2003); OECD (2007); OECD (2006); Sauer (2002);	9
Demographic changes	Macro factor	Accenture (2001); Banister D. *et al.* (2000a); Bertrand G. and Rood J. (2000); Bleijenberg A. (2002); De Ceuster G. (2007); OECD (2006); Ringland (2004); Singh (2004); Timms *et al.* (2005);	9
Geopolitical situation	Macro factor	Accenture (2001); Banister D. *et al.* (2000a); Bertrand G. and Rood J. (2000); Eijkelenbergh P. *et al.* (2004); Institut für	8

		Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Jensen (2007); Singh (2004); Timms *et al.* (2005);	
Labour market	Macro factor	Akashi O. (2006); De Ceuster G. (2007); European Commission (2007b); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); OECD (2007); Scenario Study Team (2006); Singh (2004);	7
Changes in demand taste / trends	Macro factor	Akashi O. (2006); Banister D. *et al.* (2000b); European Commission (2007b); Jespersen and Nielsen (2003); Leleur *et al.* (2004); Scenario Study Team (2006); Singh (2004);	6
Globalisation	Macro factor	Banister D. *et al.* (2000b); Grammenos (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); OECD (2007); Singh (2004);	6
Social implications	Macro factor	Eijkelenbergh P. *et al.* (2004); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2002); Institut für Wirstschaftspolitik und Wirtschaftsforschung (DE) *et al.* (2000); Singh (2004);	4
Security matters	Macro / Industry factor	Bertrand G. and Rood J. (2000); Jensen (2007);	2

Urban development	Macro factor	Queenland Department of Transport and Main Roads (1999); Scenario Study Team (2006);	2

The literature review evidences that concerns over environmental issues and the cost of externalities as congestion and pollution are becoming more and more relevant in the analysis of future scenarios. Expected policy measures over the matters are likely to affect considerably the future evolution of infrastructure investment and pricing policies and therefore the future modal split.

Dominant trends in literature

1. **Transport modes:** Most of the analysis focuses on road and rail with a partial assessment of other modes, as it is the case in Banister D. *et al.* (2000b) who considers the effect on traffic flows by air and inland waterways. Existing literature does not include specific analysis in terms of SSS because it is comparatively a new term but mainly because it is only recently that states are concerned with more environmentally friendly solutions and options that include SSS as a measure to reduce congestion from road traffic.

2. **Energy:** Freight transport is considered one of the key factors in terms of energy consumption. Several studies analyze the matter: Matzos *et al.* (2003);(2004), Akashi O. (2006), Scenario Study Team (2006) and Jensen (2007). Concerns over the price of oil and energy sources are present in most recent studies and are certainly a relevant aspect of economic or transport outlooks. The need for more efficient types of fuels as well as alternative sources of renewable energy is a main concern in terms of the future evolution of the transport sector in Europe.

3. **Economic growth:** GDP growth, GDP per capita and demographic changes will relate directly to the increase of transport but particularly to the evolution of road transport as they will result in higher vehicle ownership, more freight transport, more road traffic and demand for road infrastructure (OECD (2006)). While they are also relevant for other modes of transport, there is a general conception that rail, inland navigation and SSS use and infrastructure will be much more controlled by public spending priorities and sustainability policy to affect mode shift from road to other modes.

4. **Trade, production and distribution:** Changes in trade patterns and production and distribution structures appear to be relevant to the

evolution of transport in work developed as early as 1996 by McKinnon and Woodburn as well as in more recent studies like the ones perform by Dalla Palma R. *et al.* (2001), McKinnon (2002), Jespersen and Nielsen (2003), Singh (2004), Lemoine and Skjoett-Larsen (2004), Institute of Shipping Analysis, Göteborg *et al.* (2006) and OECD (2007). Location of production and consumption will determine transport level requirements, infrastructure needs and seamless logistic structures in the regions were the existing configurations can be altered.

5. **Technological developments:** In terms of transport those will affect not only the speed and quality of services of the different modes but rather also the ability to develop more environmentally friendly transport solutions and sustainable mobility.

6. **Geopolitical situation:** Reference to the importance of the geopolitical situation of Europe is carried out, among others, in the work of Bertrand G. and Rood J. (2000), Leleur *et al.* (2004), De Ceuster G. (2007), and Jensen (2007). The geopolitical situation of Europe concerning the EU enlargement and Constitution and the corresponding effects over the economy, trade and integration, will affect the levels of liberalization and harmonization in the transport sector and the development of common projects within the TEN-T initiative.

7. **Security:** Matters of security are not taken into account as a main driver of change in most of the existing literature mainly because effects over freight transport in terms of security are only considered in the last 2-3 years after concerns were raced by the USA as a result of 9/11. In the few reports that take security matters in consideration, there is little evidence that security concerns will prevail over market factors and are rather considered to influence cost structure at particular nodes rather than affecting the whole supply chain.

8. **Challenges of globalization:** The future of the logistics service industry is characterised by many upcoming challenges and opportunities. The industry experiences strong growth rates, but is also confronted with major challenges in an increasingly complex and dynamic environment. Intensifying globalisation, stronger competition and higher customer demands are just some of the factors that lead to a more turbulent and uncertain environment (Gracht *et al.* (2008)).

Future developments

Dominant themes of the probable futures in terms of macro developments include a general notion towards strong social responsibility and environmental awareness which did not prevail before, the intensifying pace of globalisation combined with the strong emergence of developing nations as major players in the global economy (e.g. the BRIC countries (Brazil, Russia, India, China)), the influence of oil and energy prices and the change in population mix in terms of race and cultural aspects which will imply the existence of more sophisticated and demanding customers.

At the industry level, the pictures of the possible futures present supply chains where the link between the different actors is high and supported by the appropriate technology. Collaborative Planning[1], Hybrid Logistic Chains[2] and Postponed Logistics are some of the features mentioned as part of the characteristics of the Logistic chains in the future. Value added will be given to clients from service more than from the physical product, therefore efficient and cost effective supply chains will be crucial to compete.

The long term analysis of the logistics environment helps managing complex and dynamic environments like the one expected in the future in the logistics and distribution chains.

Key transport service characteristics

In terms of creating the appropriate integrated service to compete with road transport, 57 references (see References) were reviewed to analyze current trends in freight transport demand and mode choice. A mix of research papers, EU funded projects and surveys in user's preferences have been identified as relevant literature on transportation decision-making.

Among the research studies selected, 39 are country-specific or investigate traffic between two neighbouring countries. Except for 2 studies (National Economic Research Associates (2007) and INRETS *et al.* (2000)), no research on transport decision-making at the European scale has been found.

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[1] Two companies sharing transport assets/providers to optimize their logistic structures and cost.

[2] Slower moving chains for stable demand and handle picks with more flexible modes as road transport

Freight transport mode choice decisions

There are various methodologies to define the determinants of freight transport demand and therefore mode choice. Table 2 presents a rough summary of some of the most relevant models for freight transport decision.

Table 2: Models for freight transport decision

Model	Main reference	Principle	Strength	Weakness
Classical Economic Model	Meyer et al[d] (1959)	It evaluates fixed and variable costs of competing modes, excluding factors of service.	Simple and straightforward	It omits service criteria, competition variables; disregarding cargo weight
Inventory Theoretic Model	Baumol&Vinod[e] (1970)	Two-dimensional approach: costs and time or costs and size.	It includes total logistics costs (opportunity costs, inventory cost etc.)	It needs large amount of data
Behavioural Models	Craig[f] (1973)	It enables the researcher to include perception and behavioural characteristics of the decision maker.	It introduces routine decision-making.	Judgement subject to bias: constraints, or motivation to reply in a certain manner.
Trade-off model	Roberts[g] (1975)	Rational shipper choice between 2 mode alternatives will minimize the sum of 2 costs categories: transportation costs (TC) and non-transportation costs (NTC)	Good for measuring the relative importance of choice criteria	Complicated to adapt to multimodal chains
Constraint optimization model	Mc Ginnis, Corsi, & Roberts[h] (1981)	Optimization process with TC optimized subject to several NTC constraints (product, distribution pattern, service need).	More consideration of qualitative aspects	

The models identified for the mode split include aggregate and disaggregate models like:

- Elasticity-based models (Reflect the effects of changing a single variable)
- Aggregate mode split models (Provide a market share of a mode)
- Neoclassical economic models (Estimates the demand function for transport based on a cost function)
- Econometric direct demand models (Trips and distances of each mode predicted directly).
- Disaggregate mode split models (Include inventory-based models and behavioural models. Most disaggregate freight models deal with mode choice only, while a few number include logistics considerations).
- Micro-simulation approach (Tour and trip level models for freight transport by lorry)
- Multi-modal network models (Predict modal choice and assignment simultaneously)

Decision makers

Most of the references selected for the analytical review focus on shippers' decisions. The more recent studies also include freight forwarders in their panel of respondents. For example, the Logiq project investigated the decision making process at the firm's level, as well as the factors that affect the choice of intermodal transport. The survey conducted in Logiq included different types of decision makers: large shippers, forwarders, large road hauliers or shipping lines, which were seen as the actors imposing requirements and making decisions for using Intermodal transport. On the other hand, the Stella Project (2002-2004), which used adaptive conjoint analysis to estimate the relative importance of transport costs, travel time, risk of late arrival and risk of damage and loss, focused on shippers as main decision-makers.

The SPC[3] Belgium's project conducted in 2001 (Market-Orientated Short Sea Shipping– Study and Action within the Flemish Region) gives a good analysis of target groups for promotion of SSS, including transportation decision-makers. In the study, shippers are seen as the most important decision-makers. They are the ones generating trades and thus transport. Even if they often work via a forwarder who chooses transport mode so as to maximize its revenue, shippers still are the final customer of transport service providers. Forwarders are relevant decision-makers in the sense that they are the ones taking over the responsibility for the transport. Even if their role has changed with the increase of large manufacturers dealing directly with transport providers, freight forwarders still control a large part of transportation decisions, especially those of small and medium size cargo owners.

The most cited / identified attributes that are taken into consideration when making decisions about transportation services are listed in Table 3.

[3] Shortsea Promotion Centre Flanders

Table 3: Attributes taken into account in transport decision making

	Related Attributes	Time Cited
FREIGHT RATE	Costs, Charges, Rates, Price	44
REALIABILITY	Accuracy, Pick up & delivery performance, Dependability, Delay	39
TRANSIT TIME	Delivery time, D2D transit time, Speed	38
LOSS & DAMAGE	Risk of loss & damages, Safety, Security, Claim processing quality, Restitution	21
SERVICE	Shipper consideration, Customer service, User satisfaction	20
FREQUENCY	Frequency of the transport service available	18
CAPACITY / AVAILABILITY	Equipment availability & suitability, Infrastructure, Practicability, ease of use	17
FLEXIBILITY	of services, of shipments	10
TRACING / TRACKING	Possibility for tracking/tracing the shipment	7
REPUTATION	Financial reputation, Industrial reputation	7
INFORMATION	Transparency, Information availability, Information processing system, ICT	5
ENVIRONMENTAL IMPACT	Emissions, Environmental impact	3

- **Congestion problems in general**

In the category of the distribution companies, road congestion seems to be a very serious problem. Trucks arrive daily too late for their appointments. The time lost because of road congestion has already been taken into account by those companies, this makes it difficult to assess the loss of efficiency caused by road congestion. Mainly the bottlenecks listed in section 2 are a big problem. The problems are roughly situated between Antwerp-Brussels-Charleroi and the ports of Antwerp and Zeebrugge. Peak moments in road congestion are lasting longer everyday. The quiet period which used to be in between morning and evening queue apparently is disappearing. Distribution companies are looking for solutions, such as the spreading of commodity flows in time and putting more trucks on the road. Because of the congestion problems, more flexibility and 24/24 working are consequences. An example is Colruyt: 30% of the transport from the main warehouse in Halle to the distribution points across Belgium is done during the night between 8pm and 6am. Although there are limitations (because of location of the company, county regulations and personnel), only 50 out of 250 stores have no limitations on the delivery time. Nike doesn't have any congestion problems because mainly inland navigation transport is being used. (Cortvriendt (2008); De Maesschalk and Herremans (2008); Vanbuylaere and Bessems (2008); Van de Sande (2008))

Shipping companies face other problems. They compose their commodity flows in a trimodal way. These companies search for the best way in which the goods can leave the port; this can be by truck, rail or inland navigation. They often choose truck transport in comparison with inland navigation. Some examples are listed here. Cosco: 50% road, 25% rail and 25% inland navigation. CMA-CGM: 70% inland navigation, 30% road. An increase in rail transport is expected because of the establishment of the rail company Rail Link Europe (joint venture between CMA-CGM and Veolia). (De Kesel (2008); Beerlandt (2008); Kerstens (2008))

Terminal operators consider road congestion problems as less important. Terminals are confronted with congestion peaks at the moment that containers are arriving and leaving. Because of road congestion and mainly because of the inexistence of a pre-track system, trucks arrive at irregular times. Many of the production companies also think the goods have to arrive at 8 am in order to start the production; this enhances the traffic peaks at terminals in the morning. (Olesen (2008); Noterman (2008)) Hauliers arrive half an hour earlier at the terminal keeping in mind the structural waiting times. Solutions for this problem could be: partly in the transport of containers via other modes apart from road transport, but certainly with the introduction of a pre-track system. Though, shipping companies pass on the problem of congestion problems on the road to subcontractors. (De Kesel (2008); Beerlandt (2008); Kerstens (2008))

It is obvious that hauliers are confronted with road congestion problems. Transport companies use mainly international routes at night time while production companies work mainly during the day time. The delay on the road results in problems concerning delivery and collect appointments. The departure times are mainly determined by the production companies and are mostly in the busiest moments. (Van Mullem (2008))

Part of the problem is the fact that the expansion of the infrastructure is not in line with the expansion of the port. The road system is still the same as in the 60s, while traffic has increased. (Geerts (2008))

- **Congestion problems in road transport**

Congestion results in higher costs. A selection of hauliers has been made and the results of the survey are described here. The companies were divided in three groups: small companies with a balance total of less than € 250.000; big companies with a balance total of more than € 1.000.000;

and the in between category (the medium sized companies) with a balance total of € 250.000 till € 1.000.000.

Table 4: Enquiry results: congestion costs per truck

Cost	Balance total				Total
	Large	Medium	Small	N.a.*	
€1000 - €10.000	12	13	22	13	60
€10.000 - €20.000	10	8	3	5	26
€20.000 - €30.000	6	6		1	13
€30.000 - €40.000	3				3
> €40.000	5		2	1	8
Total	36	27	27	20	110

*N.a. = Not available

The results from the survey show that because of the congestion, large companies will end up losing more than small companies. 14 out of 36 big companies make a loss because of congestion of more than € 20.000 a year. 21 out of 60 say they loose more than € 10.000 a year.

- **Inland navigation congestion**

Because of increased popularity, traffic by inland navigation faces congestion problems in sea ports. Waiting times within the port vary between 0 en 10 hours. Inland vessels have several destinations within a port before reaching their final destination. Whether an inland vessel has to load/unload 1 or 20 containers, the terminal operator has to prepare the installation in function of one vessel. On a regular basis, barges arrive with a limited number of containers, nevertheless these barges need a full shift of dockworkers. The possibility of bundling containers on bigger ships is considered. In practice, terminal operators prefer to use full shifts of dockworkers in order to load/unload sea vessels after which these dockworkers can be used to load/unload inland vessels. The operational cost for loading/unloading of inland vessels leads to an increase of the total terminal cost (Noterman (2008)).

The basic problem is that the operations of the inland vessels is performed on the basis of an opposite logic. In practice, it would be better if an inland vessel is (un)loading at a limited number of locations in the port and then performing several stops alongside the rivers and canals. However, in practice, it turns out that a vessel makes a trip through the port and is (un)loading at one or two locations e.g. in Germany (Noterman (2008)).

- **Transport by rail**

Shipping companies have enough volume in order to demand their own train services from rail operators. Shipping companies don't have their own railway material. The result of interviews shows transport should be done more by rail. At this moment the cost of a train movement is too high, and some rail companies are not thinking enough in a commercial way. Transport between terminals is mainly still done by trucks because of the high cost of a train movement. This results in a lot of unnecessary truck movements between terminals. Because of the establishment of AP Rail (subsidiary from NMBS, see www.ap-rail.be) "last mile" train movements in the port of Antwerp are getting more efficient and cheaper. (De Kesel (2008); Beerlandt (2008); Kerstens (2008); Van de Sande (2008))

- **Road pricing as a solution?**

Through interviews opinions were asked about the introduction of road pricing in Belgium. Road pricing is being accepted in a mixed positive way. However, experts don't expect miracles. Road pricing can be one of the solutions for congestion problems but it should be placed within a wider package of measures. It is stated that road pricing will be passed on to the client and in the short term the traffic will not decrease. A positive attitude is existing towards the potential investment of the collected funds in the maintenance and expansion of the road infrastructure. However, the distributors are not keen to put an extra device in the trucks. One fears that within a couple of years, an European truck is equipped with tens of systems. European coordination and the use of existing technologies is at stake. (Cortvriendt (2008); De Maesschalk and Herremans (2008); Vanbuylaere and Bessems (2008))

The attitude of shipping companies is positive towards road pricing. It is expected that a correct pricing system will help short sea shipping, inland navigation and rail transport, without structural disadvantages for road transport. All extra capacity being used or created on other modes is an advantage. Road transport will always be necessary and will always fulfill its role, if only because of last-mile trajects. (De Kesel (2008); Beerlandt (2008); Kerstens (2008))

Terminal operators are moderate positive towards road pricing. It is a way to smooth out the peak moments on the roads. Road charging with a correction on the basis of a higher load factor has a lot of possibilities. The regulations concerning possible waiting and delivery times should evolve simultaneously in a flexible way. (Olesen (2008); Noterman (2008))

The results of the survey show that the main priority is maintenance, and only in second place one should think about the construction of new infrastructure. Also provisions of other modes should be supported. As such, multimodal traffic can be supported. Road pricing is preferred above a tolling system: a variable charging system doesn't give a psychological avoid-effect. (Boels (2008); Van Loon (2008))

Hauliers believe that the cost of road pricing will be passed on to the client/ end consumer. Having a real effect on traffic flows is till in doubt. However, the extra money for infrastructure works is more than welcome. (Van Mullem (2008)). One also doubts whether this measure is cost neutral or not (Lansay (2008)). From this perspective, it is quoted that policy makers have to make decisions, preferably implicating that the tool is used effectively (with corresponding vision) and that other taxes are reduced. (Geerts (2008))

A lot of experts state that road pricing should also be applied on passenger cars. Funds resulting from road pricing can straighten out the road infrastructure at last.

70% of the respondents from the online survey are positive with respect to road pricing. A lot of answers for road pricing are conditional and are shown in the table below.

Table 5: Survey results: In favor of road pricing on condition that…

Answer
vignette and road taxes will be cancelled.
additional costs and administration can be passed on in the total cost price.
confusion or time loss is not a consequence . If there is any delay in any way, it isn't right to charge.
money will also be used for maintenance and the construction of roads.
user pays + collection via DSRC (Dedicated Short-Range Communication) system; exception applies for road workers traffic; bottlenecks can't be avoided; secret routes can't be used.
charging for trucks and passengers should be implemented at the same time.
there are costs only at certain parts of the road network.
the system is international, preferably on an European level.
who drives the most km, who pays more.
agreements exist with the client that the charge will be on top of the standard price, this means that a prepaid system is not so good, it will be better to pay afterwards.

In the survey people were asked to what extent additional costs of road pricing can be charged to the client. 60% of 30 small companies in the survey think that the additional charges can be passed on to at least 60% of the clients. 37% from the small companies even think that additional charges can be passed on to 80% of the clients.

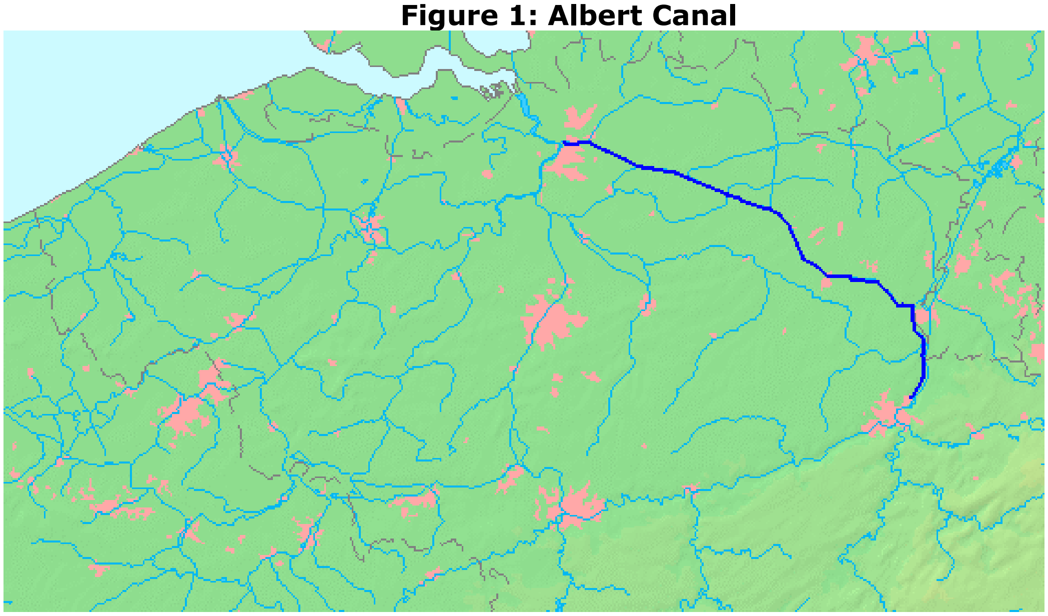
In medium sized transport companies there is a minority who thinks additional costs can be passed on to customers. The opinion in big companies is divided: 43% think additional cost can be passed on to 80% of the clients. But 23% of big transport companies think that it will be possible to pass on extra costs to less than 20% of the clients.

Further more the survey shows mainly that the government and shippers have to be revised to solve congestion problems. Positive effects are expected from online file reporting, GPS/GPRS-technology and board computers.

Section 1b: Albert canal

The Albert canal is a direct competitor to the E313 motorway. The Albert Canal was dug from 1930-1939. The German construction firm Hochtief AG worked on the canal between 1930 and 1934. It was used for the first time in 1940, but because of World War II the actual exploitation only started in 1946. Between Antwerp and Liège there is a height difference of 56 meters. A total of 6 canal locks were needed to overcome the difference. Five canal locks have a height difference of 10 meter (located in Genk, Diepenbeek, Hasselt, Kwaadmechelen and Olen), while the canal lock of Wijnegem has a difference of 5.45 meter. (Thiebaut (1985))

Figure 1: Albert Canal



Source: Demis b.v. (2008)

A project to increase the capacity of the Albert Canal will require the replacement of a number of bridges between Antwerp and Schoten. Modernization of the Albert Canal waterway for navigation of vessels of up to 9,000 t carrying capacity will allow barges with containers stacked up to four high. The work that still has to be done includes the elimination of a bottleneck between Wijnegem and Antwerp where the Canal is barely navigable for vessels of class Va, whereas the rest of the Canal is suited for class VIb vessels and pushed convoys. Moreover, on this section, the bridges have the lowest clearance, some less than 7 m, which is the standard for three-layer container navigation only. Eliminating these barriers will open up the Albert Canal for bigger and wider vessels and will make it possible that the Canal can be used fully on its total length. The project includes the widening of the Canal up to a minimum width of 63m. (United Nations Economic and Social Council (2006); European Commission (2008a); nv De Scheepvaart (2008))

Planned capacity improvements of the Albert canal are:

- adapting the cross section of the Albert canal between Wijnegem and Antwerp. As such, it will be possible to use four barges trains (10 000 tons) instead of the current limitation up to 4 500 tons;
- raising the bridges in order to have a free height of 9.10m, in order to be able to ship with 4 layers of containers.

The advantages of these improvements are:

- the Albert canal will be fully navigable with vessels/pushers up to 10 000 tons;
- the Albert canal will be navigable for vessels with a higher loading volume and/or height: container vessels with 4 layers, improvement of accessibility with coasters (SSS) and the increased possibilities of the transport of indivisible parts.

<u>Evolution of inland navigation in Belgium</u>

In this sub part an overview is given of the relative position of inland navigation in Belgium in relation to road[4] and rail transport (freight transport in period 1970-2005). [5]

Analysis of performed tonkilometer in Belgium[6]

Figure 2 shows between 1970 and 2005 a growth of the total freight transport from 27 380 million tonkilometer (*tkm*) to 69 387 million *tkm*, indicating an increase of 153% in 35 years, or on average 2.7% yearly. This growth is mainly concentrated on road transport, having a growth of 308% (from 12 869 million *tkm* to 52 537 million *tkm*), or on average 4.1% yearly. Figures for inland navigation show an increase from 6 734 million *tkm* to 8 720 *tkm* (total growth of 29% or 0.7% yearly). Rail transport shows an increase of 4.5% (7 777 million *tkm* to 8 130 million *tkm*), being almost a status quo in the period under study.

Striking is the strong drop in 1975, affecting mainly inland navigation and rail transport (see Figure 3). Inland navigation and rail transport drop respectively with 25% and 26% in comparison with the year 1974. Road transport is affected less (-4%). This could indicate that inland navigation and rail transport is affected harder in an economic period of crisis. On

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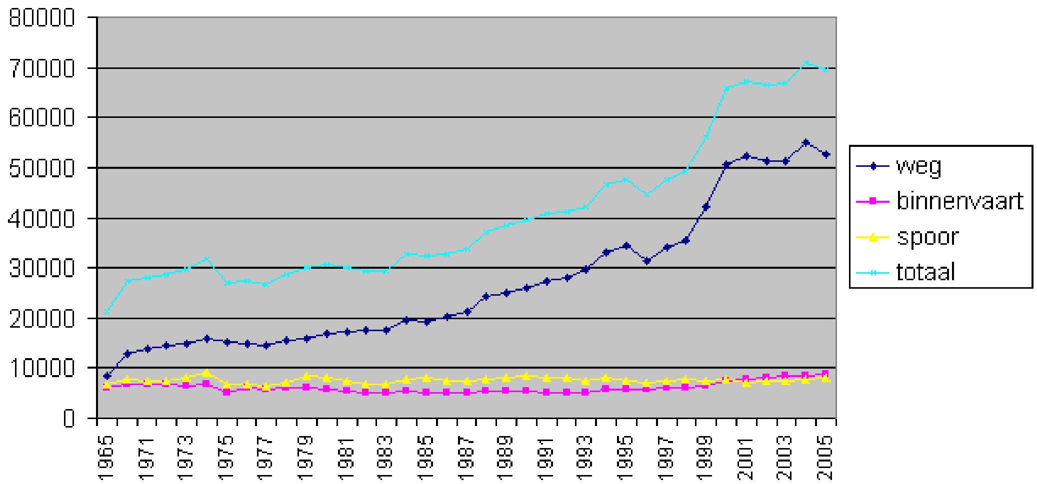
[4] As well Belgian as non-Belgian trucks. Belgian trucks: at least 1 ton load capacity.
[5] Take into account that the choice of a reference year could influence the conclusions. For example, in 1840 the distribution road-rail-inland navigation was 50%-0%-50%. In 1880 this was 3%-77%-20%. In 1930 8%-73%-19%. In 1950 35%-49%-16%. (Pauwels (2007) and Van der Herten (1997))
[6] Only the transport on Belgian infrastructure is taken into account.

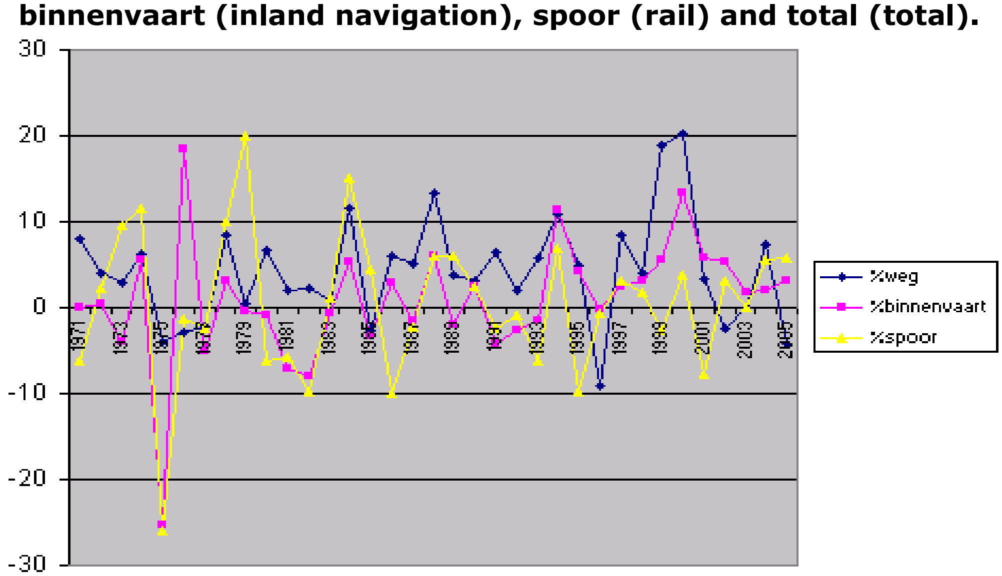
the other hand it should be noted that in this period a further extension of the road network was established. In the year 2000 road transport increases with 20%, while inland navigation and rail increase respectively with 13% and 4%.

Figure 2: Comparison of performed tonkilometer in Belgium (x 1 000 000) per mode (period 1970-2005): road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).



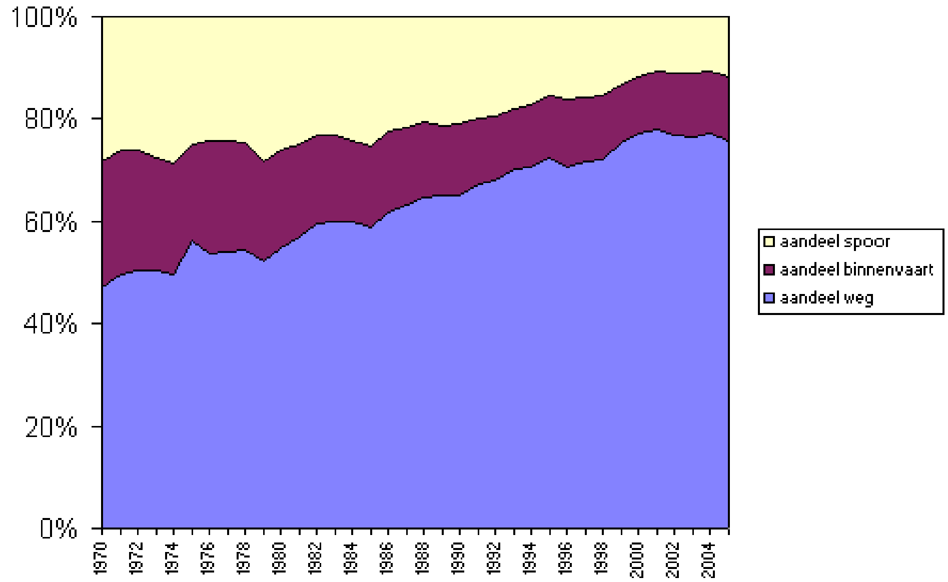
Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Figure 3: Comparison of performed tonkilometer in Belgium in procentual change (period 1970-2005) per mode road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).



Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Figure 4: Comparison of performed tonkilometers in Belgium in modal share (period 1970-2005) per mode: road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).

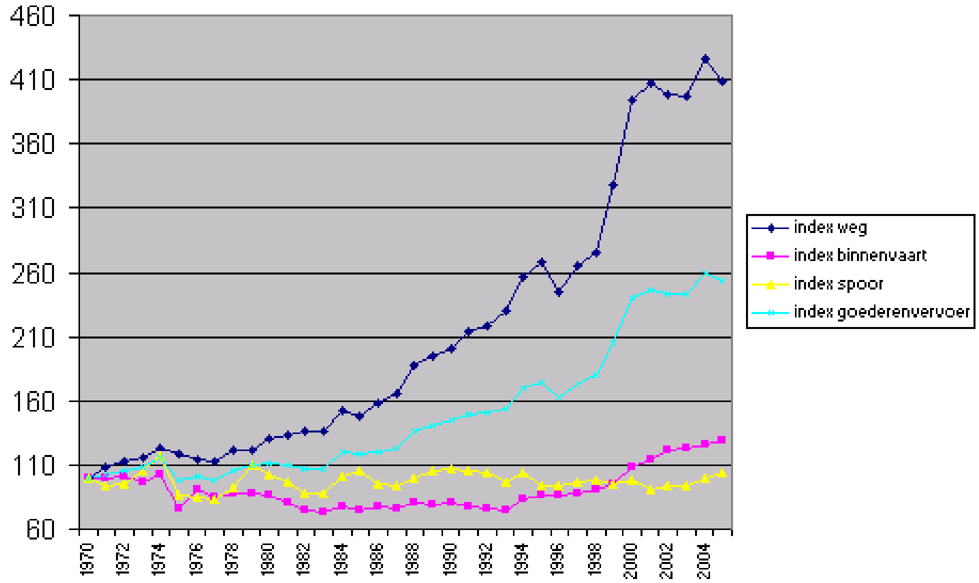


Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Modal shares on the basis of *tkm* (Figure 4) show also the increased importance of road transport. In 1970, 47% of total freight transport was moved via the road and, respectively, 25% and 28% via inland navigation and rail transport. The figures referring to 2005 show an increase of the modal share of road to 76%, 13% for inland navigation and 12% for rail transport.

Figure 5 shows the evolution on the basis of indices (year 1970 = 100). This figure also shows the stronger growth of road transport, while inland navigation and rail transport are more stable.

Figure 5: Comparison of performed tonkilometer in Belgium in indices (period 1970-2005) per mode: road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).



Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

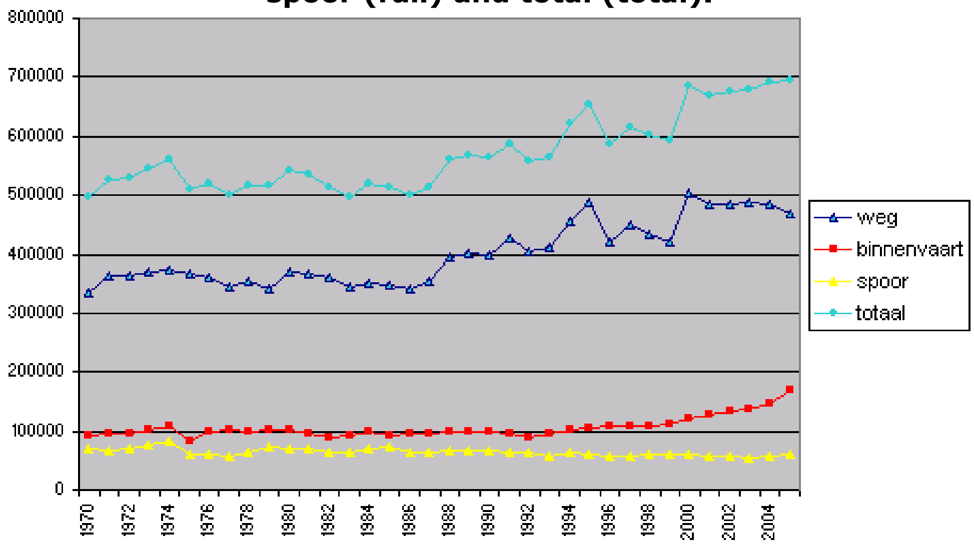
Analysis of transported tons in Belgium

Figure 6 shows the evolution of freight transport in ton (*t*) in the period 1970-2005. Total transport increased with 40% (from 498 382 thousand *t* to 696 077 thousand *t*), or 1% yearly. Road transport shows an increase of 39% (335 948 thousand *t* to 467 008 thousand *t*), also 1% on average. Inland navigation increased with 84% (1.8% yearly) and rail decreased with 14% (-0.4% yearly).

The strongest decrease is situated in the year 1975 (Figure 7). Inland navigation and rail decrease respectively with 22% and 26%, road transport with 2%.

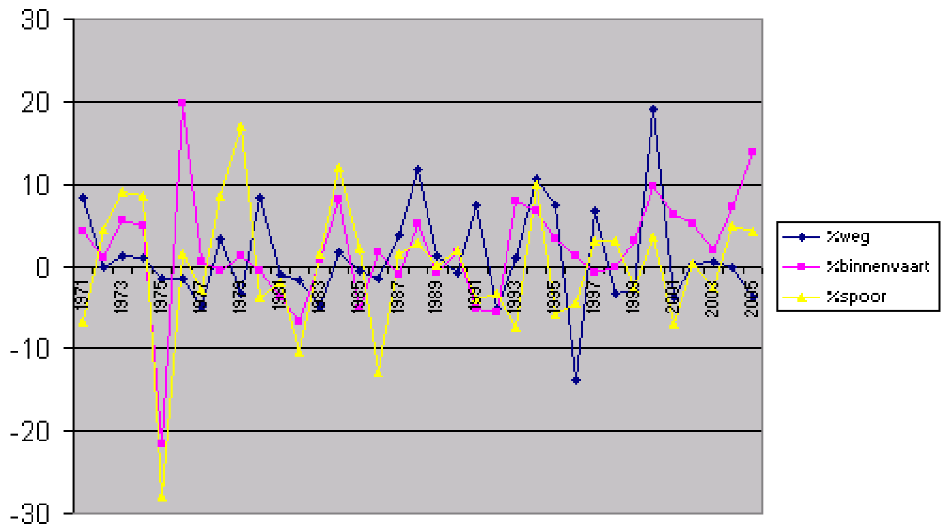
From 1999 on, inland navigation is characterized with yearly positive growth figures (with a peak in 2000: 10%). These positive figures are the result of the liberalization of the inland navigation sector in 1998 and the several support measures of the government(s), e.g. the "kaaimurenprogramma" gives a financial contribution to companies investing in quay walls.

Figure 6: Comparison of transported tons in Belgium (x 1 000 000) per mode (period 1970-2005): road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).



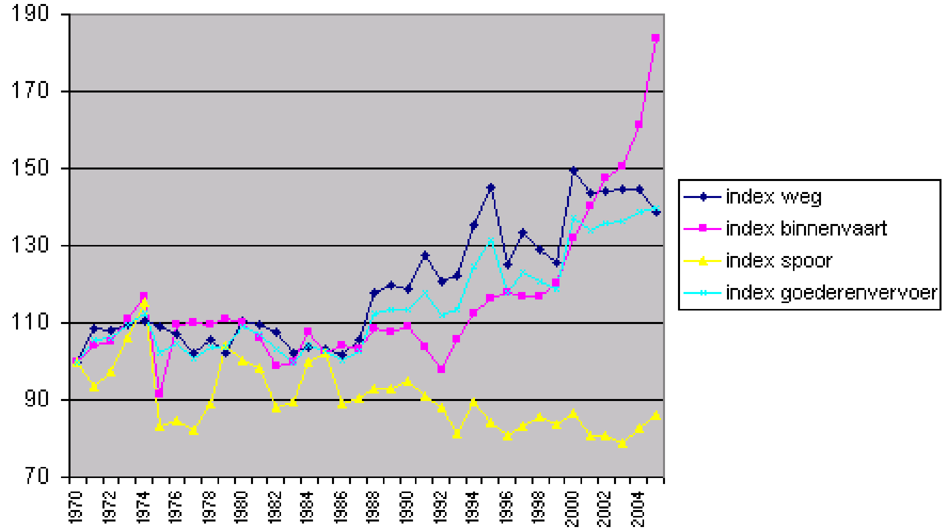
Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Figure 7: Comparison of transported tons in Belgium in procentual change (period 1970-2005) per mode: road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).



Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Figure 8: Comparison of transported tons in Belgium in indices (period 1970-2005) per mode: road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).

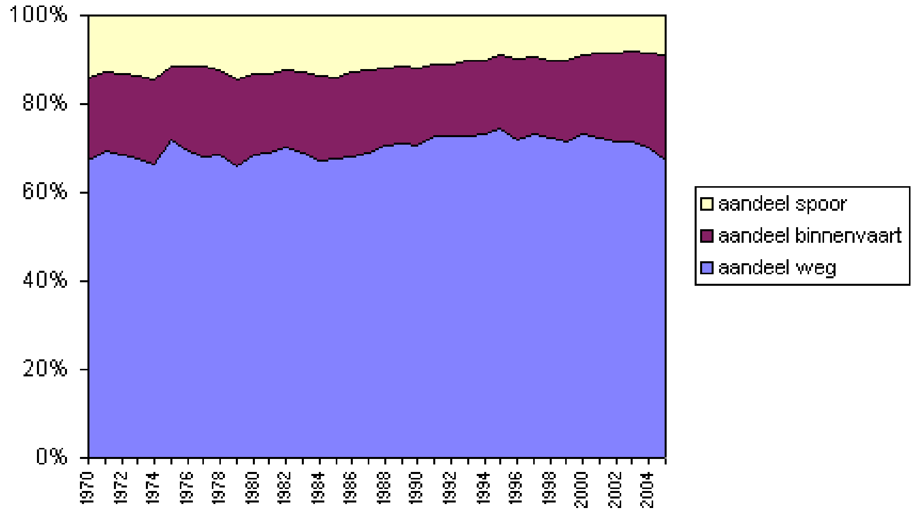


Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Figure 8 shows the evolution on the basis of indices of *t*. In comparison with Figure 5 we see that inland navigation grew stronger than total freight transport. Freight transport shows indices which are lower than the the index in the starting year.

Modal shares as shown in Figure 9 show a different result in comparison with Figure 4. In 1970, modal share of road was 67%, 18% for inland navigation and 14% for rail transport. In 2005 these shares are respectively 67%, 24% and 9%. It is striking that the modal share of inland navigation is 24% on the basis of *t*, while the share is 13% on the basis of *tkm*. An explanation can be found on the basis of the calculation of average distances.

Figure 9: Comparison of transported tons in Belgium in modal share (period 1970-2005) per mode: road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).

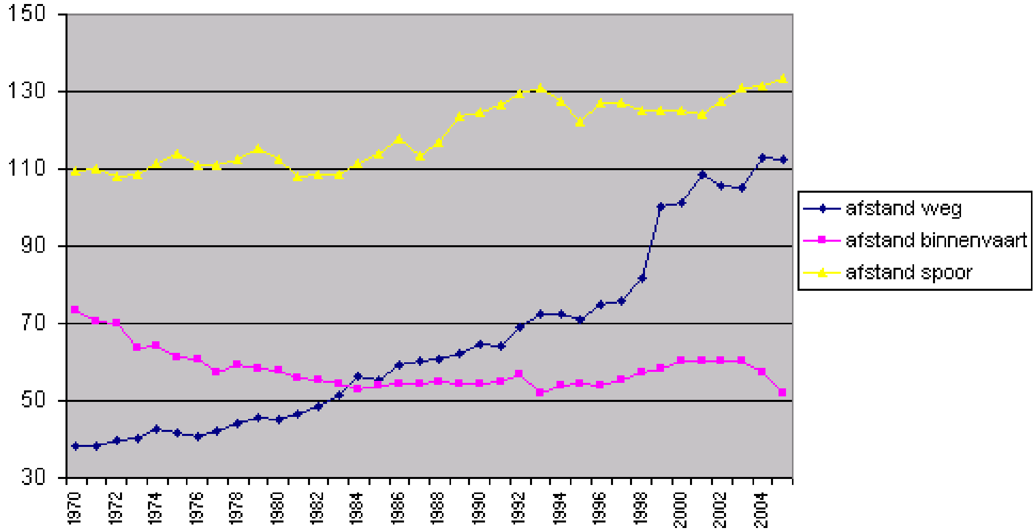


Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Analysis of the performed average distances in Belgium

On the basis of the information of *tkm* and *t* it is possible to calculate average distances (Figure 10). As well road and rail transport show an increase of the average distance (road: 38 *km* in 1970 and 113 *km* in 2005; rail: 110 *km* in 1970 and 133 *km* in 2005). On the other hand the average distance of inland navigation decreased (74 *km* in 1970 and 52 *km* in 2005). We could therefore conclude that the evolution of road and rail is characterized by longer distances. The importance of inland navigation for shorter distances has become more important. From 1984 on, the average distance of inland navigation became the lowest of the 3 modes. Please note that this analysis is an indicative analysis. Only the distance performed on the Belgian infrastructure has been taken into account, not the distance abroad. Also note the rise of inland container terminals, collecting and distributing flows in relation to the ports. Also note this is an unimodal analysis and not a total logistics chain analysis.

Figure 10: Average distances in km (period 1970-2005) per mode: road (weg), binnenvaart (inland navigation), spoor (rail) and total (total).



Source: own composition on the basis of information of "FOD Economie – Algemene Directie Statistiek", "Ministerie van Verkeer en Infrastructuur" and "NMBS".

Section 1c: Port traffic

Evolution of port traffic

Logistics in general, and the maritime and port industry in particular, are evolving very rapidly. Port authorities and enterprises are always confronted with new technologies. From a business economics perspective, strategies are constantly adapted with a view to increasing market share and, more importantly still, profits. All of this translates into an altered market structure. For a highway like the E313 which is bound in a certain way to commodity flows from the port of Antwerp (and in less degree to the port of Zeebrugge) this is extremely important. The benefits the highway are being evaluated on the basis of the surface under the demand curve. The bigger the demand and thus the use of the highway, the bigger the corresponding potential benefits.

The short-, medium- and long-term future of the seaports in the Hamburg-Le Havre range is fraught with uncertainty too. However, the previously outlined trends point at certain elements that can help us reduce this uncertainty to some extent. We summarise them as follows:

- We may reasonably assume that the economy and international trade will continue to grow substantially in the future. This trend will also manifest itself in maritime trade. Throughput in the Hamburg-Le Havre may be expected to grow proportionately, and so too may demand for hinterland transport services. Any shifts in the competitive balance between ports may however result in relative shifts in freight flows between those ports. Hence, an improvement of the E313 has direct relevance, not only to ports' capacity for growth, but also to shifts in the competitive balance.
- There are no indications of increasing profit margins in maritime transport. This is in itself rather surprising, as ocean carriage involves a risk for which investors may reasonably expect a premium. Consequently, at the level of individual shipping companies, shareholders will exert constant pressure on management to improve business results. Management will in turn continue to pressurise other links in the logistics chain, including hinterland transport services, thereby occasioning further vertical integration.
- Some shipping companies have, in recent years, taken a number of important long-term decisions, including in relation to fleet expansion. At aggregate level, this holds a real danger of overcapacity, which would inevitably lead to further rationalisation and cost reduction through partnerships, takeovers and mergers. Such movements may, or will, result in changes in terms of

shipping companies' ports of call, loops and frequency of service. Obviously this will have a knock-on effect for transport via the E313.
- In the short to medium term, overcapacity will result in lower freight rates and lower ROI, putting additional pressure on market players elsewhere along the logistics chain. Over a slightly longer time horizon, a lack of working capital may give rise to cooperation agreements that go beyond the level of dedicated terminals. Transport via the E313 will then become potential participants in an integrated logistics chain.

So how do the above insights translate into recommendations regarding the forecasting of future freight flows to ports and, subsequently, taking into account the modal distribution, regarding potential E313 flows?

1. In the first instance, one could make aggregate forecasts of future maritime transport. Preferably, one should distinguish between the general goods categories (coupled with the type of transport and vessel, e.g. containers versus break bulk) and the different shipping areas. By applying growth figures to current flows and modal shares, one obtains an initial indication of future demand.

2. Much will depend on the behaviour of the shipping companies, who are, after all, ports' largest and most influential customers. They may determine their behaviour individually or under so-called strategic alliances. Carriers may even go so far as to reduce or end their footloose behaviour if they are allocated a dedicated terminal in a particular port. In order to gain insight into such strategies, a detailed analysis is required at the level of individual shipping companies.

3. A decisive factor in individual shipping companies' behaviour is their aversion to any potential time loss. They will opt first and foremost for seaports and terminals that are free of bottlenecks. Hence the importance of having enough free and directly available capacity. Available (theoretical) container capacity, multiplied by a realistic capacity utilisation factor, is therefore a useful indicator of future throughput.

We have thus far focused primarily on container traffic and throughput. However, the ports of Antwerp and Rotterdam attract not only containers, but just about any unit load, liquid as well dry bulk, and virtually any goods category on virtually any geographical relation. And each of these submarkets is characterised by different degrees of freedom.

Moreover, a detailed analysis ought also to take account of all actors present within a particular port. Major shipping companies are approached differently than minor ones, if only because they possess different market power; terminal operators are approached differently than shipping companies, etc. In the once much praised port cluster analysis, very divergent subsectors are combined into a single measure. However, while an adequate policy does require an awareness of cluster effects, one should not neglect the singularity of individual enterprises and sectors. It would therefore appear to make sense also to look within the port perimeter at the production capacity and capacity utilisation of industrial companies and sectors (e.g. the petrochemical industry), in conjunction with existing investment plans.

The most likely scenarios, which therefore deserve to be studied in depth, are more or less known. However, the speed at which the various market players within the maritime logistics chain will take specific initiatives shall depend on a battery of exogenous and endogenous variables. As is the case with pricing in the maritime sector, and with successfully covering oneself against price fluctuations and other risks, timing is what ultimately determines who will emerge a winner. In this sense, it should be very clear that transport via the E313 is largely dependent upon the strategic decisions and the success of other market players, but that it can also contribute to the success of specific maritime logistics chains.

Table 6 provides an overview of the general trend in Antwerp's tonnage throughput in the period 1996-2008. Over the past years, an average annual growth of 3.97% has been realised in terms of tonnage unloaded. The corresponding annual average for tonnage loaded is 5.40%. In 2007, total maritime cargo handled amounted to 183 million tonnes, comprised of 105 million tonnes unloaded and 84 millions tonnes loaded.

Table 6: Maritime cargo in the port of Antwerp: Loaded en unloaded ships in tonnage (in term of percentage)

	Unloaded in port	Loaded in port	Total
year	%growth	% growth	% growth
1996	-8.01	8.54	-1.43
1997	5.29	4.71	5.04
1998	13.84	-1.70	7.05
1999	-7.86	3.14	-3.45
2000	13.70	11.75	12.86
2001	-1.31	0.91	-0.37
2002	-2.20	5.75	1.21
2003	6.89	10.58	8.54
2004	7.10	6.03	6.62
2005	4.77	5.43	5.07
2006	5.62	3.32	4.57
2007	8.54	10.17	9.28
2008	5.20	1.57	3.55
Minimum	-8.01	-1.70	-3.45
Maximum	13.84	11.75	12.86
Gemiddelde	3.97	5.40	4.50
Standard deviation	7.00	4.04	4.61

Source: Gemeentelijk Havenbedrijf Antwerpen (2009)

Container traffic has grown more rapidly than overall traffic in the port, with a recorded annual increase of approximately 11% in both loading and unloading of vessels (see Table 7). The year 2005 saw the inauguration of Deurganck Dock, whose terminals represent an additional annual capacity of approximately 7 million TEU (Gemeentelijk Havenbedrijf Antwerpen (2006)).

Table 7: Container traffic in the port of Antwerp: unloaded and loaded containers in TEUs (in terms of percentage)

	Unloaded in harbour	Loaded in harbour	Total
	%growth	%growth	%growth
1996	13.13	14.74	13.94
1997	12.72	11.07	11.88
1998	11.60	8.43	9.99
1999	9.96	11.38	10.67
2000	11.82	14.06	12.95
2001	3.95	2.73	3.33
2002	12.44	14.04	13.25
2003	12.74	15.19	13.99
2004	11.50	11.21	11.35
2005	6.93	6.87	6.90
2006	9.05	7.55	8.28
2007	16.13	16.85	16.50
2008	5.40	6.47	5.95
Minimum	3.95	2.73	3.33
Maximum	16.13	16.85	16.50
Gemiddelde	10.57	10.82	10.69
Standarddeviation	3.42	4.17	3.72

Source: Port of Antwerp (2009)

If the growth rates presented in Table 7 are indicative of future trends, then total TEU in Antwerp is set to increase from 6.482 million in 2005 to 14.938 million by 2013. In other words, supposing that all of this additional future container traffic is accommodated at Deurganck Dock, the new goods-handling facility will have reached full capacity by 2013. A further expansion of the port's capacity, with the addition of Saeftinghe Dock, is therefore under consideration.

In Table 8 and Table 9 similar tables are shown for the port of Zeebrugge. We notice that the growth of the maritime cargo is in general (a bit) lower than the growth of these flows in the port of Antwerp. The growth percentage from the container traffic is around 12%.

Table 8: Maritime cargo in the port of Zeebrugge: unloaded and loaded ships in tonnage (in terms of percentage)

	Unloade in harbor	Loaded in harbor	Total
Year	%growth	%growth	%growth
1995			
1996	-7.86	-5.11	-6.78
1997	7.43	23.26	13.71
1998	-0.17	6.50	2.70
1999	5.47	7.74	6.48
2000	-0.15	0.40	0.10
2001	-13.59	-4.71	-9.57
2002	2.81	2.51	2.66
2003	-7.33	-7.01	-7.18
2004	1.16	7.12	4.01
2005	6.08	11.60	8.79
2006	16.94	11.34	14.11
2007	3.74	9.55	6.60
2008	n.a.	n.a.	-0.13
Minimum	-13.59	-7.01	-9.57
Maximum	16.94	23.26	14.11
Average	1.21	5.27	2.73
Standard deviation	8.06	8.63	7.49

Source: Port of Zeebrugge (2009)

One may reasonably assume that, in the short to medium term, maritime throughput at Antwerp will continue to increase. Without additional investment in port throughput capacity (i.e. terminals), the port is in danger of reaching its upper throughput limit.

Table 9: Container traffic in the port of Zeebrugge: unloaded and loaded ships in TEU (percentage changes)

	Unloaded in harbour	Loaded in harbour	Total
Year	%growth	%growth	%growth
1995			
1996	4.47	4.87	4.67
1997	16.36	17.96	17.17
1998	22.76	16.94	19.78
1999	4.37	14.65	9.51
2000	12.85	14.19	13.55
2001	-10.51	-8.14	-9.26
2002	9.88	9.13	9.48
2003	5.18	5.98	5.60
2004	17.92	18.40	18.18
2005	18.11	17.24	17.65
2006	17.45	17.43	17.44
2007	25.75	19.09	22.21
2008	n.a.	n.a.	9.35
Minimum	-10.51	-8.14	-9.26
Maximum	25.75	19.09	22.21
Average	12.05	12.31	11.95
Standard deviation	10.00	8.09	8.46

Source: Port of Zeebrugge (2009)

Port of Antwerp, the second largest port in Europe for international shipping freight, is one of the main sources of lorry traffic for the route E313. Mode split data (in TEU) for recent years show that ~60% of the container turnover that is generated by Port of Antwerp is transported to/from port by road.

Ocean Shipping Consultants (2006) produced a prognosis for the future demand for container handling services in selected North-West Europe ports (see Table 10).

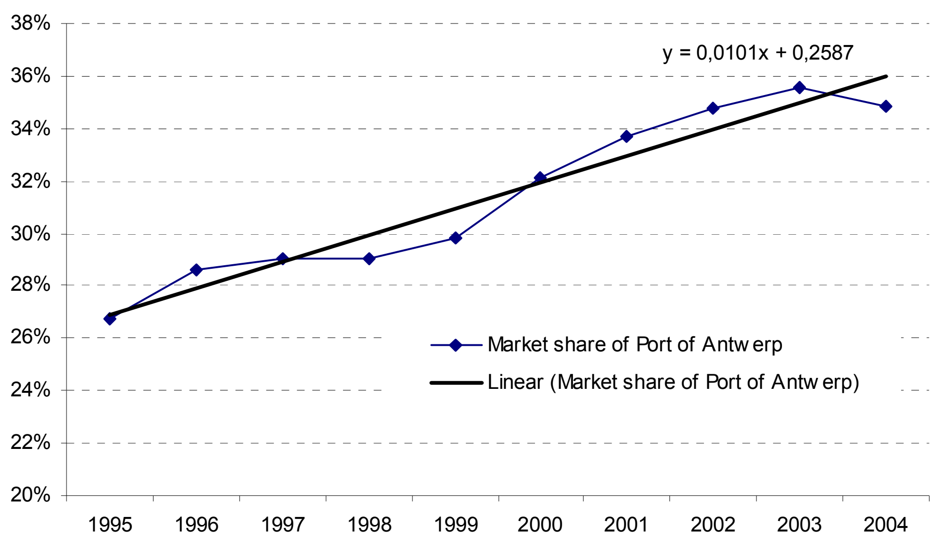
If we look at the share of port of Antwerp among these ports in Figure 11, we see that it has had an average yearly increase of 1% since 1995. There can be no assumptions that this increase in market share among other ports could continue indefinitely, but in the short run it can progress along the historic trend.

Table 10: Prognosis of Capacity and Demand for North-West Europe ports 2003-2015

Year\m TEUs	Capacity	Demand
2003	20,02	15,31
2004	21,48	17,42
2005	24,18	18,52
2006	31,62	19,87
2007	34,92	21,25
2008	40,39	22,6
2009	43,52	23,98
2010	45,64	25,41
2011	47,74	26,87
2012	47,74	28,35
2013	48,59	29,85
2014	49,44	31,36
2015	51,14	32,89

Source: Ocean Shipping Consultants (2006)

Figure 11: Port market share increase trend, Port of Antwerp



For the purpose of forecasting we will assume that there are two scenarios of port market share increase.

- Case1 – the market share of Port of Antwerp increases according to the trend as in Figure 11.
- Case2 – the market share of Port of Antwerp stays at current level, around 37%.

Based on Capacity and Demand forecast by Ocean Shipping Consultants (2006) and the two possible scenarios of the port market increase a forecast of container turnover for Port of Antwerp can be done using linear extrapolation technique (see Figure 12).

Figure 12: Container turnover forecast, Port of Antwerp

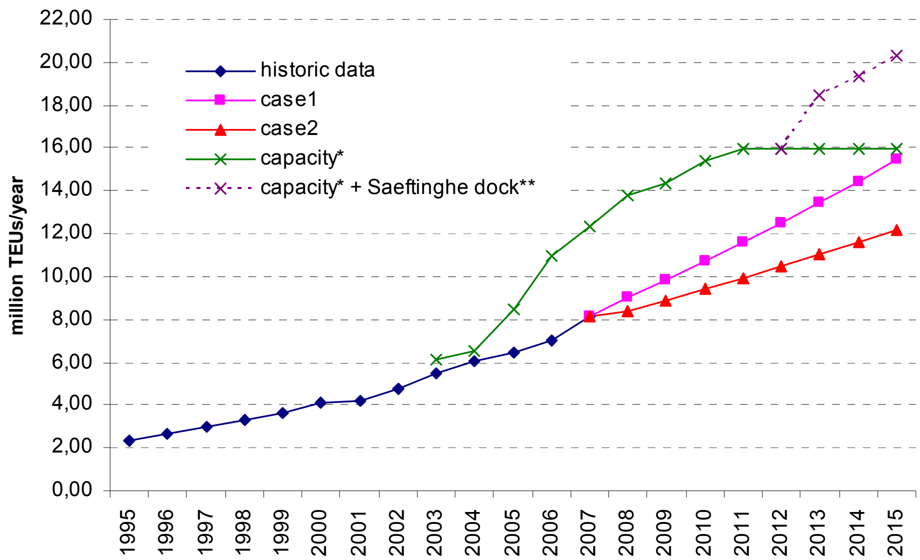


Table 11: Container turnover forecast, Port of Antwerp

	Historic data	Case1	Case2	Capacity*	Saeftinghe dock**
1995	2,33				
1996	2,65				
1997	2,97				
1998	3,27				
1999	3,61				
2000	4,08				
2001	4,22				
2002	4,78				
2003	5,45			6,15	
2004	6,06			6,55	
2005	6,48			8,50	
2006	7,02			10,95	
2007	8,18			12,36	
2008		9,04	8,36	13,78	
2009		9,84	8,87	14,38	
2010		10,68	9,40	15,38	
2011		11,56	9,94	15,98	
2012		12,49	10,49	15,98	
2013		13,45	11,04	18,48	2,5
2014		14,45	11,60	19,38	3,4
2015		15,48	12,17	20,28	4,3

*Capacity forecast for Port of Antwerp by Ocean Shipping Consultants (2006)

** Forecast of Saeftinghe dock capacity

Container turnover in future years is expected to continue its growth and in the optimistic scenario (Case1) it is expected to reach 15.5 million TEUs. However, in a pessimistic case, (Case2) it will rise to 12.7 million TEUs in 2015.

It is important to look at the port container handling capacity, because it is a limiting factor in port development. There is also a risk in decreased service level in the port in case it is working near its full capacity. The information on forecasted container handling capacity by Ocean Shipping Consultants is displayed in Figure 12 and Table 11. Forecast of Saeftinghe dock capacity development in Port of Antwerp from 2013 is given.

Comparison of the historic data on port turnover for port of Antwerp (see Table 11) to the traffic count data obtained from Verkeerscentrum on heavy goods vehicle traffic for years 2001-2007 was done. The analysis showed that there is correlation between the traffic volumes of those vehicles on the motorway E313 and the port turnover, however not very pronounced. Therefore, the forecasted increase in port traffic (see Table 11) will also have effect on the heavy goods vehicle traffic on the motorway E313.

Section 1d: Short Sea Shipping

The United Nations (Economic Commission for Europe), European Conference of Ministers of Transport (ECMT), and the European Commission (EC) in 2001 jointly defined Short Sea Shipping (SSS) as 'the movement of cargo by sea between ports situated in Europe as well as between ports in Europe and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe'. SSS services are needed both for feedering, that is, distribution of intercontinental shipments, and intra-continental transport. (Becker J.F.F. *et al.* (2004))

Although SSS reduces the overall amount of the traffic by road, it is linked with locally centralized traffic (from and to ports) increase. This also affects motorway E313 and trends of increase in SSS should be taken into account.

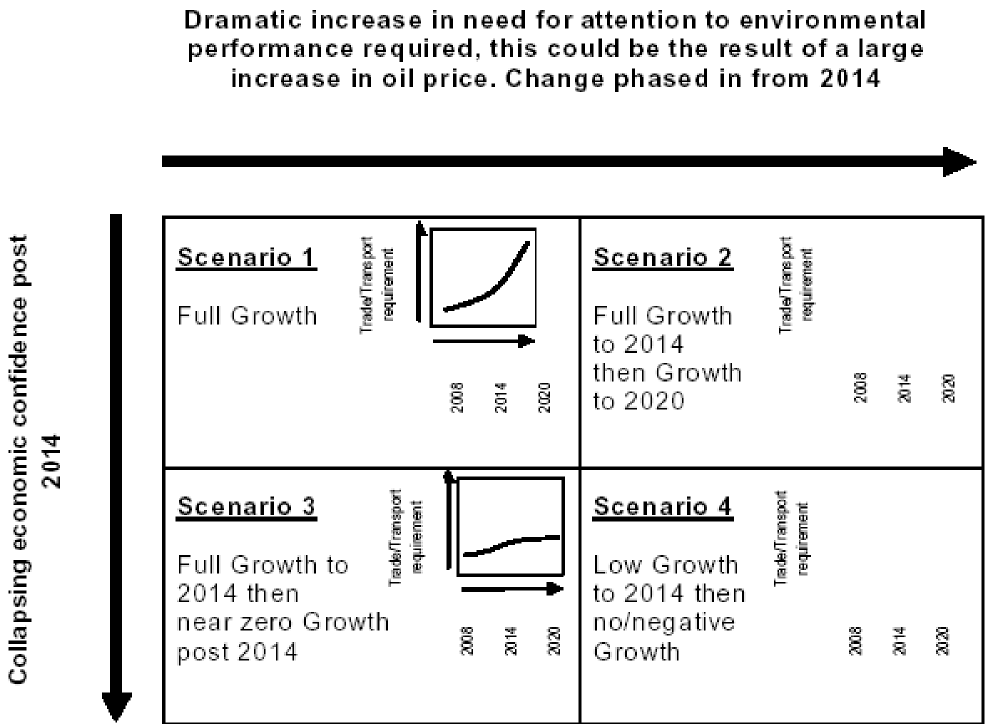
To be able to test the effectiveness of SSS within this context, it is important to place SSS as an integrated part of a door-to-door logistics chain under the framework of Motorways of the Sea (MoS) services. Therefore, the strength of the MoS concept will be evaluated under different scenarios.

Under the MOSES Project, four scenarios to test the MoS Concept were developed. Two high level key drivers were chosen to drive scenario development: the degree of collapse in economic confidence and the degree of environmental awareness and energy cost. The scenarios are depicted in Figure 13, for each scenario its influence on trade levels and therefore transport demand are schematically presented. A timescale of 2008 to 2020 was chosen for scenario development. Within these twelve years, it could be expected that major structural changes will have been planned and implemented. The 2020 limit was also chosen as it is a key date used within the Commission’s White Paper on Transport Policy.

A base scenario, scenario 1, uses optimistic trade forecasts to produce a high growth scenario covering the period 2008-2020. During this period, Europe will experience high economic growth, and the low energy prices further boost the transport intensity. Moreover, scenario 1 follows the same general prediction for increase in demand for transport used for 2020 in the White Paper on transport issued by the European Commission. Two additional scenarios were developed directly from this base scenario.

Scenario 2 assumes full growth occurred for around half the time period considered and after this the growth was tempered by major energy cost increases in combination with an increased focus on sustainability.

Figure 13: Four SSS scenarios



Scenario 3 again assumes full growth for half the time period considered followed by a collapse in confidence in the financial markets leading to reduced consumer demand and investor confidence. This drives was assumed to have a more marked negative effect on trade volume growth than in scenario 2.

A fourth scenario assumed that a market driver depressed growth in trade volumes from 2008 to around 2014 and then assumed that both of the negative drivers of high energy costs and reduced confidence in the financial markets both occurred (used in scenarios 2 and 3). The combined effect of these drivers will be considerably reduced requirements for transport volumes in 2020 compared to today.

These four scenarios were further analyzed in the context of MoS and a SWOT analysis was executed to understand the strengths, opportunities, weaknesses and threats of MoS under the different scenarios. The results of the SWOT analysis are presented in Table 12.

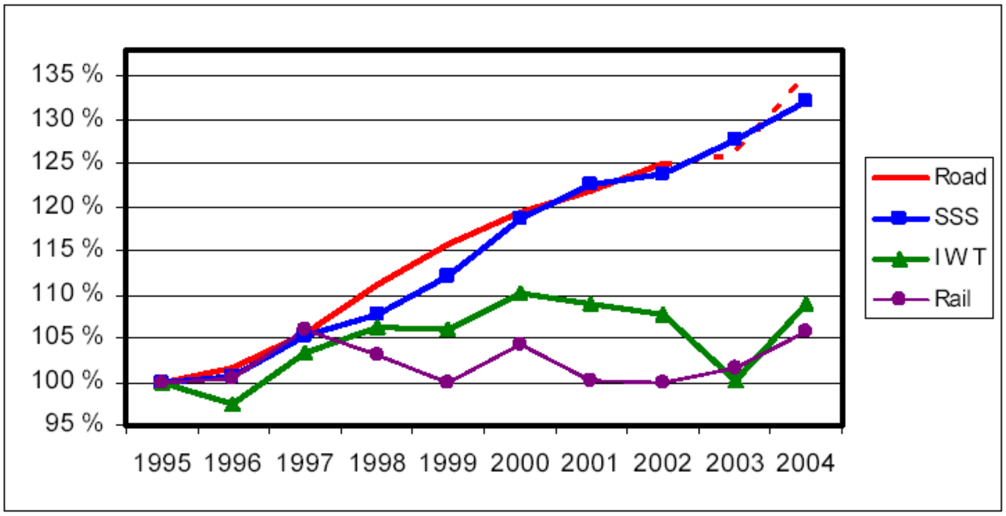
Table 12: SWOT Analysis MoS

	SCENARIO 1 Full Growth	SCENARIO 2 Environmental/Sustainability Driver – Reduced Growth	SCENARIO 3 Financial Driver – Reduced Growth	SCENARIO 4 Reduced Growth and Decreased Transport Volumes
Strength	• Able to provide transport capacity • In general MoS solutions are cost competitive in comparison to road only solutions • Perception as an environmentally friendly mode of transport	• Good environmental performance due to the fact that seagoing vessels need less fuel than trucks to do the same transport work • Cost effective transport mode • Increased market share of MoS and SSS in Europe will contribute to a reduction of European energy consumption	• Some routes pre-existing and MoS concept/implementation accepted	• Good environmental performance due to the fact that seagoing vessels need less fuel than trucks to do the same transport work • Cost effective transport mode • Increased market share of MoS and SSS in Europe will contribute to a reduction of European energy consumption
Weakness	• Availability/cost of suitable vessels • Ports need to continually expand • Use of large vessels to gain economy of scale will give concentration of cargo through fewer ports which might contribute to addition increase of road transport • Increased pressure on the road and rail infrastructure in port hinterlands	• Unless smaller vessels (below 5-10 000dwt) are made more fuel and cost efficient, then improvements made by truck manufactures will make them better in terms of cost and environmental performance • Risk that there is a lack of investment to develop the vessels of the future that can 'match' the fuel and emission gains achieved by aviation and trucks during the last few decades • Availability/cost of suitable vessels	• Investors want good returns on their investments. This favours investments in trucks which have a fast payback compared to vessels • High capital costs of ships and port developments • Low investment in vessels and MoS land based infrastructure due to predicted low returns • No/low investment in R&D/innovation	• Slow/limited take-up of MoS • High capital costs of ships and port developments • Low level of investment due to low returns • High capital costs of ships and port developments • Limited funds for R&D/innovation
Opportunity	• High trade flows • Money available to invest in new technologies • The market is prepared to pay good freight rates • Investors see good returns on their investments	• Environmentally efficient transport required and demanded by the European population • Excellent availability of capital to invest in new vessels and port facilities • Customers will pay a premium for new vessels which offer additional improvement in fuel efficiency and a lower carbon footprint	• MoS services could be competitive but on fewer routes • Good availability of ships due to some cancelled MoS routes • Ship prices 'reasonable' • More hub ports used therefore less feedering offers more opportunities for pure SSS ships	• Environmentally efficient transport required and demanded by the European population • There will be a market for new vessels which have better environmental performance than older ones.(C.f. aviation where old planes have been grounded and replaced by new more fuel efficient aircraft)
Threat	• Limited port space available • More port facilities allocated to DSS and less to SSS • Congestion around port hinterlands • Pressure for more port developments • Conflict between logistics operations and neighbours • Environmental threats have to be well managed	• The increased environmental pressure and high cost of energy makes local production more profitable. This might result in reductions of transport volumes • The pressure for more port developments gives conflict between logistics operations and neighbours in port areas. Due to this it becomes politically easier to use more road only solutions	• Reduced trade volumes • Focus on low capital investment modes of transport such as trucks • New tonnage gets cancelled • Reduced trade results in cancellation of marginal services • No new MoS routes required	• Low trade volumes • Reduced land transport congestion may negate need for MoS services • Improvements in truck efficiencies make them more fuel efficient than comparable MoS based D2D chains

SSS has maintained its position as the only mode of transport able to challenge the fast growth of road transport. Between 1995 and 2004 (Figure 14), the tonne-kilometre performance of Short Sea Shipping in the EU-25 grew by 32 %, while road performance grew by 35 % (European Commission (2006b)).

SSS holds an important share of the transport market within the European Union. Around 43% of the moments of goods within Europe are executed by SSS and the relevance of this transport mode in maintaining an efficient transport system in Europe today and in the future was emphasized by the European Commission in its White Paper on European Transport Policy 2010.

Figure 14: Tonne-kilometre growth 1995-2004 per transport mode in the EU



Source: Mid-Term Review of the Programme for the Promotion of Short Sea Shipping, European Commission (2006b)

SSS plays a key role in ensuring sustainable mobility and also contributes to meeting other objectives, like alleviating congestion and environmental pressure. However, the development of SSS should be analyzed under the principle that efficient SSS routes are relevant for the development of sustainable transport only if they are an integrated part of a door-to door logistic chain, and mainly as part of the MoS network that will be connected to the hinterland transport structure. Linking therefore sea transport with all other surface transport modes by transforming port terminals into seamless motorways junctions (MOSES Project, European Commission (2007c)).

Nevertheless, a number of obstacles still hinder Short Sea Shipping from developing faster:

• It has not yet reached full integration in the multimodal door-to-door supply;
• It involves complex administrative procedures;
• It requires higher port efficiency and good hinterland accessibility.

The increased utilization of SSS therefore depends not only on the appropriate promotion of suitable legislative, technical and operational actions by the corresponding national and European institutions but also the development within the market of an appropriate service that integrated in a door-to door chain would compete in equal terms with road transport. In that sense, the elevation of the bridges and the widening of the Albert canal make that SSS vessels can go door to door to waterbound companies along the canal.

In terms of measures promoting SSS and the appropriate infrastructure development, programmes like Marco Polo I and II, as well as the projects that will be funded by the TENT-T Programme will contribute to set the conditions required to operate services in a competitive way. Additional policy measures will be analyzed on in section 1f, linking the actions to the existing logistic trends within the EU and the development of different scenarios to evaluate the strengths and opportunities of SSS as part of an integrated door-to-door logistic chain (MoS concept).

The research reveals that SSS services as an integrated part of a logistic chain competing with road only solutions need to comply with the requirements of the users in terms of reliability, price, speed, frequency, flexibility and capacity (points of parity). However, is the sustainability of SSS as a mode of transport at the economic, social and environmental level (Table 13), that will provide SSS the points of differentiation and therefore the ability gain market share.

Table 13: Sustainability of SSS

Economic	*Social*	*Environmental*
• Energy use • Economy of Scale / Efficiency • Extra Capacity • Lack of Truck drivers + Road Congestion	• Congestion of road • Road accidents • Truck-drivers life style	• Air pollution • Environmental impact of infrastructures • Noise

The evolution and therefore the success or failure of SSS as an integrated part of door-to-door logistic chains depend on the ability to develop the appropriate infrastructure, operational conditions (e.g. maritime space without frontiers) and the product (points of parity and differentiation) to compete with road only solutions.

The annual average growth rate in tonnages of SSS for the years 2000-2006 for Belgium was 3.2%, which was above the average of EU-15 countries of 3.0%. The container turnover in SSS in Belgium for the same years has gone up on average by 19.3% compared to the average of EU-15 countries of 8.0%. (Amerini (2008))

Experts notice that on bigger waterways (e.g. Zeekanaal, Albert canal, Boven-Zeeschelde and Beneden-Zeeschelde) inland shipping can be substituted by SSS and vice versa. Last years, a trend has been identified showing that SSS-flows have been transported by barge (designed for inland waterways) to the port of Antwerp, where the goods have been loaded into a sea vessel. Cause for this trend is the increase in scale of sea transport and SSS-vessels having problems using the Albert canal (given the limitations of the Albert canal). However, after the improvements of the Albert canal infrastructure, a boost in SSS on the Albert canal is expected.

Section 1e: European developments

Developments / decisions

Europe is currently in a situation where the pressure from increasing goods flows rises. The road network is congested, the rail sector is struggling to increase freight transport capacity, and the land based infrastructure cannot readily cope with the increase in traffic volume. Additionally, in Flanders, a supplementary problem occurs with inland navigation, which is hampered in some locations by too shallow waters. As European freight volumes might increase with as much as 50% by the year 2020[7] the situation will continue to worsen unless action is taken.

To tackle this, the European Commission has the following EU transport ambitions:

- Relieving the pressure on the roads through reducing distances driven by trucks.
- Reducing energy consumption and emissions of green house gases per tonne of transported cargo.
- Improving European competitiveness with respect to North America and Asia through reduced energy consumption and more efficient logistics practices[8].
- Enabling the small and medium enterprise (SME) sector involved in logistics (as users and/or operators) to compete on an equal footing with the 'big players' and to provide them access to the same advantages of SSS services that the larger industry players charter for their shipping within Europe.

In order to plan future developments of the E313 motorway, it is essential to know current and future legislative restrictions that apply. Since 1992, the European Commission has made SSS one of the major priorities for European transport and maritime industries have made it one of their key areas for development. Short sea shipping is defined as any carriage of goods or people between two European Union ports or The European Union and ports in neighbouring countries. Various initiatives have been taken to promote short sea shipping, including the establishment of a

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[7] Institute of Shipping Analysis, Göteborg *et al.* (2006)

[8] Jacques Barrot, in his address to the consultation workshop on Transport Logistics (Brussels, 5th Oct 2006)

European network of National Short Sea Promotion Centers and a number of EU funded projects (e.g. REALISE and, recently started, PROPS)

A number of specific actions have been taken by several European bodies to support and promote the development of SSS:

- The Commission's Communication on SSS in 1999 analyzed obstacles that hinder the development of the mode and advocated a door-to-door approach with one-stop shops.
- In June 2002, the European Union Transport Ministers held an informal meeting in Gijón (Spain) dedicated to Short SSS. Following this meeting, the Commission prepared a Programme for the Promotion of Short Sea Shipping.
- In 2004, the Commission presented a further Communication on SSS reporting on progress since 1999. This was followed by an informal meeting of the European Union Transport Ministers in July 2004 in Amsterdam.
- In January 2006, a Ministerial conference in Ljubljana (Slovenia) prepared conclusions on MoS.
- Also the European Parliament has, on several occasions, confirmed its dedication to promoting SSS. Its latest Resolution on the subject dates from April 2005.

Additionally, the Trans-European Networks policy was gradually developed during the 1990s. In 1996, the European Parliament and the Council of Ministers adopted a decision setting out the guidelines for the development of the Trans-European Transport Network in 2010. This decision was revised in 2001 to include sea and inland ports. The White Paper considered that one of the primary missions of the Trans-European Network for Transport (TEN-T) was to "relieve congestion on major routes". At the meeting in Gijón in Spain (2 June 2002), EU Transport Ministers invited the Commission to draw up an action plan for SSS. On 10 April 2003, the European Commission adopted a 14-point programme for boosting short sea shipping, citing, inter alia, sea motorways. The sea motorways concept had been developed in the proposals made by the working group under the direction of Mr Karel Van Miert in 2001.

On 1 October 2003, the European Commission announced the extension of the TEN-T to contribute to the success of enlargement, to reduce congestion, and to encourage intermodality: "A new mechanism for supporting motorways of the sea is proposed to encourage joint initiatives by the Member States to launch new regular transnational cargo shipping lines (...). It will give the sea motorways which improve links with island and countries isolated by natural barriers such as the Alps, the Pyrenees and the Baltic Sea the same importance as motorways, inland navigation and railways in the trans-European network." It was made clear that: "freight flows concentrated on sea-based logistical routes"; "increased cohesion", and reducing road congestion" were the essential aims to be incorporated in the MoS concept.

There is a variety of European funding instruments and support measures that may be deployed to support the development of SSS/MoS. These include:

- **Infrastructure funding**, including:
  - TEN-T Finance
  - EU Structural Funds
  - European Investment Bank Loans and Guarantees

- **Operational funding,** including
  - Marco Polo Programme

- **Other Support,** including:
  - EU InterReg Funding
  - Marketing and Promotion Activities
  - EU RTD Funding
  - EU Standardisation Actions
  - National Agencies and Actions

From June 2006 the Commission has extended the Focal Points Short Sea Shipping meetings (twice a year) to cover also MoS issues. These meeting bring together the European Commission key officials from the Member States, together with the Short Sea Promotion Centres; representatives of maritime industries (the MIF); the EIB, and others providing briefings on key issues and projects.

Finally a further Working Document on Motorways of the Sea was included in a Communication on Freight Transport Logistics published 18.10.2007, and a further web-based consultation of stakeholders was carried out between October 2007 and January 2008. The aim has been to try to achieve a coherent and common view among Member States and the main stakeholders on a way forward for MoS.

Other EU legislation and developments that may have influence on further development of E313 motorway are the following.[9]

1. **Taxation of heavy goods vehicles: "Eurovignette" Directive**
   Directive 1999/62/EC of the European Parliament and of the Council of 17 June 1999

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[9] Sources: European Commission (2008d) and European Commission (2008c).

Amending acts:

1. *Directive 2006/38/EC*
2. *Directive 2006/103/EC*

The Directive covers vehicle taxes, tolls and user charges imposed on vehicles intended for the carriage of goods by road and having a maximum permissible gross laden weight of not less than 12 tonnes. From 2012 onwards Directive 2006/38/EC will apply to vehicles weighing between 3.5 and 12 tonnes.

Proposal for a Directive on road tolls for lorries (ammending 1999/62/EC)

This proposal would enable Member States to reduce environmental damage and congestion through more efficient and greener road tolls for lorries. Revenue from the tolls would be used to reduce environmental impacts and cut congestion.

This proposal is part of Greening Transport Package (adopted 8 July 2008).

(European Commission (2008c))

In the consolidated version of 1999/62/EC:

Chapter I: general provisions

Chapter II: defines vehicle taxation (annual)

Chapter III: on tolls and user charges:

Member States may maintain or introduce tolls and/or user charges on the trans-European road network, or on parts of that network, only under the conditions set:

- only to vehicles having a maximum permissible laden weight of not less than 12 tonnes
- to **all vehicles** (used for carriage of goods and having a maximum permissible laden weight of over 3,5 tonnes) **from 2012**

Tolls and user charges may not discriminate.

Member States may provide for reduced toll rates or user charges for exemptions from the obligation to pay tolls or user charges for vehicles exempted from the requirement to install and use recording equipment under Council Regulation (EEC) No 3821/85.

User-charge rates shall be in proportion to the duration of the use made of the infrastructure. A Member State may apply only annual rates for vehicles registered in that State.

Toll rates may be varied according to:

— EURO emission class, provided that no toll is more than 100 % above the toll charged for equivalent vehicles meeting the strictest emission standards; and/or
— the time of day, type of day or season.

Maximum toll rates are set according to EURO emission class and number of axels:

Table 14: European toll rates

	maximum three axles	minimum four axles
EURO 0	1332	2233
EURO I	1158	1933
EURO II	1008	1681
EURO III	876	1461
EURO IV and less polluting	797	1329

Maximum monthly and weekly rates are in proportion to the duration of the use made of the infrastructure. The daily user charge is equal for all vehicle categories and amounts to EUR 11.

In the greening package proposal (ammending 1999/62/EC):

It is proposed to enable Member States to calculate tolls on the basis of the costs of local pollution, congestion and noise.

Member States shall not impose within their territory both tolls (for using certain roads) and user charges (whole road network).

For a transitional period until 31 December 2011 inclusive, a Member State may choose to apply tolls and/or user charges only to vehicles having a maximum permissible laden weight of not less than 12 tonnes. From 1 January 2012, tolls and/or user charges shall be applied to all vehicles used for carriage of goods and having a maximum permissible laden weight of over 3,5 tonnes (possibe exemption under certain conditions if a country decides).

User charges shall be in proportion to the duration of the use made of the infrastructure and shall be available for the duration of a day, week, month and a year. In particular, the annual rate shall be no less than 80 times the daily rate, the monthly rate shall be no less than 13 times the daily rate and the weekly rate shall be no less than five times the daily rate.

User charges, including administrative costs, for all vehicle categories shall be set by the Member State concerned at a level which is no higher than the maximum rates (rates stay unchanged).

Tolls can be varied, but no toll is more than 100% above the toll charged during the cheapest period of the day, type of day or season.

Memberstates can choose to include external costs in user charges. The amount of the external cost charge for each combination of class of vehicle, type of road and time period shall be set in accordance with the minimum requirements, the common formulae and the maximum chargeable external costs in Annex IIIa of the proposed directive. For each vehicle class, type of road and time period, the independent authority shall determine a single specific amount. External cost elements are:

1. cost of traffic-based air pollution
2. cost of traffic-based noise pollution
3. cost of congestion

Values in euro cent/vehicle kilometre are given for those costs.

2. **Road safety: Road Safety Action Programme (2003-2010)**
   Main measures: to propose a Directive on road infrastructure safety, draw up technical guidelines concerning audit methods, urban safety management and speed-moderation techniques, draw up good practice guidelines for level-crossings, carry out research and demonstration projects on 'intelligent roads', carry out safety impact assessments of new projects, improve safety levels in tunnels , etc.
   (European Commission (2003))

3. **Road vehicles: maximum weights and dimensions**
   Council Directive 96/53/EC of 25 July 1996 laying down for certain vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic.
   Amending act: Directive 2002/7/EC

4. **Freight Transport Logistics Action Plan**[10]

   The general objective of Freight Transport Logistics general objective of the Logistics Action Plan is to mobilise untapped efficiencies in logistics in order to make more judicious and more

[10] European Commission (2007a)
http://ec.europa.eu/transport/logistics/freight_logistics_action_plan/action_plan_en.htm

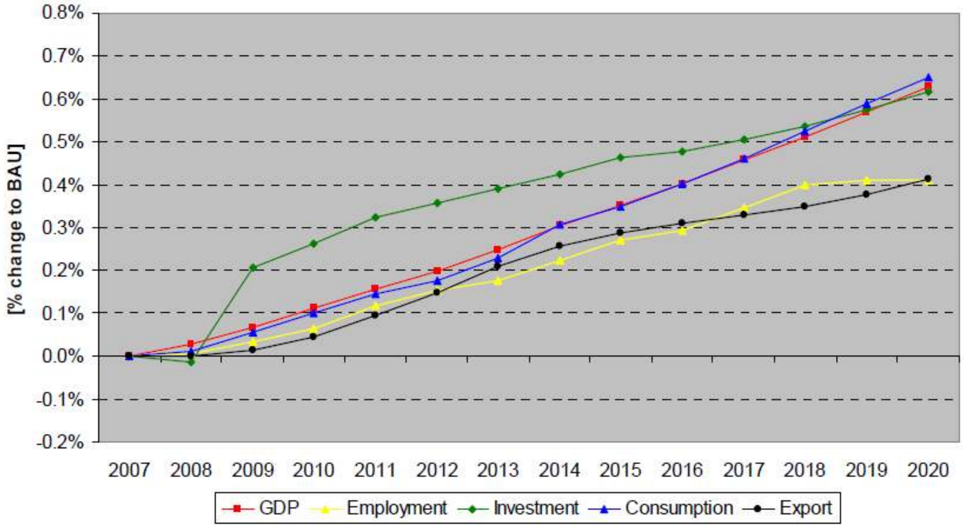
effective use of freight transport operations. It pursues the principle of comodality, i.e. to improve the efficiency of each transport mode and to overcome interoperability obstacles between modes in order to help mobilise capacity reserves in Europe's transport systems and put these on a path towards sustainable growth. (European Commission, 2007)

The Action Plan will help:
– achieve a better utilisation of transport infrastructure, including through vehicle management and loading factors, and the pin-pointing of infrastructure investments that would benefit freight,
– improve cross-border management of freight flows and the associated administrative reporting requirements,
– better integration of transport modes and the reduction of friction costs affecting intermodal transport,
– more emphasis on quality criteria in modal choices,
– and higher competence levels, mobility and attractiveness of the logistics professions. (European Commission (2007a))

The effects of the action plan

It is planned that the Action Plan will improve productivity rates in the logistics sectors by at least 3% in inland transport, by 5% for auxiliary transport services and 3% for communications. It will furthermore decrease freight logistics costs by 2% and freight transport times by 3%, as well as increase load factors by 3%. These figures are based on expert judgements of the expected overall effects of the measures proposed in the Logistics Action Plan. Using the ASTRA model for computation, it was calculated that these changes will lead to an increase of the average yearly GDP growth rates for EU27 by +0.04% compared to a "business as usual" scenario (see Figure 15). Despite the relatively smaller figure, this would still result in several billion euros additional growth per year. (European Commission (2007a))

Figure 15: Impacts of Socio-Economic Aggregates for EU27



5. TEN-T plans[11]

The Trans-European Transport Networks (TEN-T) are a planned set of road, rail, air and water transport networks designed to serve the entire continent of Europe. TEN-T envisages coordinated improvements to roads, railways, inland waterways, airports, seaports, inland ports and traffic management systems.

The following are the TEN-T axes and priority projects[12]:

1. Railway axis Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermo
2. High-speed railway axis Paris-Bruxelles/Brussel-Köln-Amsterdam-London
3. High-speed railway axis of south-west Europe
4. High-speed railway axis east
5. Betuwe line
6. Railway axis Lyon-Trieste-Divača/Koper-Divača-Ljubljana-Budapest-Ukrainian border
7. Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest
8. Multimodal axis Portugal/Spain-rest of Europe
9. Railway axis Cork-Dublin-Belfast-Stranraer (completed 2001)
10. Malpensa (completed 2001)
11. Öresund fixed link (completed 2000)
12. Nordic triangle railway/road axis

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[11] *http://ec.europa.eu/ten/transport/index_en.htm*
[12] *http://ec.europa.eu/ten/transport/maps/axes_en.htm*

13. UK/Ireland/Benelux road axis
14. West coast main line
15. Galileo
16. Freight railway axis Sines-Madrid-Paris
17. Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava
18. Rhine/Meuse-Main-Danube inland waterway axis
19. High-speed rail interoperability on the Iberian peninsula
20. Fehmarn Belt railway axis
21. Motorways of the sea
    - Motorway of the sea of western Europe (leading from Portugal and Spain via the Atlantic Arc to the North Sea and the Irish Sea);
    - Motorway of the sea of south-east Europe (connecting the Adriatic Sea to the Ionian Sea and the Eastern Mediterranean to include Cyprus);
    - Motorway of the sea of south-west Europe (western Mediterranean), connecting Spain, France, Italy and including Malta, and linking with the motorway of the sea of south-east Europe.
22. Railway axis Athina-Sofia-Budapest-Wien-Praha-Nürnberg/Dresden
23. Railway axis Gdansk-Warszawa-Brno/Bratislava-Wien
24. Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen
25. Motorway axis Gdansk-Brno/Bratislava-Wien
26. Railway/road axis Ireland/United Kingdom/continental Europe
27. "Rail Baltica" axis Warsaw-Kaunas-Riga-Tallinn-Helsinki
28. "Eurocaprail" on the Brussels-Luxembourg-Strasbourg railway axis
29. Railway axis of the Ionian/Adriatic intermodal corridor
30. Inland waterway Seine-Scheldt

The effects of the TEN-T plans:
The TEN-T network axis with most impact to motorway E313 are Nr.24 – Railway axis Lyon/Genova – Basel – Duisburg - Rotterdam/Antwerpen, which includes the “Iron Rhine” Rheidt-Antwerp railway (see Section 1g: Iron Rhine) and Nr.18 Rhine/Meuse-Main-Danube inland waterway axis and its part Albert canal (see Section 1b: Albert canal). Other TEN-T network links have little or no impact on the motorway E313.

Experts state that building a bigger lock in Ternaaien (cf. TEN-T nr. 18) will have an increase of the traffic on the Albert Canal. The bigger lock will improve the connection between the port of Antwerp and Dutch Limburg.

Section 1f: Flanders Logistics – Flanders Port Area – Flanders Inland Shipping Network

On the basis of oral interviews and online surveys, eight tracks were taken into consideration for further development and approach. Four of them can have an impact on E313 traffic. A summary is listed below.

Stimulate multimodal traffic

1. Development a public calculation tool, which can be offered by Flemish Government.
2. Appointing an active promoter of the efficiency of combinations of transport modes.
3. Next to inland waterways quays, also support railroad connections.
4. Parcels being transported with alternative transport modes (could be in combination with road transport) should be supported on the basis of avoided tkm.
5. Support of companies who want to run a pilot project on the bais of the additional costs that are made.

Stimulate co-loading

1. Conquer the obstacles of co-loading.
2. A calculation tool for illustration and support would be very useful.
3. Companies who put themselves as an example should be financially supported for their extra costs.

Night loading and unloading

Role within seaports.

- Recycling (re-usage) of small ships.
- To set up a container transferium

The aim of re-using smaller vessels (inland shipping) is mainly in function of the use of inland shipping on smaller canals (< CEMT class IV: 1350 ton), instead of increasing the share of inland shipping in sea ports. This measure is part of the action plan of Flanders Inland Shipping Network (among others: subsidy of investments in smaller vessels, facilitating investments).

Section 1g: Iron Rhine

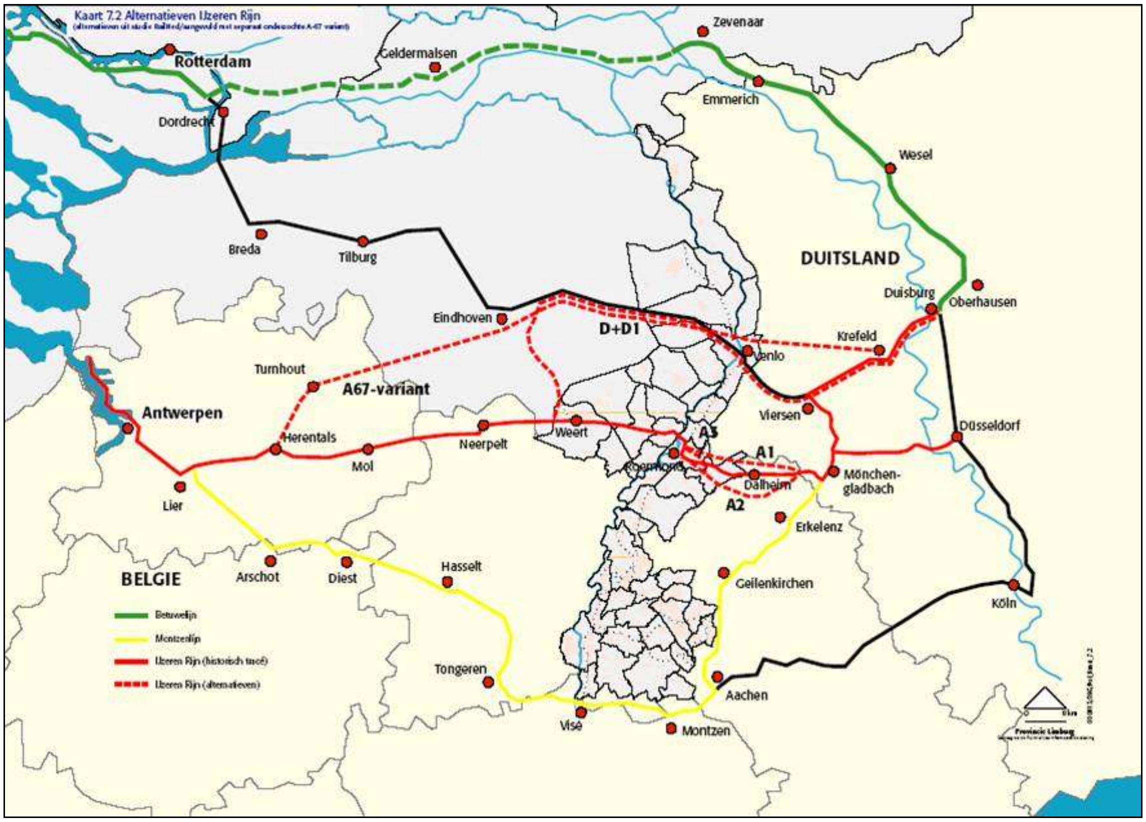
Background information

The Iron Rhine is a potential competitor of the E313 motorway. It is the historic railway line (since 1879) that runs from Antwerp to Duisburg. Since 1991 this track has not been used anymore for international through trains. The Iron Rhine is a railway line that connects the port of Antwerp to the German Ruhr area. From Antwerp the track runs through, among others, Lier, Budel, Weert and Roermond and ends in Mönchengladbach. The complete track has a length of 162 km of which 96 km is located in Belgium, 48 km in the Netherlands and 18 km in Germany. For the moment, only the Dutch part of the track is fallen into disuse.

In 2004 Belgium requested a reopening of the Iron Rhine. This is the result of the increasing transport of goods between the port of Antwerp and the German Ruhr Area. As part of the European policy of modal shift on the increasing traffic of goods, transport over railway lines and waterways is preferred over road transport.

Currently Belgium uses the Montzenroute, south of the Iron Rhine, from Antwerp to Aachen via Aarschot, Hasselt, Tongeren and Montzen, for transportation of goods to Germany. High passenger traffic on parts of this route causes a lack of capacity for goods, and a number of steep inclines over the route make it problematic for long and heavy trains.

Figure 16: Iron Rhine alternatives



Source: Provincie Limburg (The Netherlands)

The Belgian request is based on the treaty of 1839, and the Iron Rhine Treaty of 1873. Critics feel that Belgium cannot call upon these treaties, as in the treaty of 1873 Belgium had been granted a concession of 99 years on the Iron Rhine Railroad, a period which ended in 1972. Furthermore, Belgium has sold the railroad to the Dutch Government. The strongest argument is that the railroad runs through the nature reserve of De Meinweg, and nature activists fear destruction of the local habitat of several threatened species.

After a series of failed negotiations, the Belgian and Dutch governments agreed to take the issue to the Permanent Court of Arbitration and respect its ruling in the case. In its ruling of May 24, 2005, the court acknowledged both the Belgian rights under the cessation treaty of 1839 and the Dutch concerns for the nature reserve. The 1839 treaty still applies, the court found, giving Belgium the right to use and modernize the Iron Rhine. However, it has to finance the modernisation of the line, while the Netherlands have to fund the repairs and maintenance of the route. Both countries will split the costs of the construction of a tunnel beneath the nature reserve.

Forecasts Iron Rhine[13]

The Belgian Government has stated its intention to resume and intensify the use of the Iron Rhine railway line. Restoration, alteration and modernisation (referred to as "reactivation") of the Iron Rhine route will therefore be required. In March 1999, the Belgian, Dutch and German transport ministers decided to examine the feasibility of reactivating the line. Within this framework NEA, together with the University of Antwerp, undertook a study in 2001 for Railinfrabeheer (RIB).

After the verdict pronounced by the Court of Arbitration regarding the dispute between the Belgian and Dutch governments and the subsequent conditions imposed, it was decided to bring the design, transport forecast and cost analysis relating to the Iron Rhine up to date. With this objective, Infrabel and Prorail now require new transport forecasts based on the most recent information. In a future section of the study a cost benefit analysis (CBA) will be performed.

At the end of September 2006 the study was awarded simultaneously to two independent teams of consultants (consortium 1: NEA and Universiteit Antwerpen; consortium 2: TML and TNO). Although both teams have used the same basic principles, this approach permitted an independent assessment of the basic principles.

The central issue in this study can be formulated as follows:

The formulation of the transport and traffic forecasts for the Iron Rhine in 2020 and 2030

The years chosen for the forecasts are 2020 and 2030. The following three economic scenarios have been formulated:
• Scenario 1: Low economic growth
• Scenario 2: Normal economic growth (reference scenario)
• Scenario 3: High economic growth

As well as the economic scenarios, two different transport policy scenarios have been formulated:

• Scenario A: A scenario with moderate policy measures where existing policies and long-range plans are continued, including the levying of tolls on European Motorways.

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[13] This part is based on the executive summary in NEA Transport research and training and Universiteit Antwerpen (2007)

• Scenario B: A scenario with dynamic policy measures in which additional effects due to the liberalisation of the rail line are implemented in combination with the internalisation of external costs. The levying of tolls on European Motorways also applies to this scenario.

Two different infrastructure scenarios have also been established, namely:

• Scenario without the Iron Rhine.
• Scenario with the reactivating of the Iron Rhine.

No capacity restrictions have been placed upon the Iron Rhine, should this be reactivated. Likewise, as discussed with the steering group, no capacity restrictions were placed upon the Montzen-route.

There are different future scenarios predicted for freight transport, therefore the effects of economic growth, transport policy and the reactivation of the Iron Rhine can be examined in detail.

In addition to the analysis of freight transport via the Iron Rhine, the potential for passenger transport has also been assessed. It can be concluded that a long distance connection via the Iron Rhine has little potential for success and would not be financially viable. There are good competing alternatives, which are superior to the connection via the Iron Rhine. Besides the long-distance connections, the potential for regional passenger transport over the Iron Rhine was also considered. Again it has been concluded that the level of estimated demand is insufficient to support profitable services.

For the assignment of freight flows to the rail network, an "all or nothing" methodology has been used based entirely on the minimisation of travel time. For each origin-destination combination, the model selects the route with the shortest travelling time. The conclusion drawn from a sensitivity analysis of the travel times on the Montzen-route and the Iron Rhine, is that many origindestination pairs are relatively unaffected and therefore relatively indifferent between the Montzen and the Iron Rhine routes. Approximately half of the freight flows using the Iron Rhine gained less than fifteen minutes compared to the Montzen route. These freight flows could therefore be easily rerouted over the Montzen-route with very little relative time loss.

By the year 2020, in a situation where the Iron Rhine is reactivated, the line is expected to attract between 9.4 and 12.3 million tonnes on the section crossing the Netherlands-Belgium border, depending upon the scenario. Most of the freight (approximately 80%) is estimated to have diverted from the Montzenroute. Freight transport from other competing rail lines would also be attracted, e.g. the route from Belgium via

Luxembourg to Germany and the Brabant route. A slight modal shift of 0.3 to 0.4 million tonnes towards rail will also occur, mainly diverted from inland shipping. By the year 2030, the volume of freight transported over the Iron Rhine will have increased to between 10.8 and 17.2 million tonnes, depending upon the scenario.

In a subsequent step, the transported tonnes per year were converted to the number of trains per day based on reliable conversion factors estimated by type of train. Depending on the scenario, the number of freight trains expected to travel over the Iron Rhine in 2020 is between 62 and 82 per day; in 2030 this is expected to have increased to between 72 and 115 freight trains per day. These figures include the empty freight trains and are based upon estimated counts on the rail link that crosses the Belgium-Netherlands border. Most of the trains are non-stop international trains with an origin as well as a destination outside the Netherlands. A limited number of trains (in 2020, approximately five freight trains) will have an actual origin or destination in the Netherlands. Approximately three trains per day will transport hazardous materials over the Iron Rhine in 2020 and 2030.

This study has only taken into account the unconstrained demand for transport along the Iron Rhine. The supply side, i.e. the potential capacity of the Iron Rhine has not been taken into account. Also note that many trains assigned to the Iron Rhine within these forecasts could travel over alternative routes with very little time loss.

According to calculations performed in research "Vervoersprognose IJzeren Rijn"[14] by Transport & Mobility Leuven (2007) with the Trans-Tools model, it is stated that the Iron Rhine will most probably transport between 8.4 million tonne (minimum scenario, 2020) and 13.8 million tonne (maximum scenario, 2030) per year. This means between 47 and 78 trains a day.

[14] Transport & Mobility Leuven (2007) http://www.tmleuven.be/project/ijzerenrijn/home.htm

Table 15: Background scenarios

	Scenario 1A	Scenario 2A	Scenario 2B	Scenario 3B
Growth in GDP, yearly (EU25) between 2005-2020	1,8%	2,3%	2,3%	2,8%
Growth in GDP, yearly (EU25) between 2005-2030	1,5%	2,0%	2,0%	2,5%
Increase in road and rail capacity until 2020	All planned projects			
Increase in road capacity after 2020	Growth in capacity=(share passenger transport *yearly growth population)+(share truck transport *yearly growth gdp)			
Increase in rail capacity after 2020	No new infrastructure, but capacity rails follow demand			
User fee rail	€3,30/trainkm			
Internalisation external cost (all modes) – for rail via users fee, for road and inland navigation via levy	no	no	yes	yes
Far-reaching liberalisation rail – partly via user fees	no	no	yes	yes

Table 16: Transported tons (x 1 million) through the Iron Rhine – scneario with low economic growth and moderate policy (1A)

Richting	*2005*	*2020*	*2020*	*2030*	*2030*
Reactivering IJzeren Rijn	nee	nee	Ja	Nee	ja
BE-DE(IJzerenRijn)	-	-	4,4	-	4,8
DE-BE(IJzerenRijn)	-	-	5,0	-	6,0
Totaal			9,4		10,8
DE-BE(Montzen)	3,3	5,8	1,6	7,0	1,8
BE-DE(Montzen)	3,8	5,8	2,4	6,5	2,7
Totaal	7,0	11,6	4,0	13,5	4,5
Totaal richting Duitsland	**3,8**	**5,8**	**6,8**	**6,5**	**7,5**
Index richting Duitsland (t.o.v.2005)	100	153	181	172	200
Totaal richting België	**3,3**	**5,8**	**6,5**	**7,0**	**7,8**
Index richting België (t.o.v.2005)	100	178	201	213	239
Routekeuze-effect Montzen -> IR (mln ton)			7,6		9,0
Routekeuze-effect overig -> IR (mln ton)			1,4		1,5
Modal split-effect (mln ton)			0,3		0,3

Source: NEA Transport research and training and Universiteit Antwerpen (2007)

Table 17: Transported tons (x 1 million) through the Iron Rhine – sceario with normal economic growth and moderate policy (2A)

Richting	*2005*	*2020*	*2020*	*2030*	*2030*
Reactivering IJzeren Rijn	nee	nee	Ja	Nee	ja
BE-DE(IJzerenRijn)	-	-	4,6	-	5,3
DE-BE(IJzerenRijn)	-	-	5,5	-	7,1
Totaal			10,1		12,4
DE-BE(Montzen)	3,3	6,4	1,7	8,1	2,0
BE-DE(Montzen)	3,8	6,2	2,6	7,2	3,0
Totaal	7,0	12,5	4,3	15,3	5,0
Totaal richting Duitsland	**3,8**	**6,2**	**7,2**	**7,2**	**8,3**
Index richting Duitsland (t.o.v.2005)	100	164	193	191	220
Totaal richting België	**3,3**	**6,4**	**7,1**	**8,1**	**9,1**
Index richting België (t.o.v.2005)	100	195	219	249	278
Routekeuze-effect Montzen -> IR (mln ton)			8,2		10,4
Routekeuze-effect overig -> IR (mln ton)			1,5		1,7
Modal split-effect (mln ton)			0,3		0,4

Source: NEA Transport research and training and Universiteit Antwerpen (2007)

Table 18: Transported tons (x 1 million) through the Iron Rhine – sceario with normal economic growth and dynamic policy (2B)

Richting	*2005*	*2020*	*2020*	*2030*	*2030*
Reactivering IJzeren Rijn	nee	nee	Ja	Nee	ja
BE-DE(IJzerenRijn)	-	-	5,5	-	7,2
DE-BE(IJzerenRijn)	-	-	5,8	-	7,8
Totaal			11,4		15,0
DE-BE(Montzen)	3,3	6,8	1,9	9,0	2,4
BE-DE(Montzen)	3,8	7,5	3,0	9,6	3,6
Totaal	7,0	14,3	4,9	18,6	6,0
Totaal richting Duitsland	**3,8**	**7,5**	**8,5**	**9,6**	**10,8**
Index richting Duitsland (t.o.v.2005)	100	198	226	255	286
Totaal richting België	**3,3**	**6,8**	**7,8**	**9,0**	**10,2**
Index richting België (t.o.v.2005)	100	210	238	276	311
Routekeuze-effect Montzen -> IR (mln ton)			9,4		12,7
Routekeuze-effect overig -> IR (mln ton)			1,6		1,9
Modal split-effect (mln ton)			0,3		0,4

Source: NEA Transport research and training and Universiteit Antwerpen (2007)

Table 19: Transported tons (x 1 million) through the Iron Rhine – scneario with high economic growth and dynamic policy (3B)

Richting	*2005*	*2020*	*2020*	*2030*	*2030*
Reactivering IJzeren Rijn	nee	nee	Ja	Nee	ja
BE-DE(IJzerenRijn)	-	-	5,9	-	8,0
DE-BE(IJzerenRijn)	-	-	6,4	-	9,2
Totaal			12,3		17,2
DE-BE(Montzen)	3,3	7,5	2,1	10,5	2,6
BE-DE(Montzen)	3,8	8,0	3,1	10,7	3,9
Totaal	7,0	15,5	5,2	21,3	6,6
Totaal richting Duitsland	**3,8**	**8,0**	**9,1**	**10,7**	**12,0**
Index richting Duitsland (t.o.v.2005)	100	212	241	285	318
Totaal richting België	**3,3**	**7,5**	**8,5**	**10,5**	**11,8**
Index richting België (t.o.v.2005)	100	230	260	323	362
Routekeuze-effect Montzen -> IR (mln ton)			10,3		14,7
Routekeuze-effect overig -> IR (mln ton)			1,7		2,1
Modal split-effect (mln ton)			0,4		0,4

Source: NEA Transport research and training and Universiteit Antwerpen (2007)

Table 20: Total amount of transportation of goods via Iron Rhine and the Montzen Line for the scenarios (in million ton)

	2005	1A 2020		1A 2030		2A 2020		2A 2030		2B 2020		2B 2030		3B 2020		3B 2030	
		NIR	WIR	NIR	WIR	NIR	WIR	NIR	WIR	NIR	WIR	NIR	WIR	NIR	WIR	NIR	WIR
B-G Iron Rhine			4.6		5.1		5.2		5.9		5.3		6.2		5.9		7.3
G-B Iron Rhine			3.8		4.3		4.3		5.1		4.4		5.4		5.0		6.5
Total Iron Rhine			8.4		9.3		9.5		11.1		9.7		11.6		11.0		13.8
B-G Montzen Line	4.4	5.7	2.0	6.3	2.1	6.4	2.3	7.5	2.5	6.7	2.4	7.9	2.8	7.6	2.7	9.7	3.3
G-B Montzen Line	3.8	5.7	1.8	6.1	1.8	6.4	2.0	7.2	2.2	6.5	2.1	7.5	2.3	7.2	2.4	8.9	2.8
Total Montzen Line	8.2	11.3	3.8	12.4	4.0	12.8	4.3	14.7	4.8	13.2	4.5	15.4	5.1	14.8	5.1	18.6	6.1
Total both routes	8.2	11.3	2.3	12.4	3.3	12.8	13.8	14.7	15.8	13.2	14.2	15.4	16.6	14.8	16.0	18.6	19.8
Index both routes	100	138	149	151	162	156	168	179	193	161	173	188	203	180	196	227	242
Total B-G	4.4	5.7	6.7	6.3	7.2	6.4	7.4	7.5	8.5	6.7	7.7	7.9	9.0	7.6	8.7	9.7	10.5
Index B-G	100	128	151	143	164	145	169	170	192	152	176	180	204	173	197	220	240
Total G-B	3.8	5.7	5.6	6.1	6.1	6.4	6.3	7.2	7.4	6.5	6.5	7.5	7.7	7.2	7.4	8.9	9.3
Total G-B	100	149	147	161	161	168	167	189	194	171	171	197	202	189	194	234	244

NIR: no Iron Rhine, WIR: with Iron Rhine

B-G: direction from Belgium to Germany, G-B: direction from Germany to Belgium

Source: Transport & Mobility Leuven (2007)

Iron Rhine in relation to port competition

In port competition (particularly in the context of container traffic), available capacity is an important factor in a port's ability, not only to attract new cargo flows, but also to retain current flows. Shipping companies tend to opt for ports where operations are not hampered by congestion and bottlenecks. They like to think ahead, and are therefore likely to choose for open space and locations offering potential for growth. This means that loading and unloading of goods must proceed smoothly, and that available hinterland transport services (or the modal choice) is also an important factor.

Seen from the perspective of the port of Antwerp, the Iron Rhine is, first and foremost, a valuable addition to available transport capacity, which will allow the port to continue to grow. Container traffic in Antwerp has, over the past ten years, expanded by an average 11% per annum. This would seem to suggest that hinterland connections (road, rail and inland waterways) ought to prepare for further growth. If one ignores this prospect, there is a real longer-term danger of maritime cargo flows shifting to other ports.

The Iron Rhine contributes to a good accessibility to the hinterland of the port. Without the construction of the Iron Rhine the competitive position will get possibly in danger and this will probably result in loss of market share. The conclusion of the port competition research states that a negative effect can be the result for a port in case of insufficient hinterland capacity. Re-activation of the Iron Rhine increases the capacity of the hinterland, avoiding the aforementioned result.

Section 1h: Policy for the supply of waterbound industrial areas

Demand following methodology: study Arcadis in cooperation with the University of Antwerp

It is important for a government to assess the future additional demand for waterbound areas. Part of the growth from inland navigation can be treated with the help of the existing areas but in some cases there will be need for extra areas. It is also important to set up a priority list with possible locations.

By order of the "Agentschap Economie" of the Flemish Government, the study "Policy for the supply of waterbound industrial areas and waterbound transshipment locations" is being carried out by Arcadis in cooperation with the University of Antwerp (Department of Transport and Regional Economics). Part of the study which is relevant for this study aims "to make a quantitative and qualitative assessment of the future waterbound companies and transshipment activities along the navigable waterways in Flanders taking into account the most relevant future scenario's (horizon 2020)". The quantitative phase is done, the qualitative phase is being carried out. (situation: February 2009).

To carry out a quantitative analysis, the following steps were followed:

- Simulation of inland navigation flows on the basis of scenarios;
- Determining the area demand;
- To set up a priority list: area priorities.

The research starts from a demand following methodology. The analysis starts from the current, existing demand and the possible evolutions of this demand. The horizon is the year 2020 and the analysis is carried out on the level of Flemish NUTS-3 level ("arrondissementen").

In order to make simulations of inland navigation flows, the Freight model Flanders was used (developed by K+P Transport Consultants, Tritel and Mint by order of "Afdeling Verkeerscentrum" of the Flemish Government). A description of the Freight model is given in chapter 5.

Eight scenarios were calculated: a reference scenario (scenario of unchanged policy) and variations of the reference scenario. Scenarios differ from each other on the basis of assumptions.

- Economic assumptions: normal growth, low growth, high growth;
- Policy assumptions: moderate policy or dynamic policy (road charging road traffic);

- Sectoral assumptions: specific cost measures in favor of inland navigation.

To determine the need of surfaces, starting point was the predicted tonnages being transported via inland navigation in the year 2020. For each arrondissement and for each goods category, an indicator is created expressing the need for areas in 2004 and 2020. A part of the growth will be picked up by the present existing grounds. Another part has to be picked up by the usage of new grounds. The indicator was set with the usage of “regional throughput coefficients”. These coefficients represent the tonnage per m^2 per year which will be supplied and transported away per area. The survey only shows the results from the areas which are situated immediately next to the water (sum of throughput area, storage area and production). To fill in these coefficients quantitatively, surveys were carried out (internet survey and bilateral talks). Data from W&Z and De Scheepvaart were used. In that way it was possible to compare areas in 2004 and 2020. A positive difference indicates the need of additional areas.

On the basis of the aforementioned methodology, it was possible to make a priority list of NUTS-3 regions (arrondissementen) per scenario. The observations were put into 3 groups: large need, medium need and small need for extra additional waterbound areas. The following groups were distinguished in the reference scenario (unchanged policy):

- Large need: Antwerp and Ghent;
- Medium need: Sint-Niklaas, Roeselare, Kortrijk, Brugge, Hasselt and Tielt;
- Small need; Turnhout, Mechelen, Oostende, Halle-Vilvoorde, Aalst, Dendermonde, Oudenaarde, Leuven, Tongeren, Maaseik, Eeklo, Veurne, Diksmuide and Ieper.

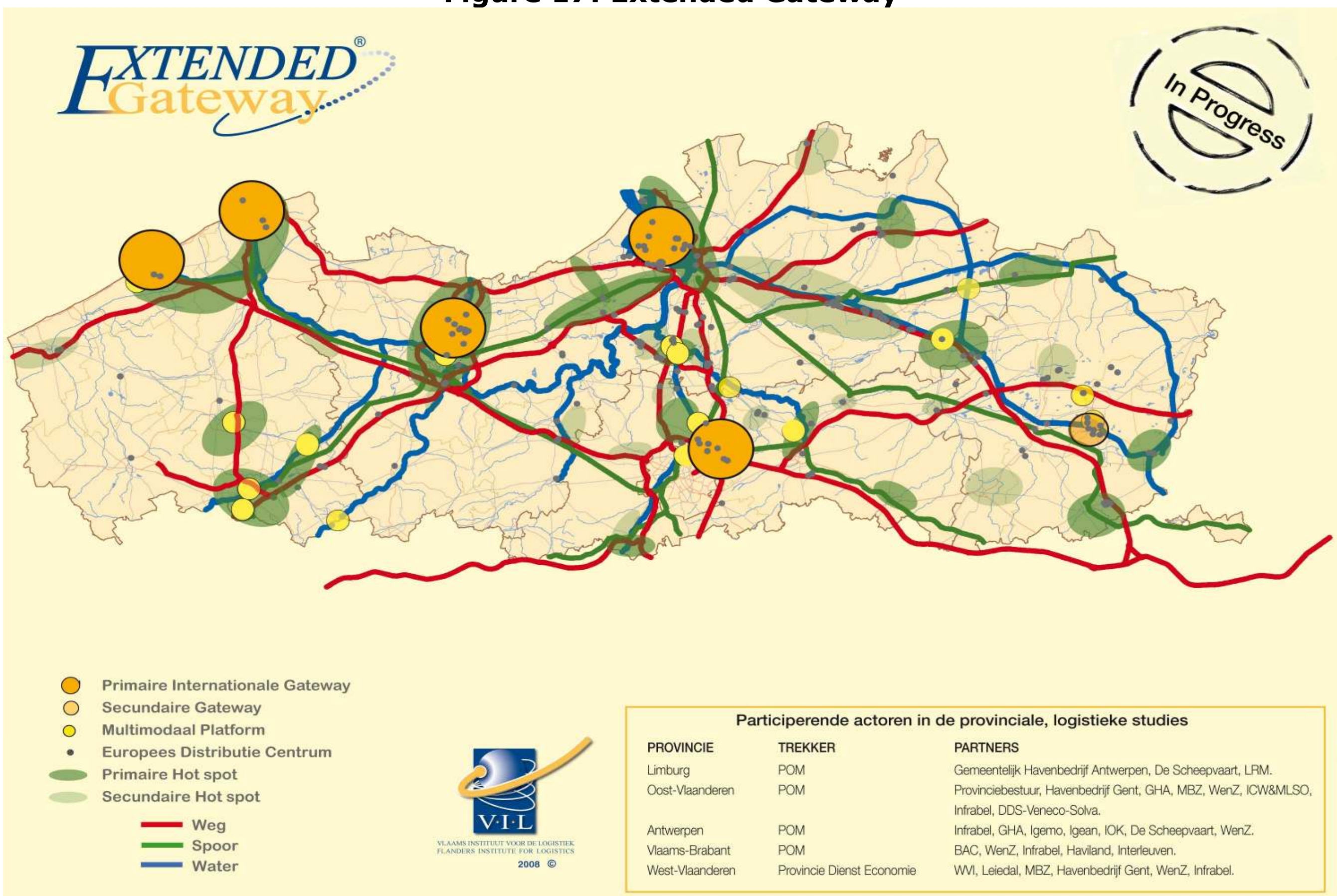
In principle, it can be expected that the policy of waterbound areas will aim first at those regions with high priorities. Please note that port related needs are taken into account. Therefore, Antwerp and Ghent also reflect the needs of the accompanying areas. It is not necessary to look for the extra areas in the port itself. In other cases, it may also be advised to find extra areas in neighbouring NUTS-3 regions instead of the NUTS-3 region under study (given a lack of space in the region under study). On the basis of the rankings, it is easier for a policy maker to select regions if confronted with financial constraints.

Supply following methodology: Extended Gateways

Within the project waterbound industrial areas, the focus is on the consequences of a demand following methodology while the concept of extended gateway ® starts with a supply following methodology.

"The term extended gateways refers to the expansion of the value added activities in logistics outside the traditional gateways by means of the establishment of logistic activities in hot spots inducing the lowest total logistic cost. … In any case, an efficient hinterland network is a network with big commodity flows. Big commodity flows offer the best insurance for a low total logistic cost. Therefore, companies treating goods in the same way should be stimulated to cooperate. This cooperation will become easier if companies are in the vicinity of each other. The Extended Gateway ® provides an accurate identification of logistic hotspots with specifically characteristics pointed at clusters of specific logistic activities." (Vlaams Instituut voor de Logistiek (2009a) and Vlaams Instituut voor de Logistiek (2009b)). A recent development is shown in figure 8.

Figure 17: Extended Gateway



Source:Vlaams Instituut voor de Logistiek (2009b)

Section 1i: Consolidation of small container volumes in inland navigation

The point under investigation is to identify solutions that would make transport through inland waterways more appealing to the shipper. More inland navigation would lead to less transport going through the road network, especially for the outgoing (and less the incoming) port volumes that would otherwise be transported by road which particularly influence traffic on the E313 motorway. Parties within the sector state that the settlement of inland navigation flows within a port area should be completed in a more efficient way.

Port terminals in particular, but also the inland navigation sector is asking for a bundling of freight flows within the port (consolidation of small container volumes). Bundling avoids the small loadings and unloadings of inland vessels by terminal operators. Bundling leads to cost and time gains.

A survey is carried out by Price-WaterhouseCoopers (PricewaterhouseCoopers (2007)) about the delivery of small volumes by container inland vessels to the Antwerp terminals. Attention is put on the use of several terminals with relatively small volumes. This causes operational, administrative, financial and security problems with respect to the transport and treatment of containers. This studie is carried out by order of the Antwerp Port Authority in collaboration with "Waterwegen en Zeekanaal nv" and "nv De Scheepvaart". On the basis of personal interviews with the stakeholders, bottlenecks were identified (Port News (2007)). In a follow-up study, a cost-benefit analysis is carried out of some specific solutions for the bundling of small volumes (within or outside the port and for certain sailing areas. In the study is mentioned: time windows and the guaranteed handling of consolidated or fixed volumes. Three solutions are suggested (in order of effectiveness): point of consolidation outside the port, point of consolidation within the port, and more networking between the existing inland terminals.

2. Road infrastructure: bottlenecks

In spite of the very dense Belgian road network, there are still a few missing links. In interviews and surveys one has assessed those points where infrastructure expansion is needed.

The connection roads in the direction of the port to Zeebrugge appear to be one of the problems. Distributors plan alternative routes to avoid certain areas (e.g. the Brussels ring). The problems on the known points (mainly the ring of Antwerp and the ring of Brussels) were always mentioned. The Antwerp ring is a problem given the surplus of entries and exits. This causes big delays. As a solution there is a suggestion to connect the E34 (Ranst) with Mechelen: therefore the traffic from and to Brussels in relation to the Kempen/Limurg is deviated. This will cause a relief for the Antwerp Ring (Geerts (2008); Van Mullem (2008))

Shipping companies state that big infrastructure works around the port of Antwerp are needed. Also around the port of Zeebrugge, there is need for a better unlocking. Concerning the competitive position of rail transport in the ports a lot of things can still happen. It can help to solve a part of the congestion around Antwerp. (De Kesel (2008); Beerlandt (2008); Kerstens (2008); Boels (2008))

Terminal operators don’t have a clear opinion about the bottlenecks in road transport, because they don’t perform these activities. Anyhow, the unlocking of the port of Zeebrugge was stated as a bottleneck.

Nike pointed out that traffic problems were caused by the the junction in Lummen. However a solution is here foreseen, therefore in the future less problems are foreseen. (Van de Sande (2008))

In the following table missing links are reported on the basis of an online survey (hauliers). What is important here is the number of times a link is mentioned and the stated priorities.

Table 21: Missing links from road transport questionnaire

Group	Missing links	Count	Average priority	Score
R0	R0 Ring Brussel, including specifically between “Leonardkruispunt” and “Groot-Bijgaarden”	20	2	10.0
	RO Waterloo - Tervuren infrastructure	1	3	0.3
R0/E411	Connection E411 with R0	1	1	1.0
R0/E40	E40 Gent – Brussel	3	2.3	1.3
R0/A12	A12 Meise - R0	1	4	0.3
R1	R1 Northerly Ring Antwerpen	21	2	10.5
	Kennedytunnel	5	2	2.5
R2/E17	Connection Liefkenshoektunnel - E17	12	3	4.0
R2/E34	Entry docks left bank Antwerpen	1	3	0.3
R8	Enclosing R8	1	1	1.0
R27	Tienen ring: capacity too limited + extension of the ring to the provincial road Tienen-Diest	1	2	0.5
R30	Beginning ring Brugge between cloverleaf highway and first traffic lights (Kinepolis): an extra lane for cars coming from Brusels and turning right at the first traffic lights	1	2	0.5
E17	Entry industrial area Kuurne-Kortrijk	1	2	0.5
E19	E19 Leuven-Mechelen	8	1.9	4.2
	E19 Breda - Antwerpen: 3d lane	3	2	1.5
E313	Connection port of Antwerp and E313	2	2	1.0
	Entry and exit Tessenderlo in industrial area located at Nike	1	2	0.5
	E313 Lummen – Antwerpen 3d lane	10	2	5.0
E313/314	Junction Lummen E313/E314	3	3	1.0
E313/E34	Junction E313- E34	2	5	0.4
E34	Unlocking of industrial areas at Beerse	1	2	0.5
	Expressweg N49/E34 Antwerpen – Zeebrugge	1	7	0.1
	Connection Mol E34	1	1	1.0
A12	A12 Antwerpen - Brussel full highway	2	5	0.4
	Extending A12 ex haven Antwerpen until Wommelgem	1	3	0.3
A19	Extending A19	1	5	0.2
A24	A24 Eindhoven - Hasselt	1	3	0.3
N16	Upgrading N16 St-Niklaas - Temse - Mechelen (E17-E19) and Mechelen or Kontich to Wijnegem (E19-E313)	5	2	2.5
N19	Noord-Zuid Kempen	3	2	1.5
N36	Roundabouts N36 Bavikhove – Kuurne	1	3	0.3
N41	N41 extension to Aalst	1	4	0.3
N47	N47 Dendermonde – Aalst	1	1	1.0
N715	Noord-Zuid Limburg N715	1	4	0.3
N76	Meeuwen-Genk N76	1	5	0.2
N111	Connection Kalmthout - Stabroek - haven Antwerpen	1	7	0.1
Others	Gent - Dendermonde - Mechelen – Tessenderlo	1	3	0.3
Others	Connection Noorderkempen – Limburg	2	2	1.0
Others	Ring Ronse	1	2	0.5

On top of the priority list is the enclosing of the R1 around Antwerp, the expansion of the RO around Brussels with an increase of traffic lanes, an extra traffic lane on the E313 Lummen-Antwerp, a good connection between E17 and the Liefkenshoek tunnel and the broadening of the Kennedy tunnel. Striking is that the connection between E313-E19 is less distinct as was shown in the results of the interviews.

Also striking is the mentioning of the urban distribution centers as a missing link. In general there is also a wish for more roundabouts instead of traffic lights. And finally there is a big need for extra parkings and parking space on the highways.

In different interviews it is mentioned to construct double deck highways (2 floors). In other parts of the world double deck highways are not new, in Belgium these plans have the opposition from the politicians. With double deck highways we could separate transit traffic and local traffic on congestion points. On the existing highways entries and exits should be limited. Congestions points mainly exist around these points. Because of the excess of entries and exits (and mainly the left entries), traffic jams (and dangerous situations) are created. (Cortvriendt (2008); De Maesschalk and Herremans (2008); Vanbuylaere and Bessems (2008); Van Loon (2008))

3. Pricing measures

Congestion pricing

Although congestion pricing is a first-best instrument in theory, the assumptions needed to arrive at this conclusion oversimplify reality. In practice, congestion pricing will most likely not be a first-best instrument for tackling the congestion externality, although it may be expected to be able to approach first-best standards more closely than does any other instrument. (Emmerink (1998))

Congestion pricing has some important advantages over other available measures for curbing levels of congestion. Nevertheless, implementing congestion pricing will give rise to may problems: (1) it will lead only to a potential Pareto improvement[15]; (2) it will cause horizontal inequity; (3) it might induce regional inequity; (4) it will provoke the question as to how to redistribute the revenues; (5) it may be perceived differently by different groups in society; (6) it might affect peoples privacy; (7) it might be perceived as a loss of freedom ; and (8) it may give rise to the problem of rat-running. (Emmerink (1998))

There are different technological ways to introduce congestion pricing. If the potential opposition is taken into account, a cordon system – in which the price is dependant on the time of the day – seems currently to be the most attractive option. Such a simple scheme might increase drivers' awareness of the costs of mobility during congested periods. Moreover, a more sophisticated scheme can always be implemented once the simple system has proven successful and the awareness of the costs of mobility during congested periods has been established. The Dutch experience indicates that overcoming all the problems of introducing a relatively simple congestion pricing scheme is already a cumbersome task. (Emmerink (1998))

Road tolls

Introduction of road tolls for trucks in general can help to:

1. increase economic transport efficiency,
2. finance road infrastructure,
3. help to shift to more environmentally sound transport modes.

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[15] In neoclassical economics, an action done in an economy that harms no one and helps at least one person.

It must be mentioned that transport expenses that arise from tolls are included in the transportation costs by hauliers. As a result, the expenses are included in the final price of the product transported. When considering introduction of road tolling on the E313 motorway, the experience of other countries has to be taken into account.

Information on road haulage taxation measures used in other European countries is available. There are two basic road charge methods used:

1. Time based charges, like vignette (used in countries like Belgium, Czech Republic, Denmark, Hungary, Netherlands, Sweden);
2. Tolls or distance based charges, like Maut (used in Germany, Austria).

Introduction of road tolls for trucks and associated extra expense for the forwarder of goods can also reduce competitiveness of a country as a transit region. Although it may reduce the traffic flow on the motorway network, it is not necessarily linked with modal shift.

Support measures for intermodal transport: inland navigation and rail

Support measures inland navigation

From 1.01.2009 a possibility exists for shippers to ask for financial support during three years from the Flemish Government. "The Flemish settlement for support to intermodal transport via inland navigation", - support intermodal traffic or SIV – give 17,5 euro to the shipper per qualified container.

On the one hand, this settlement applies to containers which are imported via Flemish seaports and reaching their end destination via an inland container terminal in Flanders. On the other hand this settlement applies to containers being transported from an inland container terminal in Flanders to a Flemish seaport, where the container will be put on a sea vessel in order to be exported. Import indicates that the final destination of the goods is located in Flanders, whereas export indicates that the origin of the goods is located in Flanders.

Support measures rail

From 1 January 2009 until 31 December 2012 (= 4 years) the federal government will subsidize inland transport of intermodal load units as well as the regular international railroad relations for the transport of intermodal load units.

4. Measures needed to reach a freight mode shift

Influential attributes in freight mode choice decisions

The need to implement measures to influence mode choice requires the identification of the major modal attributes that have influence on the mode choice decisions.

In earlier studies (60's - 70's) product characteristics, freight rates and distance for a transport performance were mostly used to explain the choice of a mode. Later on, Quality of Service (Q-o-S), was roughly estimated by the mean and variance of time in transit. As from the 80's – see Winston (1983) and Zlatoper & Austrian (1989) – authors stressed the importance of Q-o-S in transport as a determining factor in mode choice. A review of recent literature confirms this trend of a growing importance of Q-o-S in freight demand. Especially for shippers of highly valued goods, the monetary value of the Q-o-S can be more important than the transport cost in the narrow sense when deciding over modes. (De Maeyer and Pauwels (2003))

Therefore one might prefer the presence of additional quality attributes in mode choice models alongside the more traditional parameters cost, time and distance. After all, these variables are said to lead the behaviour of the decision-makers in the choice process.

In Table 22 De Maeyer and Pauwels (2003) mention the most influential attributes in mode choice behaviour per article based on the specific research question that was put forward. Where possible they use the terminology of the content analysis by Cullinane and Toy (2000).

Table 22: Most influential attributes of mode choice decisions

Authors	Type of respondents	Research question	Ranking of attributes
Mcginnis (1989)	All kinds (U.S.)	Variables that were found to affect freight transportation choice	Cost/Price/Rate Transit time reliability Speed Loss/Damage Shipper market considerations
Jeffs and Hills (1990)	Transport decision-makers within the paper, printing and publishing sector (U.K.)	To assess the respondent's perceptions on the importance of certain attributes	Customer service level Transit time reliability Flexibility Loss/Damage Speed
Matear and Gray (1993)	Irish companies which send and/or receive goods to or from Great Britain and the other way round (U.K. & Ireland)	To determine the Q-o-S attributes important in the choice of freight transport service	Flexibility Loss/Damage Transit time reliability Cost/Price/Rate Good relationship with carrier
Jovicic (1998)	Transport buyers for all types of commodities (Denmark)	To rank the eight quality parameters in order of importance based on the respondent's perception	Transit time reliability Speed Cost/Price/Rate Customer service level Flexibility
National Economic Research Associates (1997)	Shippers concentrating on unitised freight collected through more than 1000 telephone surveys (Europe)	FlexRanking of factors (excluding cost) affecting unitised freight mode choice	Reliability Speed Reliability Controllability/Traceability Environment
INRETS (2000)	Customers or potential customers of intermodal transport in the EU and Switzerland	Decisive factors in the mode choice between road and intermodal transport	Cost/Price/Rate Flexibility Best matching logistic structure Speed Transit time reliability

Source: De Maeyer and Pauwels (2003)

The attributes 'Transit time reliability', 'Speed' (or transit time), 'Flexibility' and 'Loss/Damage' are found to be most influential next to the Cost, Price or Rate for the considered transport service. The attribute Cost/Price/Rate occurs in four out of five rankings where cost was not excluded.

In Table 22 we see which attributes were indicated as influential in the choice process for different types of decision makers. The attributes that appear in the rankings are more or less the same for all surveys, although their places in those rankings are somewhat different. This means that different types of decision makers choose modes based on the same quality criteria, but that the order in which these criteria are applied is different for other types of decision makers. Product characteristics and location can explain this distinction. (De Maeyer and Pauwels (2003))

In the study of Garcia-Menendez *et al.* (2004) role of cost, transit time, and frequency of shipments as main determinants of mode choice in two mode situation is analysed. They highlight of time as a sign of a growing importance of efficiency in logistics. Following the same line of reasoning, frequency constitutes a determinant factor of mode choice as well.

In the report by The Center for Urban Transportation Research, University of South Florida (2003) the timing of mode choice factors is presented (see Table 23). Displayed also are the stages in the freight decision making process when each factor comes into play. The stages are:

- Immediate
- Mid-term
- Final

Each decision factor is also given a number between one and nine to further break out when the factor comes into play during the freight mode choice decision.

Table 23: Timing of mode choice factors

Factor 1	Factor 2	Immediate			Mid-Term		Final			
		1	2	3	4	5	6	7	8	9
Total logistics cost	Transportation charges	■								
	Capital carrying cost in transit		■							
	Service reliability costs		■							
Modal characteristics	Trip time and reliability		■							
Physical attributes of goods	Shipment size			■						
	Package characteristics			■						
	Shipment shelf life			■						
	Shipment value			■						
	Shipment density			■						
Flow & spatial distrib. of shpmnts	Distance of shipment			■						
Firm characteristics	Shippers and receivers situated on rail line				■					
	Shippers near highway				■					
	Firms own small trucks				■					
Flow & spatial distrib. of shpmnts	Shipment frequency					■				
Modal characteristics	Capacity					■				
	Equipment availability					■				
	Handling quality - damage loss reputation					■				
Total logistics cost	Order and handling costs						■			
	Loss and damage costs							■		
	Inventory carrying cost at destination							■		
	Unavailability of equipment costs							■		
	Intangible service costs								■	
Modal characteristics	Customer service									■
Firm characteristics	Firm size	Background throughout process								

Source: The Center for Urban Transportation Research, University of South Florida (2003)

Measures applicable for mode shift

In literature the mode choice between different freight transportation modes is analysed from the viewpoint of a shipper and the analysis is based on the concept of total logistics costs. (See Baumol and Vinod (1970); Buffa and Reynolds (1977); Constable and Whybark (1978); Liberatore (1979); Buffa and Reynolds (1979); Langley (1980); Blumenfeld *et al.* (1985); Allen *et al.* (1985); McFadden *et al.* (1985); Buffa (1986); Sheffi *et al.* (1988); Larson (1988); Perl and Sirisoponsilp (1988); Tersine *et al.* (1989); Tyworth (1991); Allen and Liu (1993);

Tyworth and ONeill (1997); Tyworth and Zeng (1998); Swan and Tyworth (2001); Vernimmen and Witlox (2001) and Blauwens *et al.* (2006).)

The main goal of all the articles and research papers devoted to this subject is to gather insight in the choice process of decision makers. This knowledge helps to evaluate and predict the impact of certain measures on the modal split.

Blauwens *et al.* (2006) analyze effects of three possible measures applicable for obtaining mode shift. **First**, as many countries have imposed or are planning to impose a tax on road (freight) transport (e.g. the Congestion Charge in London or the LKW-Maut in Austria and Germany) the impact of an increase in the transportation costs of road transport is investigated. **Second**, the effect of a decrease in the lead-times of combined rail/road transport and combined barge/road transport by half a day is evaluated. **Third**, the impact of a decrease in the transportation costs of rail transport is studied.

The research Blauwens *et al.* (2006) performed on this topic using a model that simulates a hypothetical market for container transport, which was 'constructed' on the basis of a single case study relating to a specific transport axis (Antwerp–Germany) showed that:

1. When the transportation costs of road transport increase by 5%, its market share decreases by about 6 percentage points. The market shares of rail/road transport and barge/road transport increase by 5 and 1 percentage points, respectively. The same is true when road transportation costs increase by 10 or 20%: the market share of rail/road transport increases significantly, while the impact on barge/road transport is limited.
2. A decrease in the lead-time of combined rail/road transport by half a day significantly increases its market share: it doubles from about 17% to about 33%. This increase is largely at the expense of road transport, which sees a reduction in market share from 37% to 26%. The impact on barge/road transport's market share is limited. As far as barge/road transport is concerned, cutting its average lead-time by half a day increases its market share by roughly 10 percentage points. Both road transport and rail/road transport lose about 5 percentage points in market share. Finally, when the lead-times of both forms of combined transport would improve by half a day, the share of direct road transport drops significantly: from about 37% to about 24%. The lost market share is mainly captured by rail/road transport (11 percentage points), yet barge/road transport remains by far the biggest transport mode in absolute volume terms with a market share of 48%.

3. The market share of combined rail/road transport increases when the transportation costs of rail transport are decreased. Both road transport and barge/road transport are affected, but not to the same extent. A decrease of 5% in the transportation costs of rail transport increases rail/road's market share by about 4 percentage points. This is almost entirely at the expense of road transport. A decrease in rail's transportation costs by 10 or 20%, on the other hand, has the biggest impact on barge/road transport's market share. A decrease of 20%, for example, results in barge/road transport losing 20 percentage points of market share. Under those circumstances, rail/road transport captures the largest share of the total market.
4. Finally, road transport's market share drops very significantly when a combination of measures is taken that simultaneously increase its transportation costs while decreasing combined transport's lead-time performance and transportation costs.

Please note that conclusions from a case-study should not be generalized.

5. Modeling results

5.1 Linkage between qualitative and quantitative stages

In this part a link is made between the research in the previous chapters and the freight model Flanders.

Commissioned by the "Kenniscentrum Verkeer en Vervoer (afdeling Verkeerscentrum)" a new freight model for Flanders has been developped by K+P Transport Consultants, Tritel and Mint.

Based on the freight model it is possible to simulate future freight flows, split up by mode (road, rail and inland waterways) and NST-freight category. A classic 4-step model has been used:

- Generation of flows: this step determines the flows leaving from (or arriving in) zone i (j) in a period. For freight transport this means that for a freight category k it is calculated how many tons are leaving from (arriving in) zone i (j);
- Distribution of flows: the generation of flows serve as input for this stage. The freight flows are determined between zones i and j;
- Mode choice: which mode is used to move tons from zone i to j;
- Assignment: this steps comprises route choice (after translating the tonnages into number of vehicles in a traffic conversion model).

Transport Logistic Nodes (TLN) are also included in the model. A TLN zone is a transfer point where loads change the means of transport (not necessarily the mode) simultaneously with a re-consolidation of the shipment.

The freight model Flanders is used in this project to determine the effects of possible scenarios on freight transport. Details of the scenarios used are described in the following sub-chapter.

It is important to note that in the freight model is taken into account the so-called agreed infrastructure changes ("lopende programma") of the Flemish government. More specifically, the following infrastructure changes have been taken into account:

- the Oosterweel-connection[16];
- AX-connection N49-N31;
- Liefkenshoek rail tunnel;
- Seine-Schelde connection;
- Albert canal capacity.

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[16] The assumption is made that freight trucks are not allowed anymore in the Kennedy Tunnel in 2020.

Table 24 summarises the previous chapters by isolating the key topics identified as most relevant in the different research blocks. The third column presents a selection of the quantified variables available in the freight model for each of the aforementioned topics. Some variables have been selected for a sensitivity analysis which will be described in subchapter 5.2. That means that the selected variable will be assigned several values in the scenarios in order to quantify the effects.

Table 24 : Variables and scenarios

Research report part	Topic	Related CUBE Variable (selection)	Selected for sensitivity analysis
1a	Economic growth / GDP growth / Income per capita	AAGR employment per NACE-category AAGR employment per region per NACE-category AAGR of the household consumption in value AAGR of the GDP per country (<> Belgium)	X X X
1a	Changes in demand taste / trends	AAGR of the household consumption in value	
1a	Production and distribution patterns		
1a	Global trade / trade patterns	AAGR of value per NST category, export AAGR of value per NST category, import AAGR of the GDP per country (<> Belgium)	X X X
1a	Globalization	AAGR of value per NST category, export AAGR of value per NST category, import AAGR of the GDP per country (<> Belgium)	X X X
1a	Demographic changes	AAGR National population AAGR population per Belgian region	
1a	Labour market	AAGR employment per NACE-category AAGR employment per region per NACE-category	X X
1a	Energy and oil prices	Road: kilometer costs highway (absolute values) Road: kilometer costs other (absolute values) Road: percentage of evolution of the kilometer cost (fuel, tires, maintenance) Road: percentage of evolution of the cost per hour (salaries, fees) Road: percentage of evolution of the cost per day (vehicle cost, insurance, structural fees) Rail: percentage of the evolution of prices Inland waterways: percentage of evolution of the prices Road, rail, inland waterways: absolute change of price per tonkilometer	X X X
1a; 3	Environmental Policy and pricing externalities	Road: kilometer costs highway (absolute values)	X

Research report part	Topic	Related CUBE Variable (selection)	Selected for sensitivity analysis
1e 1a; 1c; 1e; 1g; 3 1a; 1e; 1g; 3; 4a 1e 1e	EU legislation – political goals Infrastructure policy and developments / Quality of transport services Policy measures Logistics action plan Regulatory issues	Road: kilometer costs other (absolute values) Road: percentage of evolution of the kilometer cost (fuel, tires, maintenance) Road: percentage of evolution of the cost per hour (salaries, fees) Road: percentage of evolution of the cost per day (vehicle cost, insurance, structural fees) Rail: percentage of the evolution of prices Inland waterways: percentage of evolution of the prices Road, rail, inland waterways: absolute change of price per tonkilometer Average load per type of truck, per distance class, per NST-category Empty trucks factor Ratio tonnes large trucks/tonnes small trucks (per distance class, per type of truck, per nst)	 X X
1e; 3; 4a 2	Road pricing E313 traffic	Road: kilometer costs highway (absolute values) Road: kilometer costs other (absolute values) Road: percentage of evolution of the kilometer cost (fuel, tires, maintenance) Road, rail, inland waterways: absolute change of price per tonkilometer Average load per type of truck, per distance class, per NST-category Empty trucks factor Ratio tonnes large trucks/tonnes small trucks (per distance class, per type of truck, per nst)	X X
1c	Port traffic	AAGR employment per region per NACE-category Domestic Import/Export flows (per NST category)	X X
1b	Albert Canal traffic	Inland waterways: percentage of evolution of the prices	X

Research report part	Topic	Related CUBE Variable (selection)	Selected for sensitivity analysis
1a	Technological developments including transport and fuel technology	Average load per type of truck, per distance class, per NST-category Empty trucks factor Ratio tonnes large trucks/tonnes small trucks (per distance class, per type of truck, per nst)	
1a; 1e	Geopolitical situation	-	
1a; 1e	Security matters	-	
1a	Urban development	-	
1d; 1e	Impact of SSS	-	
1e	TEN-T	Features of the infrastructure (e.g. speed, capacity,…)	
1a	Social implications	-	
1g	Iron Rhine traffic	Rail: percentage of the evolution of prices	X

<u>Notes</u>
1. Expected developments: impact analysis, time path and investments
Section 1a: Base scenario 2020
Section 1b: Albert canal
Section 1c: Port traffic
Section 1e: European developments
Section 1f: Flanders Logistics – Flanders Port Area – Flanders Inland Shipping Network
Section 1g: Iron Rhine
2. Infrastructure: bottlenecks
3. Pricing measures
4. Framework studies
Section 4: Measures needed to reach a freight mode shift

5.2 Scenario building[17]

Several scenarios have been built to construct a min-max range (see Table 25).

Each scenario is a combination of several assumptions: economic assumptions, policy assumptions, assumptions of population and household consumption, assumptions of import and export (expressed in value), assumptions of inland navigation and port assumptions.

Table 25: Scenarios

	Economic assumptions; assumptions import and export	Policy assumptions	Assumptions inland navigation	Port assumptions
Scenario 1	Low growth	Continuation of current policy	Continuation of current policy	Following economic assumptions
Scenario 2	Low growth	Continuation of current policy	Extra measure inland navigation	Following economic assumptions
Reference scenario	**Normal growth**	**Continuation of current policy**	**Continuation of current policy**	**Following economic assumptions**
Scenario 3	Normal growth	Continuation of current policy	Extra measure inland navigation	Following economic assumptions
Scenario 4	Normal growth	Moderate transport policy	Continuation of current policy	Following economic assumptions
Scenario 5	Normal growth	Moderate transport policy	Extra measure inland navigation	Following economic assumptions
Scenario 6	High growth	Moderate transport policy	Continuation of current policy	Following economic assumptions
Scenario 7	High growth	Moderate transport policy	Extra measure inland navigation	Following economic assumptions
Scenario 8	Normal growth	Internalizing external costs of all modes	Continuation of current policy	Following economic assumptions
Scenario 9	Normal growth	Continuation of current policy	Continuation of current policy	0.5 x results economic assumptions
Scenario 10	Normal growth	Continuation of current policy	Continuation of current policy	1.5 x results economic assumptions
Scenario 11	Normal growth	Internalizing external costs of all modes	Continuation of current policy	0.5 x results economic assumptions
Scenario 12	Normal growth	Internalizing external costs of all modes	Continuation of current policy	1.5 x results economic assumptions

Source: own composition

[17] The method used has been applied in several research projects, some of them based on other transport models. Reference can be made to "Vervoersprognoses Ijzeren Rijn" (commissioned by Infrabel, research partners: NEA, UA, TML and TNO (April 2007)) and "Project Watergebonden Bedrijventerreinen" (commissioned by Agentschap Economie, research partners: UA and ARCADIS GEDAS (on-going project 2008). The scenarios used in the forementioned projects have been specifically adapted for this E313-project.

5.2.1 Scenario Assumptions

Economic, import and export assumptions

Economic assumptions

Economic growth will lead to an increase in transport (principle of derived demand). As such, different assumptions of economic growth will lead to different consequences for freight transport.

In the literature several sources can be consulted stating assumptions about future economic growth. In *European Energy and Transport Trends to 2030 – update 2005* (European Commission (2006a)), a yearly economic growth of 2% until 2020 in Belgium has been reported. This economic growth represents the yearly evolution of the Gross Domestic Product (GDP) in real terms (adjusted for inflation). This leads to 3 economic assumptions in this research project:

- Economic assumption 1: low growth
- Economic assumption 2: normal growth
- Economic assumption 3: high growth

The economic assumptions can be expressed as follows:

- Economic assumption 1: growth GDP – 0.5% = 1.5%
- Economic assumption 2: growth GDP = 2%
- Economic assumption 3: growth GDP + 0.5% = 2.5%

Economic growth is not being used directly in the freight model Flanders to determine the incoming and outgoing flows for the Belgian regions (generation of flows in the 4-step model). Instead, employment per region is used.

In relation to foreign zones, the evolution of GDP is actually used. We also refer to the report of the European Commission (2006a), see Table 26.

Table 26: Expected yearly growth of the GDP in % per country or region

Country/Region	*Normal growth*	*Low growth*	*High growth*
Netherlands	1.6	1.1	2.1
France	2.0	1.5	2.5
Germany	1.4	0.9	1.9
United Kingdom	2.5	2.0	3.0
Italy	1.6	1.1	2.1
Iberian Peninsula	2.4	1.9	2.9
Rest EU	2.2	1.7	2.7
Rest world	3.0	2.5	3.5

Source: own composition based on European Commission (2006a), except "rest world"

It is possible to examine the relation between economic growth and employment[18]. Walterskirchen (1999) reports for the European Union an elasticity of 0.41. When economic activity grows with 1%, employment will rise with 0.41%.

On the basis of available Belgian employment figures and GDP (prices of 2000, it is possible to estimate the following equation:
$\ln(\text{employment}) = \alpha + \beta.\ln(\text{GDP})$

The estimated value for β is 0.478, with a t-value of 3.62 and $R^2 = 0.972$.[19] This estimated value represents: if GDP increases with 1%, employment will go up with 0.478%. This result is also in the line of Walterskirchen (1999). A yearly economic growth of 2% in Belgium can also be expressed in a yearly growth of employment with 0.956%.

Note that the "Planbureau" indicates a yearly, estimated growth of employment with 0.9% in the period 2008-2013 (Federaal Planbureau (2008)).

Based on the previous findings, we can set up the following assumptions for the Belgian regions:

- **Low growth**: growth employment – 0.239% = 0.717%
- **Normal growth**: growth employment = 0.956%
- **High growth**: growth employment + 0.239% = 1.195%

The growth of GDP for foreign regions is based on Table 26.

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[18] We refer to the law of Okun, giving the relation between the growth of GDP and unemployment, in which the relation between the growth of GDP and employment is a part of it.

[19] Please note this is a simple time series estimation, containing no further research for possible time series effects (e.g. cointegration).

Assumptions import and export (expressed in value)

The growth of the import and export flows in value also serves as an explaining variable in the freight model. Based on Federaal Planbureau (2008) we assume that the import and export flows will raise with 4.3% yearly when we have a "Normal Growth" in the economic assumptions: "Normal assumptions import and export". If economic assumptions indicate a "Low Growth", we assume that the import and export flows will rise with 3.8%: "Low assumptions import and export". In case of "High Growth" in the economic assumptions, import and export flows will raise with 4.8%: "High assumptions import and export".

Policy assumptions

A distinction is made between:
- **Continuation of current policy**;
- **Moderate transport policy**;
- **Internalizing external costs of all modes (road, rail and inland waterways)**.

Continuation of current policy

In the assumption of "continuation of current policy" a growth of the costs of road transport and rail transport is assumed of 0.1% per year. A growth of the costs of road transport is considered as probable given the far advanced deregulation of the road freight transport sector. For the rail freight transport one assumes the persistant dominance of national railway companies. A deregulation leads to a reduction of national subsidies and will cause an upwards pressure on the prices (NEA Transport research and training and Universiteit Antwerpen (2007)). These growth percentages should be seen as relative percentages. In other words, road transport and rail transport will have a slightly bigger cost increase compared with inland navigation. In this analysis it is not necessary to look up the actual growth percentages. Growth percentages respecting the relative position between the modes are enough.

Moderate transport policy

The moderate transport policy starts with the assumptions from the "Continuation of current policy" and adds the following costs for road and rail. The values mentioned in this text refer to NEA Transport research and training and Universiteit Antwerpen (2007).

For road, a road pricing scenario is introduced. The amount is set to € 0.15 per kilometer in the Benelux, which is applied on the highways. This cost per kilometer will replace the "verkeersbelasting" and "Euro-vignette". On the non-highways, this value is set to € 0 per kilometer[20,21].

For rail, it is assumed that a higher "gebruikersvergoeding" will be introduced. In 2007, a "gebruikersvergoeding" of € 1.63 per train-km is reported. This value could be set to € 3.30 in the future. Therefore, it is suggested to add in this assumption an extra value of € 1.67 per train-km in the model. The freight model is based on calculations per ton-km. As such the value of € 1.67 is been recalculcated with the help of an average load of a train of 570 ton.
=> € 1.67 / 570 = € 0.002929 per tonkm

Internalizing external costs of all modes (road, rail and inland waterways)

External costs are costs that the transport user causes to a third party and for which he does not pay. A distinction can be made between congestion costs, infrastructure costs, environmental costs and accident costs. (Blauwens *et al.* (2008)).

The "Internalizing external costs of all modes" starts with the assumptions from the "Continuation of current policy" and "Moderate transport policy". It is now also assumed that the internalization of external costs will also apply to rail transport and inland navigation. This scenario starts from the assumptions of the "Moderate transport policy".

According to NEA Transport research and training and Universiteit Antwerpen (2007), the following values will be used in the model and applied to all types of infrastructure:

- Road: 0.075 euro per tonkm
- Rail: 0.005 euro per tonkm
- Inland waterways: 0.005 euro per tonkm

In NEA Transport research and training and Universiteit Antwerpen (2007), it is indicated that:

[20] In theory, a difference should be made between Belgian, Dutch and Luxemburg trucks on the one hand and other trucks. Given the fact that the "verkeersbelasting" and "Eurovignette" will disappear for the Belgian, Dutch and Luxemburg trucks, the other trucks have still a cost per kilometer different from zero. However, in the freight model, it was not possible to make this distinction.
[21] It is advised to calculate whether this measure is budget neutral.

- the values are used for the situation in 2020. In simulations up to 2030, those values are doubled. As such it is assumed that the internalization is introduced in a step-wise approach.
- It is indicated that the values for road are considered as quite low, in order to anticipate the effect of a shift to a new equilibrium (decrease of transport volume).

Recent research about external costs can be found in European Commission (2008b). This study gives an overview of the estimations of external costs for several modes. It is shown that a variety of values are reported. However it does not make sense to try to use these 2000-values in order to estimate the external costs in 2020. For example, changes in technological evolutions will lead to different values of external costs.

Please note that extra inland navigation measures have been introduced under the "Assumptions inland navigation".

Assumptions inland navigation

In order to simulate cost advantages for the inland waterways transport, specific assumptions have been introduced.

- **Continuation of current policy;**
- **Extra measure inland navigation**: yearly cost reduction of 2% of the cost of inland navigation (e.g. as a result of more efficient use of inland waterways).

Port assumptions

In scenarios 9-12 explicit assumptions about the port of Antwerp are taken into account. Scenarios 1-8 and the reference scenarios comprise a growth of the port of Antwerp which is the result of the included economic assumptions: "Following economic assumptions".

A difference is made between a growth of the port of Antwerp which is following the economic assumptions (scenarios 1-8 and reference scenario), a scenario in which the growth of the port is lower than predicted by the economic assumptions (scenarios 9 and 11) and a scenario in which the growth of the port is higher than predicted by the economic assumptions (scenarios 10 and 12).

The following method is used to make a difference between the types of growth of the port of Antwerp:

- In case of an extra growth we assume that the incoming flows and outgoing flows in ton for the port of Antwerp are 1.5 the initial estimated values;
- In case of a lower growth we assume that the incoming flows and outgoing flows in ton for the port of Antwerp are half the initial estimated values.

Simulations with an extra growth and a lower growth can be seen as an approximation of port competition within the freight model.

Assumptions population and household consumption

The evolution of population and household consumption is based on *European Energy and Transport Trends to 2030 – update 2005* (European Commission (2006a)). On the basis of this document a growth of the population in Belgium of 0.2% is assumed and a growth of household consumption with 1.7%. We do no assume variations of those explaining variables in the scenarios.

5.3 Simulation results

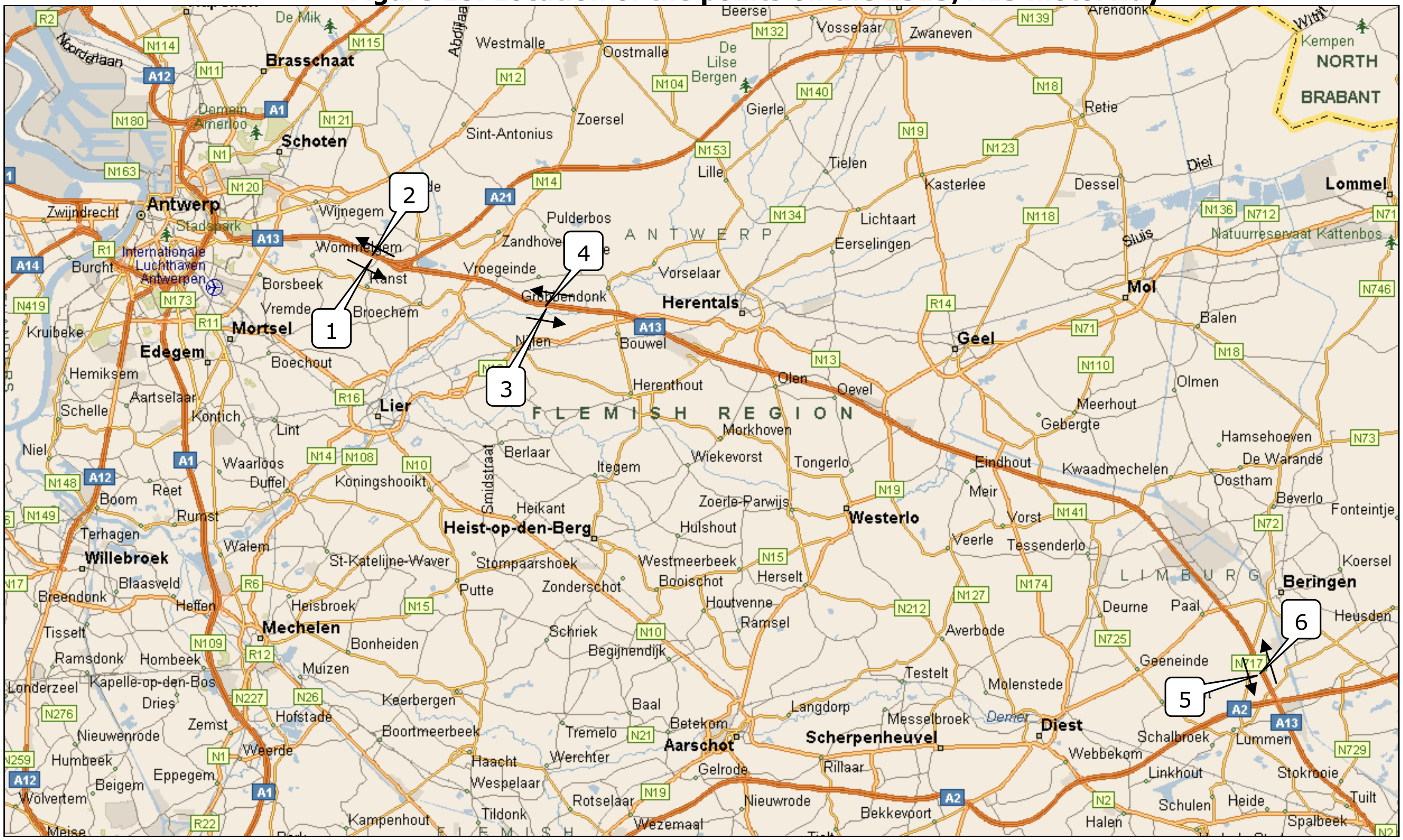
A three level approach has been performed to interpret the simulations results.

The first level calculates total tonnages and derives growth figures for every scenario. The output refers to specific points on the E313/E34 motorway and hence large variations in the results between the scenarios might be interpreted through shifts among the modes and/or route changes. These effects might come as a result of policies promoting the use of inland navigation or the diversion of traffic due to the imposition of a tolling system. For a better insight in these issues a second and third level of investigation is performed. The second and third level of investigation is applied when deemed necessary on the basis of the previous findings on the level one. They refer to alternative interpretations of the results according to mode shift and/or route diversion respectively.

In all simulation results the base year is 2004 while tonnages in the scenarios refer to 2020. Results (of the first level) refer to specific points on the E313, illustrated in Figure 18. In particular, points 1 and 2 are close to Antwerp and are selected to illustrate the direct effect of the port of Antwerp. Points 3 and 4 are selected in order to give a view on the tonnages after the split between the E313 and E34. Finally, points 5 and 6 are important because they are located in the vicinity of the intersection Lummen (E313 and E314).

It should be noted that the quantitative results are only meant to provide overall trends.

Figure 18: Location of the points on the E313/A13 motorway



Map source: Microsoft MapPoint 2009

5.3.1 Total tonnages and growth investigation

For each selected point on the E313 motorway, the total tonnage passing on that point has been calculated. The reference scenario and scenarios 1 to 12 report tonnages in 2020. All 12 scenarios are benchmarked according to:

1. Annual growth figures as compared to the Base 2004 results (see 'index', 'total growth' and 'annual growth' in Table 27a - Table 32a)
2. Total tonnages as compared to the reference scenario (see row 'tonnage' in tables Table 27a - Table 32a)

The comparison allows for the investigation of the direction, i.e. increase (+) or decrease (-), of total tonnages hence indicating overall trends. The analysis also allows for a comparison of potential policy decisions by observing the behaviour of change in total tonnages from the reference scenario.

<u>Location 1</u>

Results are explained below in detail. In particular Table 27a refers to the actual output of the simulations for location Nr.1. Observations for each scenario follow.

Table 27a: Comparison of scenarios related to location Nr.1

	Base 2004	Ref. sc.	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.9	Sc.10	Sc.11	Sc.12
Tonnage (mln tons)	29.82	30.87	30.22	29.58	30.27	19.86	19.38	20.19	19.71	16.12	24.62	37.12	12.89	19.35
Index	100	103.52	101.32	99.19	101.49	66.60	64.97	67.71	66.08	54.05	82.56	124.47	43.22	64.87
Total Growth	-	3.52	1.33	-0.81	1.49	-33.40	-35.02	-32.29	-33.92	-45.95	-17.44	24.47	-56.78	-35.13
Annual Growth	-	0.22	0.08	-0.05	0.09	-2.51	-2.66	-2.41	-2.56	-3.77	-1.19	1.38	-5.11	-2.67

Source: own composition based on simulations with the new freight model for Flanders

The following Table 27b shows the comparison of the output of the simulations to base 2004 and to reference scenario. An increase in tonnages is marked with "+" and a decrease is marked with "-". If the increase or decrease is larger than 10% in absolute value, it is marked with the symbol twice. This method is also used in the following Table 27b - Table 32b. For some scenarios some special comments or remarks are added. When conclusions are reported about mode shifts and route effects in the comments, this has been investigated further in the text.

Table 27b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.1

	Comparison to base 2004	Comparison to reference scenario	Comments
Reference scenario	+		
Scenario 1	+	-	Following expectations, no significant effects.
Scenario 2	-	-	Following expectations, no significant effects.
Scenario 3	+	-	Indication of a shift towards inland navigation.
Scenario 4	--	--	Further investigation shows that the tonnage decrease is partially due to route change and not mode shift. This effect is also true in scenarios 5, 6 and 7.
Scenario 5	--	--	The extra decrease as compared to scenario 4 gives an indication of the effect an extra measure of inland navigation has on mode shares.
Scenario 6	--	--	The annual decrease of road transport is smaller in comparison to scenario 4, given the assumption of high economic growth.
Scenario 7	--	--	The extra decrease in comparison with scenario 6 is the effect of the inland navigation measure.
Scenario 8	--	--	Scenario 8 shows a substantial decrease in tonnages, showing the effects of the internalizing of the external costs.
Scenario 9	--	--	The decrease is the result of the low port factor given the location's proximity to the port of Antwerp.
Scenario 10	++	++	Scenario 10 has exactly opposite results to those of scenario 9, resulting from the high port factor.
Scenario 11	--	--	Scenario 11 shows the same pattern as scenario 8 but it is even more pronounced due to the low port factor.
Scenario 12	--	--	Scenario 12 shows same pattern as scenarios 8 and 11 lying between those two scenarios as a result of the high port factor which moderates the effect of the internalization policy.

Location 2

The same exercise is repeated for location Nr. 2 (see map in Figure 18) with traffic in the direction of Antwerp. Comparisons with location Nr.1 are then added focusing on the differences between outgoing (matrix 1) and incoming (matrix 2) flows.

Table 28a: Comparison of scenarios related to location Nr.2

	Base 2004	Ref Sc.	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.9	Sc.10	Sc.11	Sc.12
Tonnage (mln tons)	33.97	39.33	38.24	37.51	38.59	25.62	25.06	26.24	25.68	21.65	31.92	46.77	17.33	25.97
Index	100	115.79	112.54	110.41	113.59	75.43	73.77	77.24	75.58	63.73	93.95	137.65	51.02	76.45
Total Growth	-	15.79	12.54	10.41	13.59	-24.57	-26.23	-22.76	-24.42	-36.27	-6.05	37.65	-48.98	-23.55
Annual Growth	-	0.92	0.74	0.62	0.80	-1.75	-1.88	-1.60	-1.73	-2.78	-0.39	2.02	-4.12	-1.66

Source: own composition based on simulations with freight model for Flanders

Table 28b follows the same pattern as Table 27b. In most scenarios the results are similar in volume and direction. In case of different effects resulting from the scenario based simulations those differences have been included in the comments.

Table 28b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.2

	Comparison to base 2004	Comparison to reference scenario	Comments
Reference scenario	++		More substantial annual growth.
Scenario 1	++	-	More substantial annual growth.
Scenario 2	++	-	More substantial annual growth.
Scenario 3	++	-	More substantial annual growth.
Scenario 4	--	--	Same as Table 27b, location Nr.1.
Scenario 5	--	--	Same as Table 27b, location Nr.1.
Scenario 6	--	--	Same as Table 27b, location Nr.1.
Scenario 7	--	--	Same as Table 27b, location Nr.1.
Scenario 8	--	--	Same as Table 27b, location Nr.1.
Scenario 9	-	--	Less substantial annual growth.
Scenario 10	++	++	Same as Table 27b, location Nr.1.
Scenario 11	--	--	Same as table 32b, location Nr.1.
Scenario 12	--	--	Same as table 32b, location Nr.1.

<u>Location 3</u>

The same exercise is repeated for location Nr. 3 (see map in Figure 18) with traffic away from Antwerp, see Table 29a.

Table 29a: Comparison of scenarios related to location Nr.3

	Base 2004	Ref Sc.	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.9	Sc.10	Sc.11	Sc.12
Tonnage (mln tons)	15.60	17.80	17.46	17.08	17.45	13.39	13.04	13.59	13.24	10.71	13.62	21.98	8.13	13.29
Index	100	114.15	111.99	109.55	111.87	85.84	83.61	87.14	84.91	68.67	87.33	140.97	52.10	85.24
Total Growth	-	14.15	11.99	9.55	11.87	-14.16	-16.39	-12.86	-15.09	-31.33	-12.67	40.97	-47.90	-14.76
Annual Growth	-	0.83	0.71	0.57	0.70	-0.95	-1.11	-0.86	-1.02	-2.32	-0.84	2.17	-3.99	-0.99

Source: own composition based on simulations with the new freight model for Flanders

Similarly, (as in Table 27b and Table 28b) Table 29b shows the comparison of the output of the simulations to base 2004 and to the reference scenario for the location Nr.3. In order to avoid repetition same effects have been quoted by referring to the aforementioned tables.

Table 29b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.3

	Comparison to base 2004	Comparison to reference scenario	Comments
Reference scenario	++		
Scenario 1	++	-	Substantial annual growth. Following expectations.
Scenario 2	+	-	Following expectations. Slightly lower than in scenario 1 due to additional assumptions on inland navigation. Nevertheless of a minor effect.
Scenario 3	++	-	Substantial annual growth but within expectations. Indication of a possible shift towards inland navigation.
Scenario 4	--	--	Same as Table 27b and Table 28b, locations nr.1 and 2.
Scenario 5	--	--	Same as Table 27b and Table 28b, locations nr.1 and 2.
Scenario 6	--	--	Same as Table 27b and Table 28b, locations nr.1 and 2.
Scenario 7	--	--	Same as Table 27b and Table 28b, locations nr.1 and 2.
Scenario 8	--	--	Same as Table 27b and Table 28b, locations nr.1 and 2.
Scenario 9	--	--	Significant reduction as a result of the low port factor given that location Nr.3 describes outgoing traffic on the E313.
Scenario 10	++	++	Same as Table 27b and Table 28b, locations nr.1 and 2.
Scenario 11	--	--	Same as Table 27b and Table 28b, locations nr.1 and 2.
Scenario 12	--	--	Same as Table 27b and Table 28b, locations nr.1 and 2.

Location 4

The same exercise is repeated for location Nr. 4 (see map in Figure 18) with traffic in the direction of Antwerp.

Table 30a: Comparison of scenarios related to location Nr.4

	Base 2004	Ref Sc.	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.9	Sc.10	Sc.11	Sc.12
Tonnage (mln tons)	15.92	19.32	18.88	18.47	18.89	15.35	14.95	15.68	15.28	12.79	14.59	24.05	9.47	16.12
Index	100	121.34	118.56	115.98	118.61	96.40	93.90	98.46	95.96	80.33	91.67	151.03	59.48	101.21
Total Growth		21.34	18.56	15.98	18.61	-3.60	-6.10	-1.54	-4.04	-19.67	-8.33	51.03	-40.52	1.21
Annual Growth		1.22	1.07	0.93	1.07	-0.23	-0.39	-0.10	-0.26	-1.36	-0.54	2.61	-3.19	0.08

Source: own composition based on simulations with the new freight model for Flanders

Table 30b shows the comparison of the output of the simulations to base 2004 and to the reference scenario for the location Nr.4. Comments highlight comparisons with location Nr 3 and refer to the similarities with all previously analyzed locations 1, 2 and 3.

Table 30b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.4

	Comparison to base 2004	Comparison to reference scenario	Comments
Reference scenario	++		
Scenario 1	++	-	Same as Table 29b, location Nr.3.
Scenario 2	++	-	More substantial annual growth than location Nr.3.
Scenario 3	++	-	Same as Table 29b, location Nr.3.
Scenario 4	-	--	Less substantial growth than Table 29b, location Nr.3.
Scenario 5	-	--	Annual growth is slightly higher than for location Nr.3, but still negative.
Scenario 6	-	--	Decrease in total tonnages despite the high economic growth situation and international trade increase, Annual growth is negative, but close to zero.
Scenario 7	-	--	Annual growth is negative, but higher than for location Nr.3.
Scenario 8	--	--	Same as Table 27b, Table 28b and Table 29b, locations Nr.1, 2 and 3.
Scenario 9	-	--	Less pronounced negative growth, similar decrease in tonnages as location Nr.3
Scenario 10	++	++	Same as Table 27b, Table 28b and Table 29b, locations nr.1, 2 and 3.
Scenario 11	--	--	Same as Table 27b, Table 28b and Table 29b, locations nr.1, 2 and 3.
Scenario 12	+	--	From negative to positive annual growth although of minor level. Similar decrease in tonnages as location Nr.3.

Location 5

The same exercise is repeated for location Nr. 5 (see map in Figure 18) with traffic away from Antwerp, see Table 31a.

Table 31a: Comparison of scenarios related to location Nr.5

	Base 2004	Ref Sc.	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.9	Sc.10	Sc.11	Sc.12
Tonnage (mln tons)	17.98	20.50	20.09	19.56	19.99	17.48	17.02	17.83	17.36	14.47	17.04	23.96	12.53	16.41
Index	100	113.97	111.72	108.76	111.13	97.21	94.66	99.12	96.55	80.45	94.74	133.21	69.68	91.22
Total Growth		13.97	11.72	8.76	11.13	-2.79	-5.34	-0.88	-3.45	-19.55	-5.26	33.21	-30.32	-8.78
Annual Growth		0.82	0.70	0.53	0.66	-0.18	-0.34	-0.06	-0.22	-1.35	-0.34	1.81	-2.23	-0.57

Source: own composition based on simulations with the new freight model for Flanders

Table 31b shows the comparison of the output of the simulations to base 2004 and to the reference scenario for the location Nr.5.

Table 31b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.5

	Comparison to base 2004	Comparison to reference scenario	Comments
eference scenario	++		
Scenario 1	++	-	Substantial annual growth. Following expectations.
Scenario 2	+	-	Following expectations. Slightly lower than in scenario 1 due to additional assumptions on inland navigation. Nevertheless of a minor effect.
Scenario 3	++	-	Substantial annual growth but within expectations. Indication of a shift towards inland navigation.
Scenario 4	-	--	Less pronounced annual growth reduction.
Scenario 5	-	--	Less pronounced annual growth reduction.
Scenario 6	-	--	Less pronounced annual growth reduction.
Scenario 7	-	--	Less pronounced annual growth reduction.
Scenario 8	--	--	Same as Table 27b, Table 28b, Table 29b and Table 30b, locations Nr.1, 2, 3 and 4.
Scenario 9	-	--	Less pronounced annual growth reduction.
Scenario 10	++	++	Same as Table 27b, Table 28b, Table 29b and Table 30b, locations Nr.1, 2, 3 and 4.
Scenario 11	--	--	Same as Table 27b, Table 28b, Table 29b and Table 30b, locations Nr.1, 2, 3 and 4.
Scenario 12	-	--	Less pronounced annual growth reduction.

Location 6

The same exercise is repeated for location Nr. 6 (see map in Figure 18) with traffic in the direction of Antwerp. Comparisons with location Nr.5 are then added focusing on the differences between outgoing (location Nr.5) and incoming (location Nr.6) flows in this location.

Table 32a: Comparison of scenarios related to location Nr.6

	Base 2004	Ref Sc.	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.9	Sc.10	Sc.11	Sc.12
Tonnage (mln tons)	16.50	19.65	19.21	18.78	19.21	16.92	16.52	17.30	16.89	14.18	16.03	23.28	11.92	16.45
Index	100	119.12	116.48	113.84	116.45	102.58	100.13	104.84	102.39	85.98	97.14	141.10	73.26	99.70
Total Growth	-	19.12	16.48	13.84	16.45	2.58	0.13	4.84	2.39	-14.02	-2.86	41.10	-27.74	-0.30
Annual Growth	-	1.10	0.96	0.81	0.96	0.16	0.01	0.30	0.15	-0.94	-0.18	2.18	-2.01	-0.02

Source: own composition based on simulations with the new freight model for Flanders

Table 32b shows the comparison of the output of the simulations to base 2004 and to the reference scenario for the location Nr.6.

Table 32b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.6

	Comparison to base 2004	Comparison to reference scenario	Comments
Reference scenario	++		
Scenario 1	++	-	Same as Table 31b, location Nr.5.
Scenario 2	++	-	Same as Table 31b, location Nr.5.Slightly higher annual growth.
Scenario 3	++	-	Same as Table 31b, location Nr.5. Slightly higher annual growth.
Scenario 4	+	--	Annual growth increase compared to base 2004, contrary to decrease for location Nr.5. This is also true in scenarios 5, 6 and 7. In location Nr.6 (in the direction of Antwerp) the assumptions in scenarios 4 to 7 influence the goods flow less than in location Nr.5 (in the direction away from Antwerp).
Scenario 5	+	--	From negative to positive annual growth. Similar decrease in tonnages as location Nr.5.
Scenario 6	+	--	From negative to positive annual growth. Similar decrease in tonnages as location Nr.5.
Scenario 7	+	--	From negative to positive annual growth. Similar decrease in tonnages as location Nr.5.
Scenario 8	--	--	Same as Table 27b, Table 28b, Table 29b, Table 30b and Table 31b, locations Nr.1, 2,

			3, 4 and 5.
Scenario 9	-	--	Same as Table 31b, location Nr.5.
Scenario 10	++	++	Same as Table 31b, location Nr.5.
Scenario 11	--	--	Same as Table 31b, location Nr.5.
Scenario 12	-	--	Same as Table 31b, location Nr.5. The annual growth is close to zero.

5.3.2 Network analysis: Route change

The route change investigation is done by the use of the difference plot, an illustration tool of the Cube software.

The purpose of this application is to use the difference plot for illustrating the different scenarios in both color and thickness. Hence, the scenarios for which this investigation has been deemed necessary are benchmarked with the reference scenario, showing whether an increase or decrease in tonnages has taken place.

In particular what is shown by the different colors could be summarized as follows:

- Red lines show an increase of more than hundred tons;
- Green lines show a decrease of more than hundred tons;
- Grey lines show minor differences, indicating that the scenarios have an insignificant effect on the tonnages transported on the specific network link;

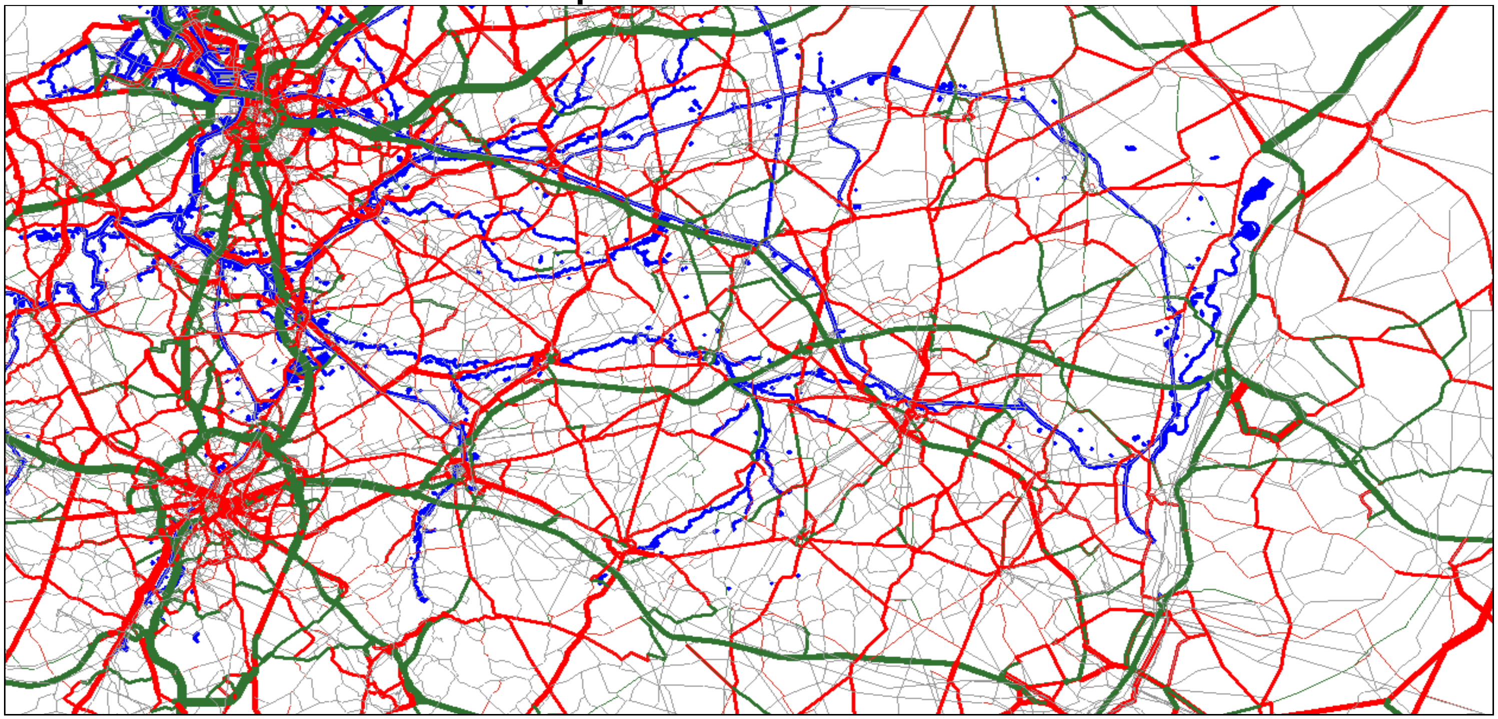
On the other hand the thickness of the lines represents the volume of tonnages for each link. Three levels of thickness have been defined (see size column in Table 33). Table 33 also shows which colors are being used according to which the criteria.

Table 33: Difference plot criteria (road network)

Criteria	Size	Colour
V_VRW_TON>10.000	1	Red
V_VRW_TON<-10.000	1	Green
V_VRW_TON>=-10.000&V_VRW_TON<=10.000	1	Grey
V_VRW_TON>=100.000	3	Red
V_VRW_TON<=-100.000	3	Green
V_VRW_TON>=1.000.000	5	Red
V_VRW_TON<=-1.000.000	5	Green
V_VRW_TON>=10.000.000	8	Red
V_VRW_TON<=-10.000.000	8	Green

According to the fist level of investigation the scenarios for which this application has been deemed necessary are scenarios 4, 5, 6 and 7 that refer to the moderate policy assumption and its variations and 8, 11 and 12 which correspond to the internalization policy assumption and its variations. Each scenario is further explained below.

Graph 1: Scenario 4 versus reference scenario

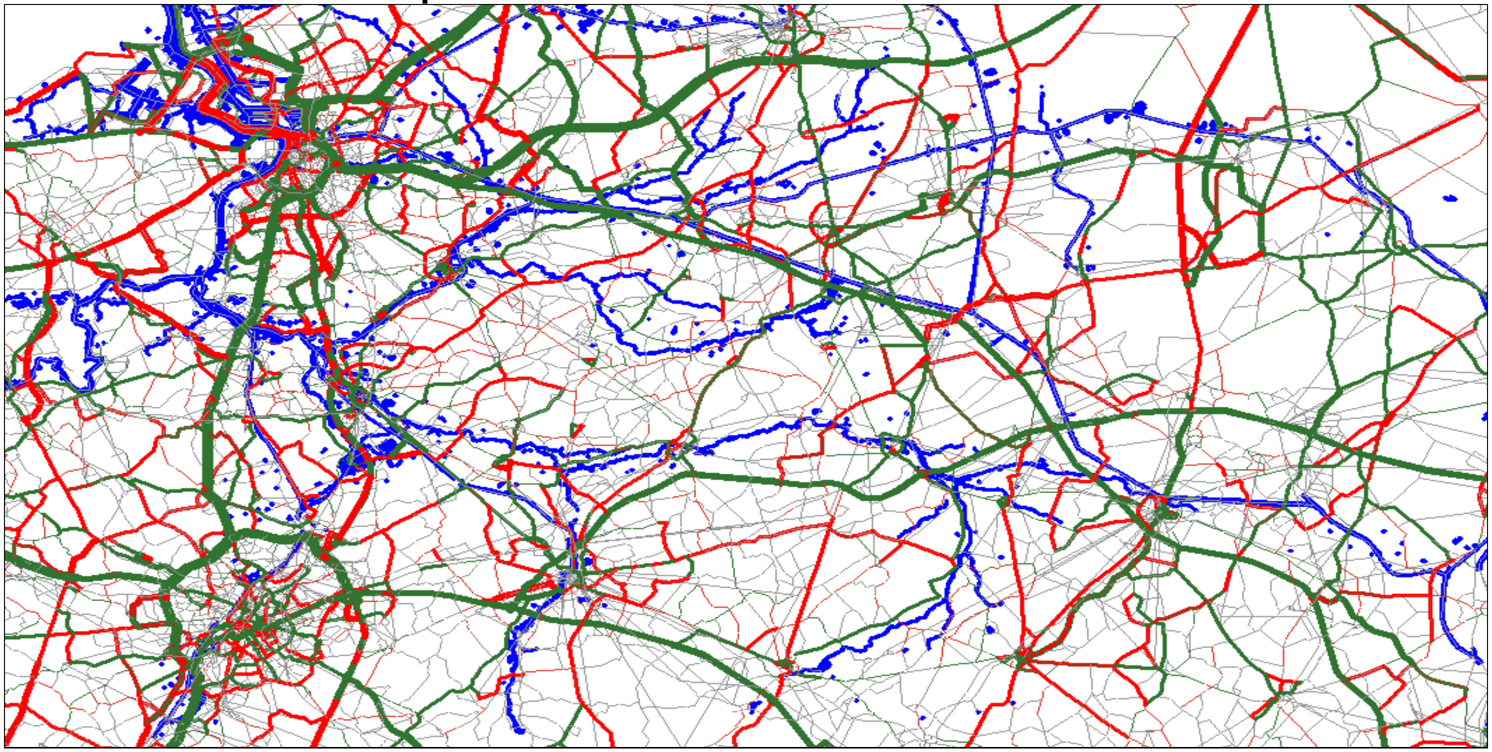


Source: Own composition based on Freight model Flanders

In scenario 4, total tonnages for the selected points on the E313 when compared to the reference scenario decrease. This is illustrated by the green color on the network. Clearly, route changes in terms of an increase in tonnages are observed on the non-highway network as shown by the red lines.

Given those results an alternative scenario is run. Scenario 4bis differs from scenario 4 by the addition of a kilometer costs variable (km costs other= 0.15) to the rest of the network together with the km cost on the highways (km costs highways= 0.15).

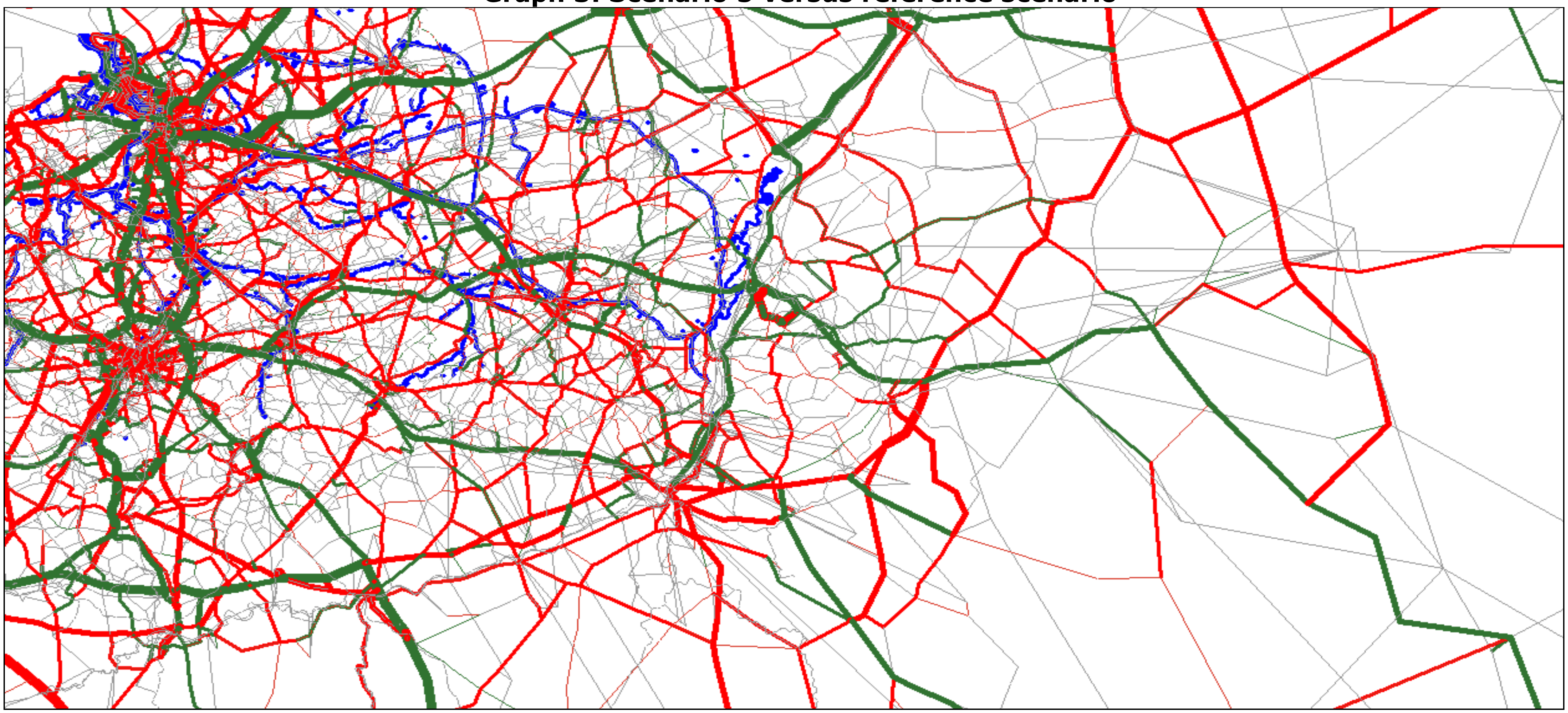
Graph 2: Scenario 4bis versus reference scenario



Source: Own composition based on Freight model Flanders

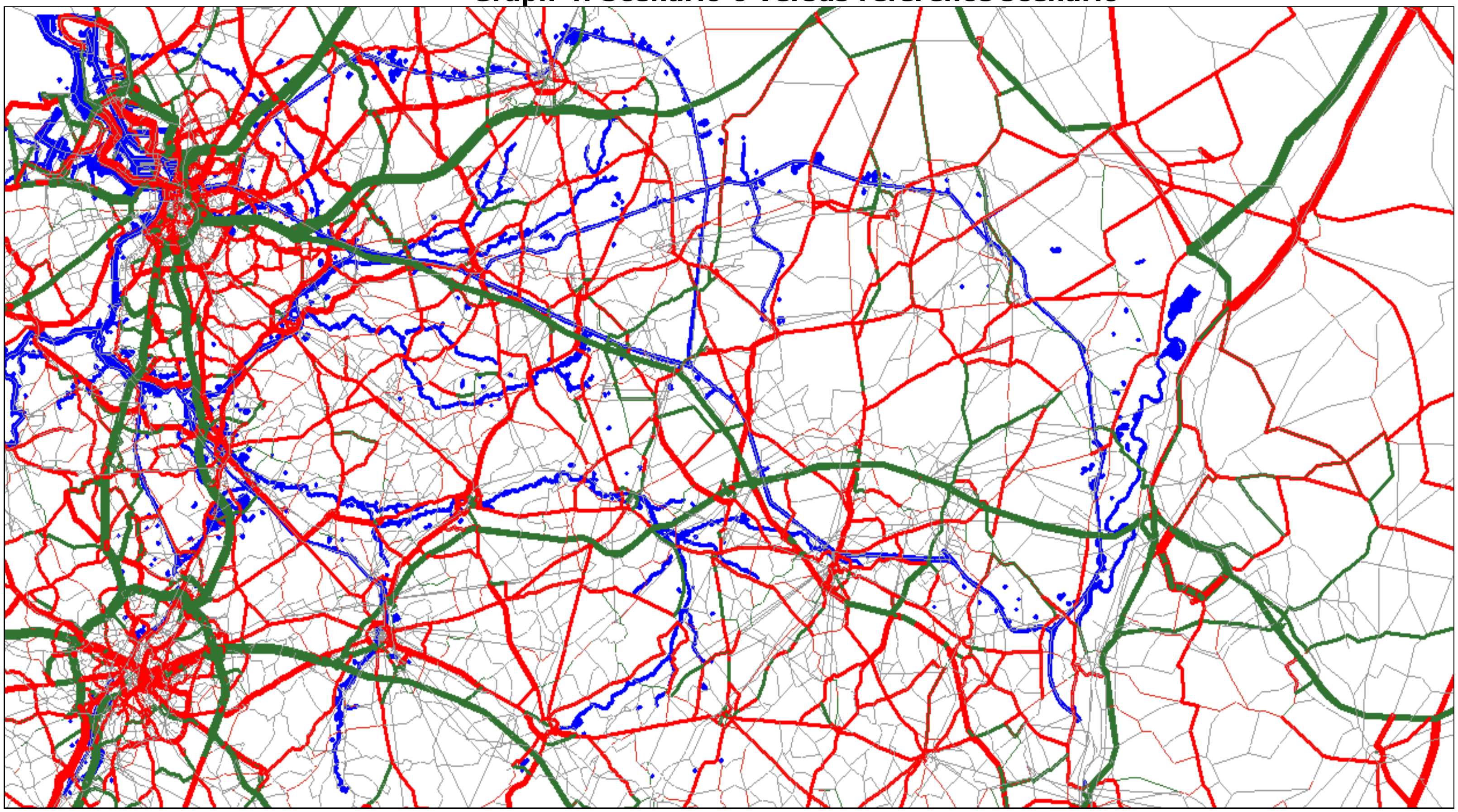
The results of this simulation seem to differ substantially from scenario 4. On the overall the decrease in tonnages (green lines) has become more widespread in the network. Given only minor differences between the scenarios 5, 6 and 7 (shown in graphs 3, 4 and 5 respectively) with scenario 4, a similar network effect is expected. For this aggregate level of investigation the main conclusion drawn is that route diversion occurs when a moderate policy in terms of kilometer costs charging on the highways is being enforced.

Graph 3: Scenario 5 versus reference scenario



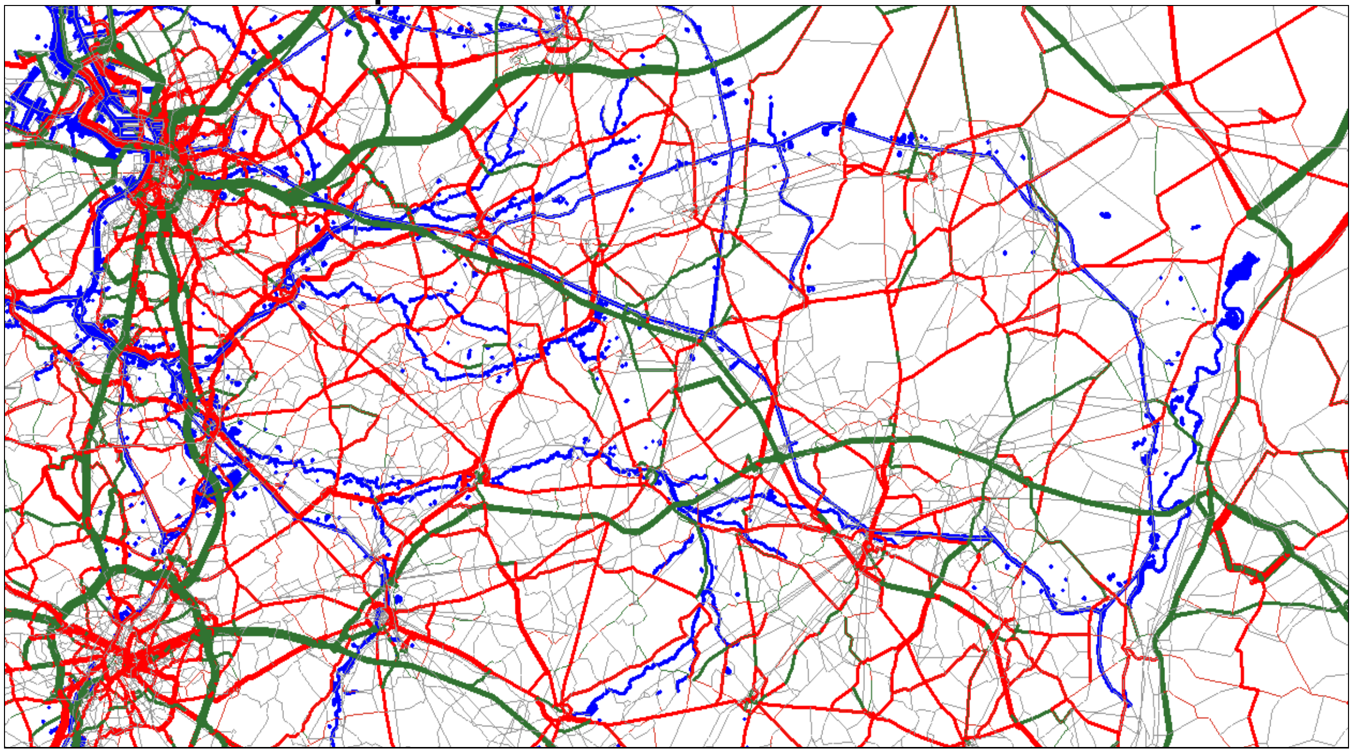
Source: Own composition based on Freight model Flanders

Graph 4: Scenario 6 versus reference scenario



Source: Own composition based on Freight model Flanders

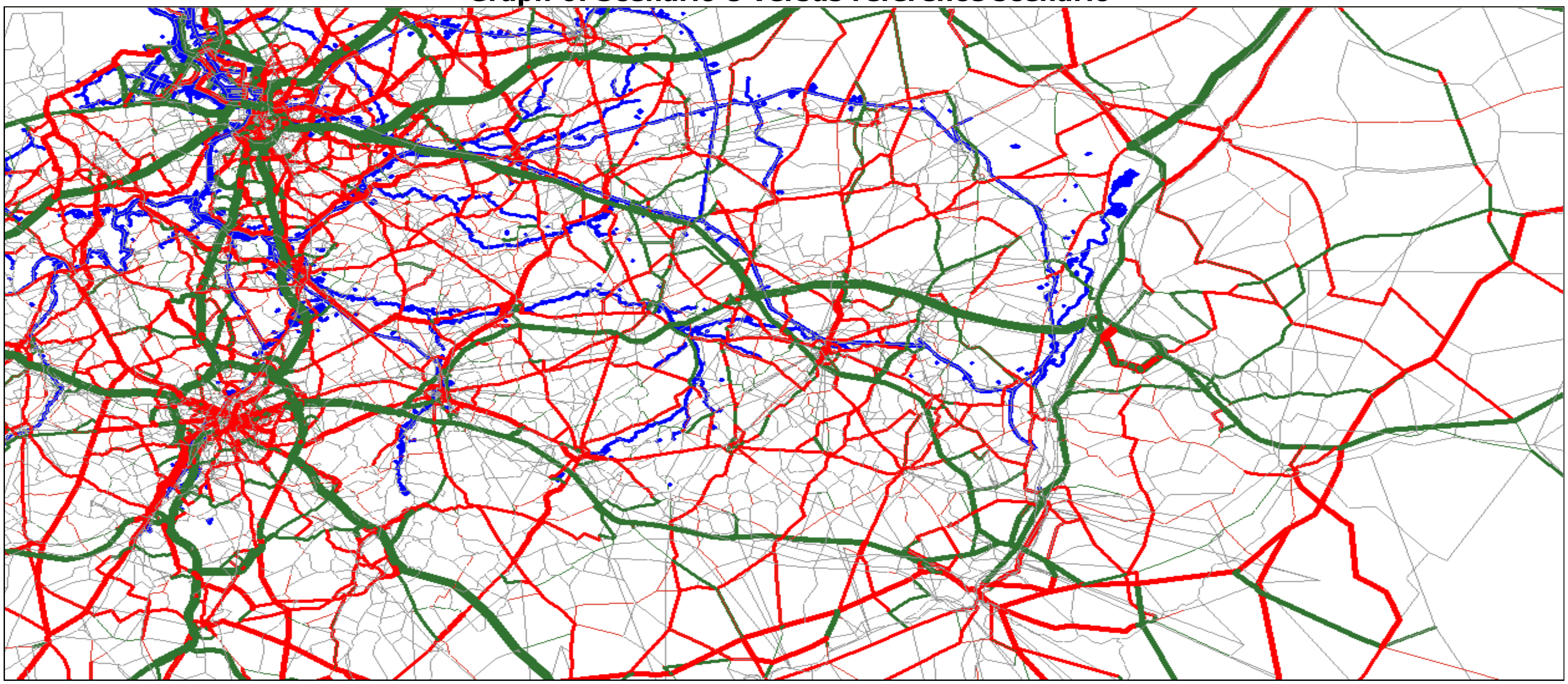
Graph 5: Scenario 7 versus reference scenario



Source: Own composition based on Freight model Flanders

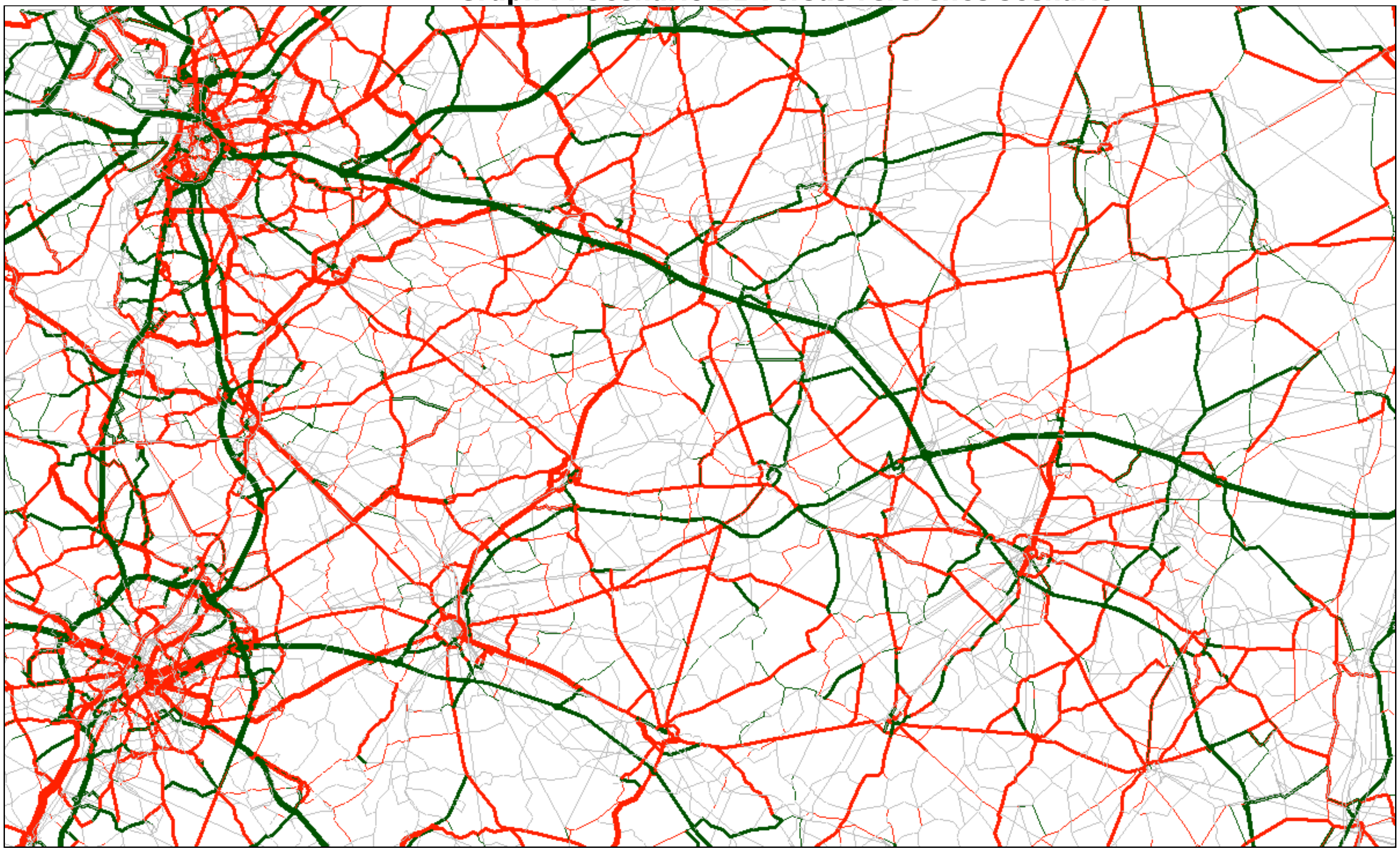
Scenarios 8, 11, 12 of the internalization policy (found in Graphs 6, 7 and 8 respectively) show once more the same network pattern but with the effects being more pronounced than the scenarios of moderate policy. Given the focus of this study on the E313 motorway, simulations of a variety of policies show the overall sensitivity of its transported traffic volumes, in terms of tonnages, to charging policies. Nevertheless, a more in depth analysis would be necessary when evaluating the appropriateness of such policies.

Graph 6: Scenario 8 versus reference scenario



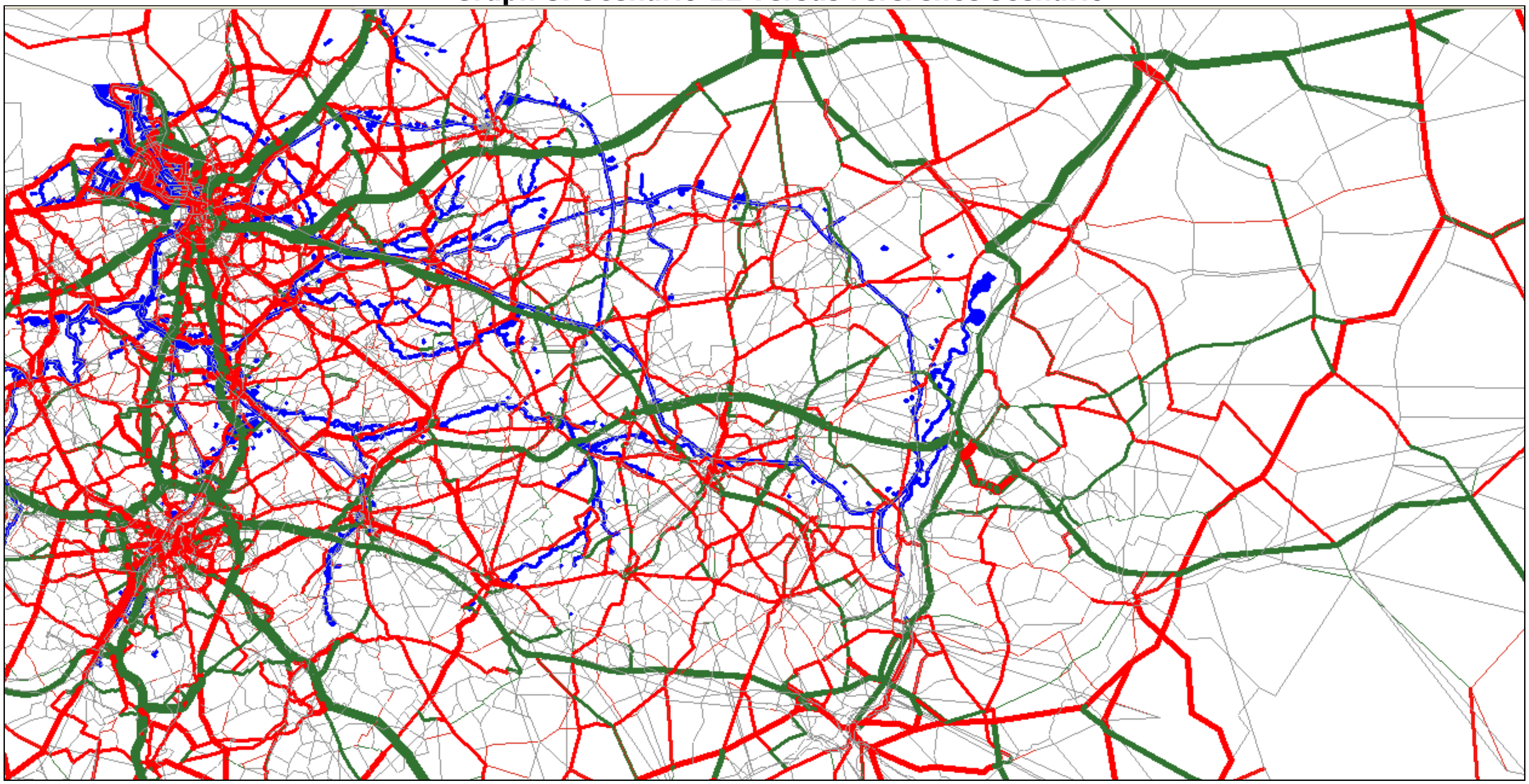
Source: Own composition based on Freight model Flanders

Graph 7: Scenario 11 versus reference scenario



Source: Own composition based on Freight model Flanders

Graph 8: Scenario 12 versus reference scenario



Source: Own composition based on Freight model Flanders

5.3.3 Mode Shift

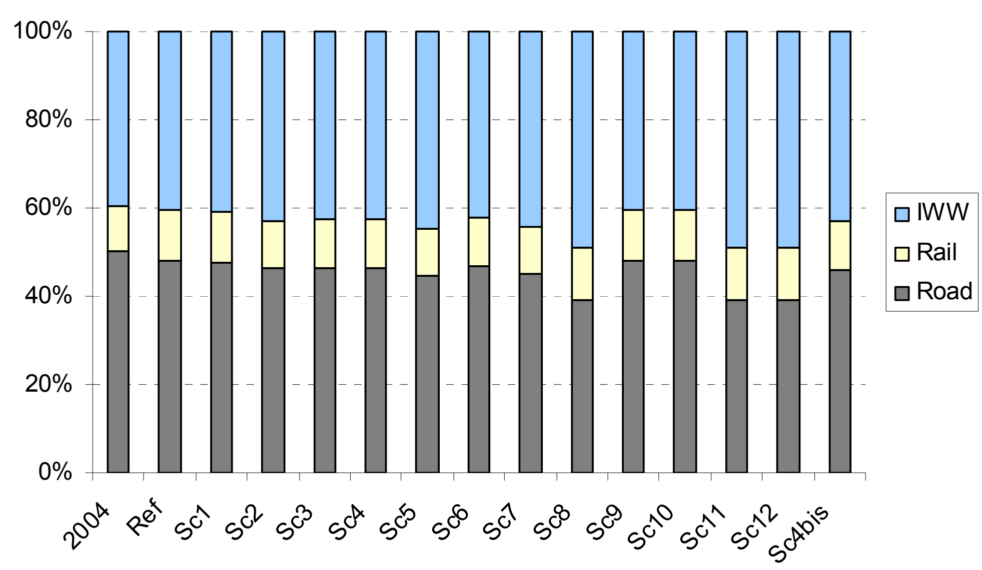
Four regions have been selected to analyze the mode shift effects of the scenarios: port of Antwerp, county of Antwerp (excl. Port of Antwerp), region of Turnhout and region of Hasselt. The E313 passes through all the aforementioned regions.

For each region, the total incoming and outgoing flows in tonnes have been calculated for road, rail and inland waterways (IWW). This enables the calculation of the modal split for the base year 2004, the reference scenario and the specific scenarios (1-12 and 4bis).

Incoming flows

In the port of Antwerp, it is known that the use of inland navigation is very important, which has been confirmed in Figure 19. The scenarios 8, 11 and 12 show the highest effect on the choice of road transport (decrease in comparison with the base year 2004 and the reference scenario). In those 3 scenarios, the policy of internalizing external costs of all modes has been assumed. According to the simulation results of the freight model, it turns out that the shift of road transport is mainly towards inland navigation.

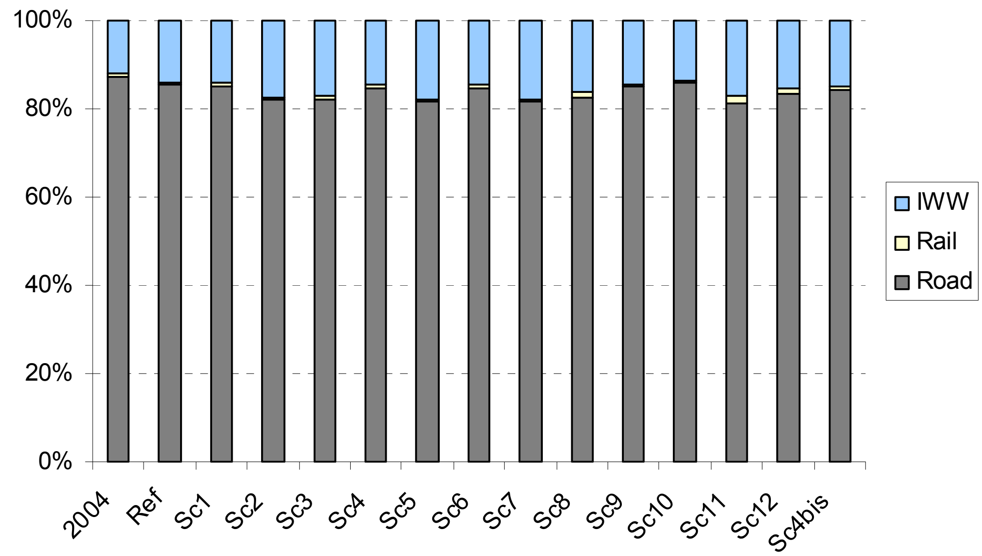
Figure 19: Port of Antwerp



Source: own composition based on simulations with the new freight model for Flanders

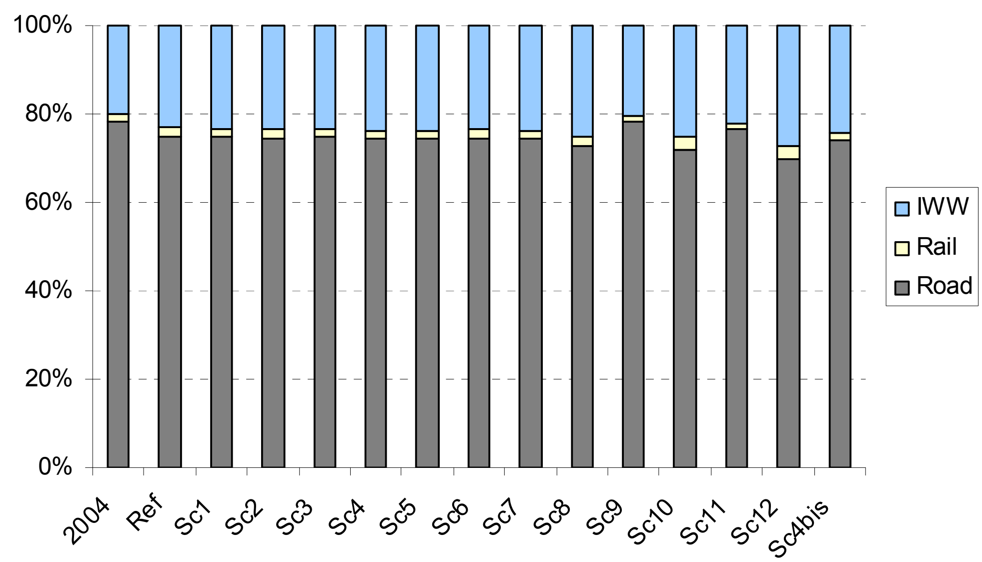
In the other regions, we can also see the decreasing effects on road transport of internalizing all external cost. However, in absolute values, these effects are smaller in comparison with the port of Antwerp. According to the freight model, it turns out that the port-related traffic is sensitive to the policy assumptions made in the scenarios.

Figure 20: Region of Antwerp (NUTS-3) excl. Port of Antwerp



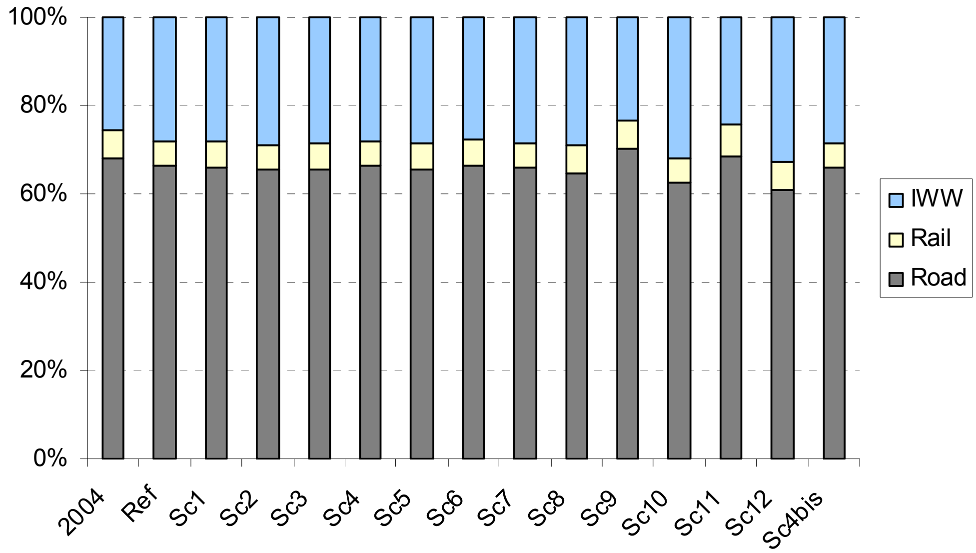
Source: own composition based on simulations with the new freight model for Flanders

Figure 21: Region of Turnhout (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

Figure 22: Region of Hasselt (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

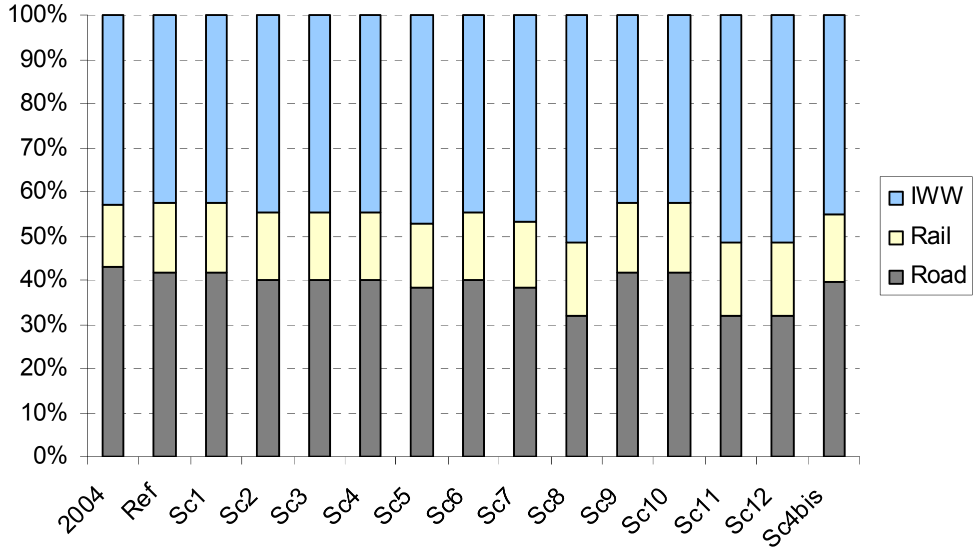
In all regions the scenarios introducing the extra measure for inland navigation (scenarios 2, 3, 5 and 7) do not seem to significantly influence the mode choice (expressed in percentages). Moreover, the same effect is observed in the scenarios for which a moderate policy is assumed (scenarios 4, 5, 6 and 7). The latter, combined with the network investigation (see chapter 5.3.2) demonstrate that the decrease in tonnages in the investigated points on the E313 is a result of route changes rather than mode shifts.

Outgoing flows

The underlying figures of outgoing flows from the port of Antwerp show a higher modal part of inland navigation in the port of Antwerp, in comparison with the incoming flows and as shown also in Figure 19.

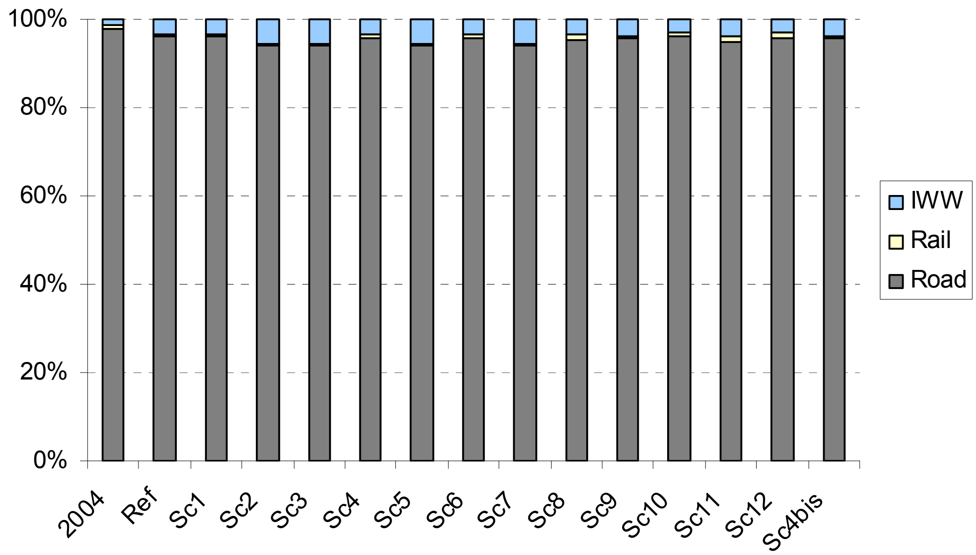
The effects of the several scenarios are similar for the outgoing flows compared to the effects for the incoming flows.

Figure 23: Port of Antwerp



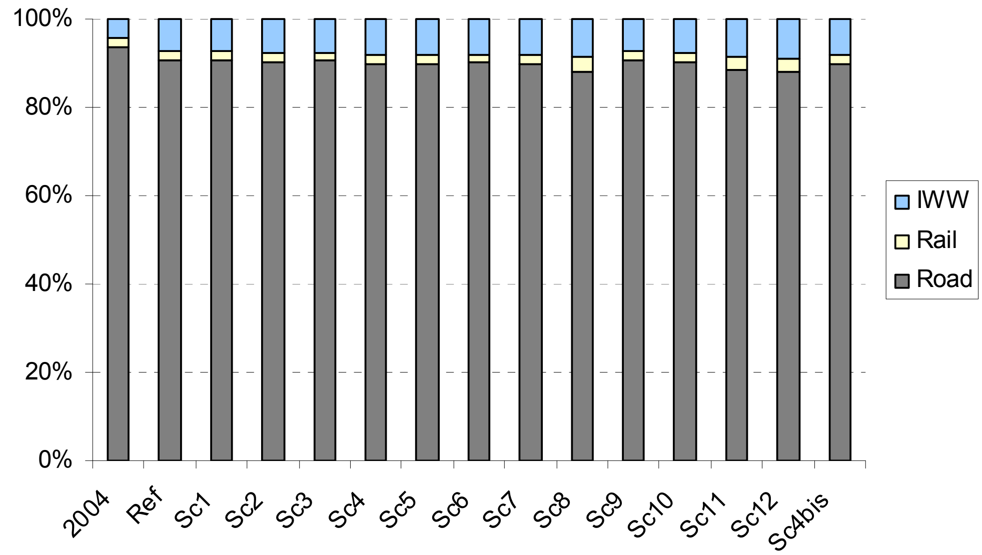
Source: own composition based on simulations with the new freight model for Flanders

Figure 24: Region of Antwerp (NUTS-3) excl. Port of Antwerp



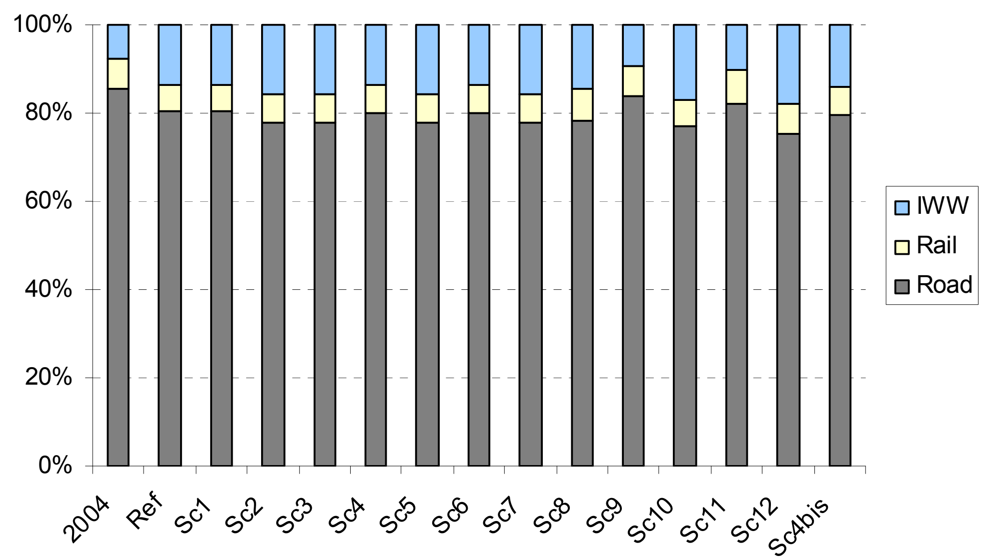
Source: own composition based on simulations with the new freight model for Flanders

Figure 25: Region of Turnhout (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

Figure 26: Region of Hasselt (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

Region Antwerpen, Mechelen, Turnhout and Sint-Niklaas

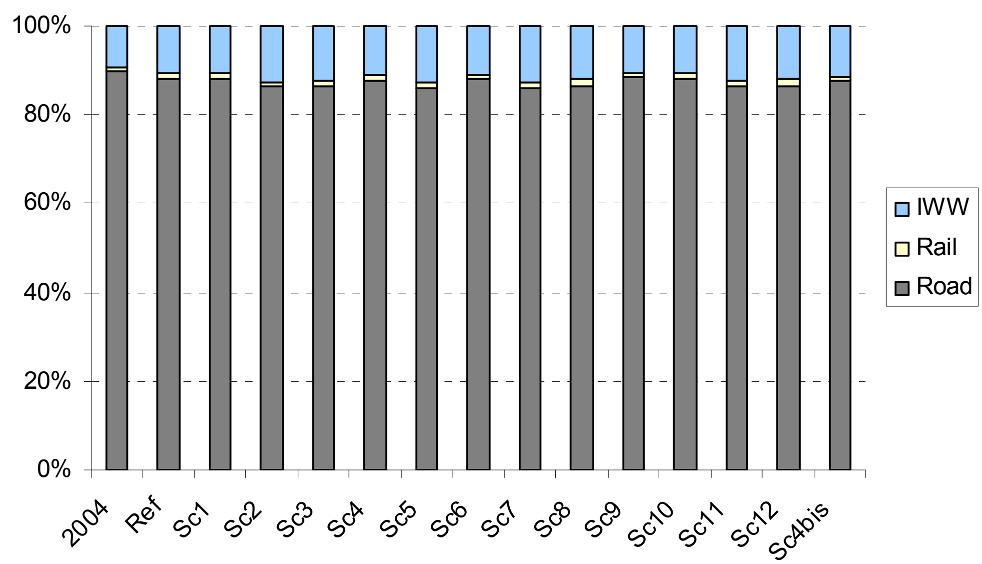
A seperate analysis has been performed for the region Antwerpen, Mechelen, Turnhout and Sint-Niklaas as one study area. In the following Table 34 and Figure 27 an overview is given of the mode split, taking into account as well the incoming as the outgoing flows.

Table 34: Mode split (region Antwerpen, Mechelen, Turnhout and Sint-Niklaas)

	Road	Rail	IWW
2004	89,63	0,98	9,38
Ref	88,31	0,99	10,70
Sc1	88,25	0,99	10,76
Sc2	86,53	0,96	12,51
Sc3	86,59	0,96	12,45
Sc4	87,88	1,01	11,11
Sc5	86,10	0,98	12,92
Sc6	87,94	1,01	11,05
Sc7	86,16	0,97	12,87
Sc8	86,35	1,64	12,01
Sc9	88,45	0,82	10,73
Sc10	88,20	1,13	10,67
Sc11	86,25	1,52	12,23
Sc12	86,43	1,74	11,84
Sc4bis	87,51	1,07	11,42

Source: own composition based on Freight model Flanders

Figure 27: Mode split (region Antwerpen, Mechelen, Turnhout and Sint-Niklaas)



Source: own composition based on Freight model Flanders

For the region of Antwerpen, Mechelen, Turnhout and Sint-Niklaas (regions 11, 12, 13 and 46 taken together) the introduction of the extra measure for inland navigation (scenario 3) results in a 1.8% mode share increase for inland navigation.

Region Antwerpen, Mechelen, Turnhout, Sint-Niklaas and port of Antwerp

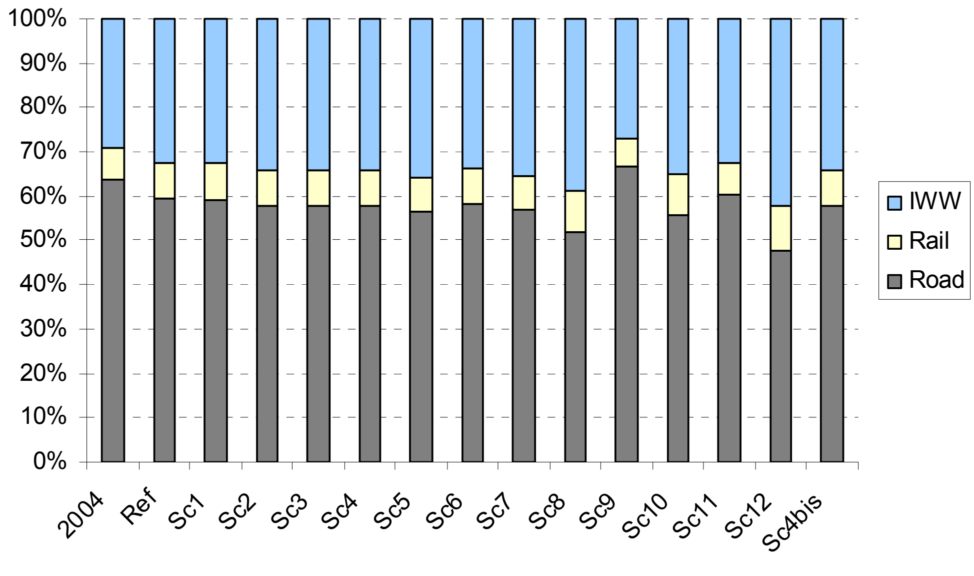
A seperate analysis has been performed also for the region Antwerpen, Mechelen, Turnhout, Sint-Niklaas and port of Antwerp as another study area. In Table 35 and Figure 28 an overview is given of the mode split, taking into account as well the incoming as the outgoing flows.

Table 35: Mode split (Antwerpen, Mechelen, Turnhout, Sint-Niklaas and port of Antwerp)

	Road	Rail	IWW
2004	63,71	7,35	28,94
Ref	59,35	8,30	32,35
Sc1	59,09	8,31	32,59
Sc2	57,74	8,00	34,26
Sc3	58,02	7,98	34,01
Sc4	57,96	7,98	34,06
Sc5	56,59	7,65	35,76
Sc6	58,23	7,98	33,79
Sc7	56,86	7,65	35,48
Sc8	51,87	9,18	38,96
Sc9	66,55	6,41	27,04
Sc10	55,78	9,24	34,98
Sc11	60,29	7,26	32,46
Sc12	47,69	10,13	42,18
Sc4bis	57,74	7,96	34,29

Source: own composition based on Freight model Flanders

Figure 28: Mode split (region Antwerpen, Mechelen, Turnhout, Sint-Niklaas and port of Antwerp)



Source: own composition based on Freight model Flanders

5.3.4 Interpretations of the scenarios

- Scenario 1 differs from the reference scenario with low economic growth assumptions and low growth assumptions for export and import (for details see chapter 5.2). The result of these assumptions on the goods flows on the motorway E313 is as expected – the volumes of the goods flows and also the annual growth has decreased in all the locations on the motorway. The model successfully captures the decrease in economic growth and international trade and links it to the lower growth of goods flows on the motorway E313.
- Scenario 2 differs form scenario 1 by an extra assumption on inland navigation – a yearly cost reduction of 2% of the cost of inland navigation, e.g. as a result of more efficient use of inland waterways. The inland navigation assumption in scenario 2 re-inforces the effect of low economic and trade assumptions and reduces the tonnages even further in all the reviewed locations on the motorway. The effect tends to be bigger on goods flows in the direction away from Antwerp.
- Scenario 3 starts with the reference scenario and adds only the assumption on the yearly cost reduction of inland navigation (as in scenario 2). In this case the model demonstrates the mode shift effects of the inland navigation measures. The cost reduction allows reaching the objective of mode shift towards inland navigation. It must be mentioned that the shift is moderate.

- Scenario 4 starts with the reference scenario and introduces road pricing set to € 0.15 per kilometer in the Benelux, which is applied on the highways (see chapter 5.2 for details). This does not apply to local roads. The effects of this situation are as expected: the goods flows on the motorway E313 reduce substantially. However this is associated with adverse effects to the local roads for which the charging is not in force. Further investigation of the situation (running an additional scenario 4bis with road pricing on all roads) showed that a certain part of the traffic chooses alternative routes instead of shifting modes. This phenomenon tends to be more pronounced on the points of the motorway E313 closer to Antwerp, but as the distance from Antwerp increases the difference between scenario 4 and 4bis decreases.
- Scenario 5 starts with road pricing assumptions like in scenario 4 and adds the assumptions for inland navigation from scenario 3 thus combining those two scenarios. The combination of the measures gives the expected effect and the goods flows decrease. This decrease is partially due to mode shift, but also due to changes in route choice for road transport.
- Scenario 6 introduces road pricing in a high growth economic situation with high export and import growth. If compared to scenario 4 (only road pricing, see above), the effects of road pricing on goods flows on motorway E313 are less pronounced due to extra assumptions in the scenario. However it can be speculated that the reduction in traffic flows on the E313 that scenario 6 demonstrates brings with it similar adverse effects to other parts of the transport network as in scenario 4.
- Scenario 7 adds extra assumptions on inland navigation (see chapter 5.2 for details) to the existing scenario 6. If compared to scenario 6, we see a slight decrease in tonnages in all matrixes as a result of the extra inland navigation assumption.
- Scenario 8 starts with a reference scenario and brings in internalization of external costs for all modes – all parts of transport networks are charged. This policy gives a substantial effect if compared to measures tested in other scenarios.
- Scenarios 9 and 10 test the effect of the growth of the Port of Antwerp on goods flows on the motorway E313. There is a slight decrease in goods flows in the low port growth situation and an opposite effect in the high growth situation.
- Scenario 11 adds to scenario 8 a low port growth factor which, as expected, has a reinforcing effect on the internalization policy of external costs.
- Scenario 12, however adds a high port growth factor to scenario 8. This has a weakening effect on the internalization policy of external costs.

Table 36: Comparison of indexes for the selected locations

	Ref Sc.	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.9	Sc.10	Sc.11	Sc.12	Sc. 4bis
Loc. 1	104	101	99	101	67	65	68	66	54	83	124	43	65	79
Loc. 2	116	113	110	114	75	74	77	76	64	94	138	51	76	88
Loc. 3	114	112	110	112	86	84	87	85	69	87	141	52	85	104
Loc. 4	121	119	116	119	96	94	98	96	80	92	151	59	101	115
Loc. 7	114	112	109	111	97	95	99	97	80	95	133	70	91	94
Loc. 8	119	116	114	116	103	100	105	102	86	97	141	72	100	100

Source: own composition based on simulations with the new freight model for Flanders

5.3.5 General conclusions

- The results of the simulations show that combinations of measures with similar consequences have greater effect. This is clearly demonstrated by scenarios 8, 11 and 12 where a set of combined policy measures are enacted. Therefore for practical implementation a combination of measures is more advisable.
- One scenario may have different effect (even adverse) on the traffic volumes in different points and directions of the road network.
- Scenarios with port growth variations clearly show the impacts of port turnover dynamics on the traffic on the points on the motorway E313. The increased/decreased port throughput has an influence both on incoming and outgoing flows, but the level of effect is different. The incoming flows are influenced less than the outgoing flows. For example, in matrix 8 (in the direction of Antwerp) the assumptions of scenarios 4 to 7 influence the goods flow less than in matrix 7 (same point, in the direction away from Antwerp).
- In all regions the scenarios introducing the extra measure for inland navigation (scenarios 2, 3, 5 and 7) do not seem to significantly influence the mode choice (expressed in percentages). Moreover, the same effect is observed in the scenarios for which a moderate policy is assumed (scenarios 4, 5, 6 and 7).

5.4 Additional Scenarios

In order to further investigate the effects of measures concerning Iron Rhine and Albert canal, additional scenarios were created:

- Scenario 14 – starting from the reference scenario and adding the assumption that the Albert canal has the capacity of 2004. This enables to see the effects of a canal capacity increase: using a bigger vessel size in reference scenario (9000 tons) than in Scenario 14 (4500 tons).

- Scenario 15 – starting from the reference scenario and including the Iron Rhine link.

5.4.1 Results of Additional Scenarios

For additional scenarios 14 and 15 a similar approach as in the chapter 5.3.1 was adapted. Both scenarios are benchmarked to:

1. Annual growth figures as compared to the Base 2004 results (see 'index', 'total growth' and 'annual growth')
2. Total tonnages as compared to the reference scenario (see row 'tonnage')

The following tables (Table 37 - Table 42) refer to the actual output of the simulations for locations Nr.1 - 6. Observations for scenarios 14 and 15 follow.

Table 37: Comparison of additional scenarios related to location Nr.1

	Base 2004	Ref Sc.	Sc.14	Sc.15
Tonnage (mln tons)	29.82	30.87	30.87	30.87
Index	100	103.52	103.52	103.52
Total Growth	-	3.52	3.52	3.52
Annual Growth	-	0.22	0.22	0.22

Source: Own composition based on Freight model Flanders

Table 38: Comparison of additional scenarios related to location Nr.2

	Base 2004	Ref Sc.	Sc.14	Sc.15
Tonnage (mln tons)	33.97	39.34	39.34	39.34
Index	100	115.79	115.79	115.79
Total Growth	-	15.79	15.79	15.79
Annual Growth	-	0.92	0.92	0.92

Source: Own composition based on Freight model Flanders

Table 39: Comparison of additional scenarios related to location Nr.3

	Base 2004	Ref Sc.	Sc.14	Sc.15
Tonnage (mln tons)	15.60	17.80	17.80	17.80
Index	100	114.15	114.15	114.15
Total Growth	-	14.15	14.15	14.15
Annual Growth	-	0.83	0.83	0.83

Source: Own composition based on Freight model Flanders

Table 40: Comparison of additional scenarios related to location Nr.4

	Base 2004	Ref Sc.	Sc.14	Sc.15
Tonnage (mln tons)	15.92	19.32	19.32	19.32
Index	100	121.34	121.34	121.34
Total Growth	-	21.34	21.34	21.34
Annual Growth	-	1.22	1.22	1.22

Source: Own composition based on Freight model Flanders

Table 41: Comparison of additional scenarios related to location Nr.5

	Base 2004	Ref Sc.	Sc.14	Sc.15
Tonnage (mln tons)	17.98	20.50	20.50	20.50
Index	100	113.97	113.97	113.96
Total Growth	-	13.97	13.97	13.96
Annual Growth	-	0.82	0.82	0.82

Source: Own composition based on Freight model Flanders

Table 42: Comparison of additional scenarios related to location Nr.6

	Base 2004	Ref Sc.	Sc.14	Sc.15
Tonnage (mln tons)	16.50	19.65	19.65	19.65
Index	100	119.12	119.12	119.11
Total Growth	-	19.12	19.12	19.11
Annual Growth	-	1.10	1.10	1.10

Source: Own composition based on Freight model Flanders

Scenario 14

Despite the insignificant results on the basis of total tonnages what is striking in this scenario is that when the capacity of the Albert Canal increases from a capacity of 4 500 tonnes to 9 999 tonnes the size of the vessels changes. In particular (see Table 43) an increase of 50% for the largest vessel category of 9 000 tonnes is observed.

Table 43: Scenario 14

Vessel Size (Tonnes)	Ref(Cap=9999)	Sc.14(Cap=4500)	% Change
300	69.86	70.01	-0.21
600	334.3	339.69	-1.59
1350	298.32	312.83	-4.64
2000	114.12	123.75	-7.78
4500	129.36	161.19	-19.75
9000	69.4	46	50.87
Total	1015.89	1053.98	-3.61

Source: Own composition based on Freight model Flanders

Scenario 15

Previous research (see Section 1g: Iron Rhine) shows that the main effect of the re-activation of the Iron Rhine is a shift from the Montzen route. A modal shift is not the main effect. If any modal shift is reported, this applies more to a shift from inland waterways to rail transport. Research based on the Flanders freight model also shows a small effect. The re-activation of the Iron Rhine is important for the port of Antwerp in the sense that this means an increase of the capacity of hinterland traffic (and in particular rail transport). Therefore, the hinterland rail traffic will be ready to cope with potential increased rail traffic, which could not be dealt with today (given current limitations). It should be noted here that in the current version of the Freight model Flanders, capacity use of the network is not yet taken into account.

6. Modeling results II

In chapter 5 simulations were made on the basis of a "Moderate transport policy". This policy leads to a pricing mechanism on the highways of €0.15 per km. The non-highways were not priced. This mechanism also applies to the scenarios with the "internalizing external costs of all modes", meaning that €0.15 is not an extra price on non-highways, but the internalized costs are indeed applied on highways and non-highways.

Non-pricing of non-highways leads to a route change from the highways to non-highways. This could lead to problems on the underlying network in reality (e.g. congestion). In order to avoid this problem, two approaches could be distinguished. First of all, in practice, it could be realized that trucks can't use the underlying network (physical measures). Second, it could be argued to price also the underlying network (€0.15 per km). In this chapter 6, the effects of such a pricing measure of the underlying network have been investigated.

In this chapter, new results of scenarios 4, 5, 6, 7, 8, 11, 12 are reported.

6.1 Total tonnages and growth investigation

Location 1

Table 44a: Comparison of scenarios related to location Nr.1

	Base 2004	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.11	Sc.12
Tonnage (mln tons)	29.82	23.68	23.47	24.10	23.90	19.76	16.40	23.11
Index	100	79.39	78.70	80.82	80.13	66.25	55.00	77.49
Total Growth	-	-20.61	-21.30	-19.18	-19.87	-33.75	-45.00	-22.51
Annual Growth	-	-1.43	-1.49	-1.32	-1.38	-2.54	-3.67	-1.58

Source: own composition based on simulations with the new freight model for Flanders

Table 44b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.1

	Comparison to base 2004	Comparison to reference scenario
Scenario 4	--	--
Scenario 5	--	--
Scenario 6	--	--
Scenario 7	--	--
Scenario 8	--	--
Scenario 11	--	--
Scenario 12	--	--

Location 2

Table 45a: Comparison of scenarios related to location Nr.2

	Base 2004	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.11	Sc.12
Tonnage (mln tons)	33.97	30.12	29.89	30.83	30.61	25.77	20.98	30.58
Index	100	88.65	87.99	90.75	90.09	75.87	61.75	90.00
Total Growth	-	-11.35	-12.01	-9.25	-9.91	-24.13	-38.25	-10.00
Annual Growth	-	-0.75	-0.80	-0.60	-0.65	-1.71	-2.97	-0.66

Source: own composition based on simulations with the new freight model for Flanders

Table 45b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.2

	Comparison to base 2004	Comparison to reference scenario
Scenario 4	--	--
Scenario 5	--	--
Scenario 6	-	--
Scenario 7	-	--
Scenario 8	--	--
Scenario 11	--	--
Scenario 12	--	--

Location 3

Table 46a: Comparison of scenarios related to location Nr.3

	Base 2004	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.11	Sc.12
Tonnage (mln tons)	15.60	16.16	16.04	16.41	16.29	13.42	10.82	16.02
Index	100	103.64	102.87	105.25	104.47	86.02	69.35	102.69
Total Growth	-	3.64	2.87	5.25	4.47	-13.98	-30.65	2.69
Annual Growth	-	0.22	0.18	0.32	0.27	-0.94	-2.26	0.17

Source: own composition based on simulations with the new freight model for Flanders

Table 46b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.3

	Comparison to base 2004	Comparison to reference scenario
Scenario 4	+	-
Scenario 5	+	--
Scenario 6	+	-
Scenario 7	+	-
Scenario 8	--	--
Scenario 11	--	--
Scenario 12	+	--

Location 4

Table 47a: Comparison of scenarios related to location Nr.4

	Base 2004	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.11	Sc.12
Tonnage (mln tons)	15.92	18.28	18.16	18.66	18.54	15.40	12.08	18.73
Index	100	114.78	114.03	117.19	116.44	96.73	75.87	117.62
Total Growth	-	14.78	14.03	17.19	16.44	-3.27	-24.13	17.62
Annual Growth	-	0.87	0.82	1.00	0.96	-0.21	-1.71	1.02

Source: own composition based on simulations with the new freight model for Flanders

Table 47b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.4

	Comparison to base 2004	Comparison to reference scenario
Scenario 4	++	-
Scenario 5	++	-
Scenario 6	++	-
Scenario 7	++	-
Scenario 8	-	--
Scenario 11	--	--
Scenario 12	++	-

Location 5

Table 48a: Comparison of scenarios related to location Nr.5

	Base 2004	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.11	Sc.12
Tonnage (mln tons)	17.98	16.83	16.72	17.08	16.96	14.03	12.05	16.01
Index	100	93.57	92.95	94.95	94.32	78.03	67.03	89.02
Total Growth	-	-6.43	-7.05	-5.05	-5.68	-21.97	-32.97	-10.98
Annual Growth	-	-0.41	-0.46	-0.32	-0.36	-1.54	-2.47	-0.72

Source: own composition based on simulations with the new freight model for Flanders

Table 48b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.5

	Comparison to base 2004	Comparison to reference scenario
Scenario 4	-	--
Scenario 5	-	--
Scenario 6	-	--
Scenario 7	-	--
Scenario 8	--	--
Scenario 11	--	--
Scenario 12	--	--

Location 6

Table 49a: Comparison of scenarios related to location Nr.6

	Base 2004	Sc.4	Sc.5	Sc.6	Sc.7	Sc.8	Sc.11	Sc.12
Tonnage (mln tons)	16.50	16.47	16.35	16.77	16.66	13.61	11.31	15.91
Index	100	99.83	99.13	101.69	100.98	82.51	68.55	96.46
Total Growth	-	-0.17	-0.87	1.69	0.98	-17.49	-31.45	-3.54
Annual Growth	-	-0.01	-0.05	0.10	0.06	-1.19	-2.33	-0.22

Source: own composition based on simulations with the new freight model for Flanders

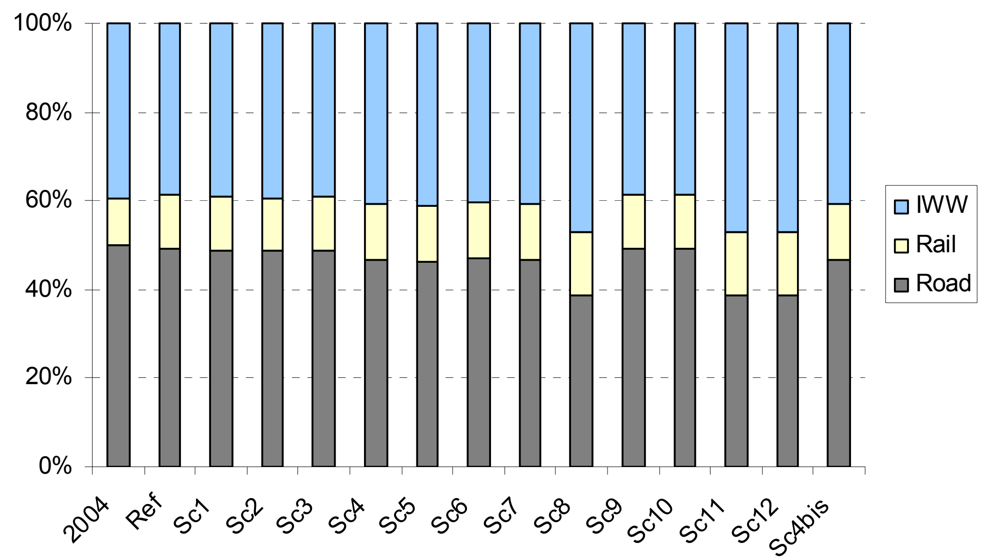
Table 49b: Comparison of scenarios to base 2004 and to reference scenarios related to location Nr.5

	Comparison to base 2004	Comparison to reference scenario
Scenario 4	-	--
Scenario 5	-	--
Scenario 6	+	--
Scenario 7	+	--
Scenario 8	--	--
Scenario 11	--	--
Scenario 12	-	--

6.2 Mode Shift

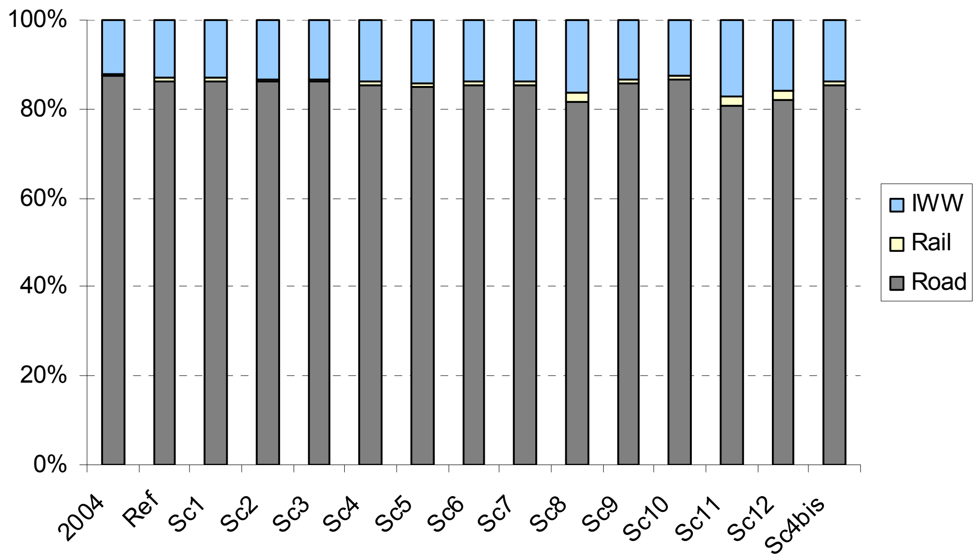
Incoming flows

Figure 29: Port of Antwerp



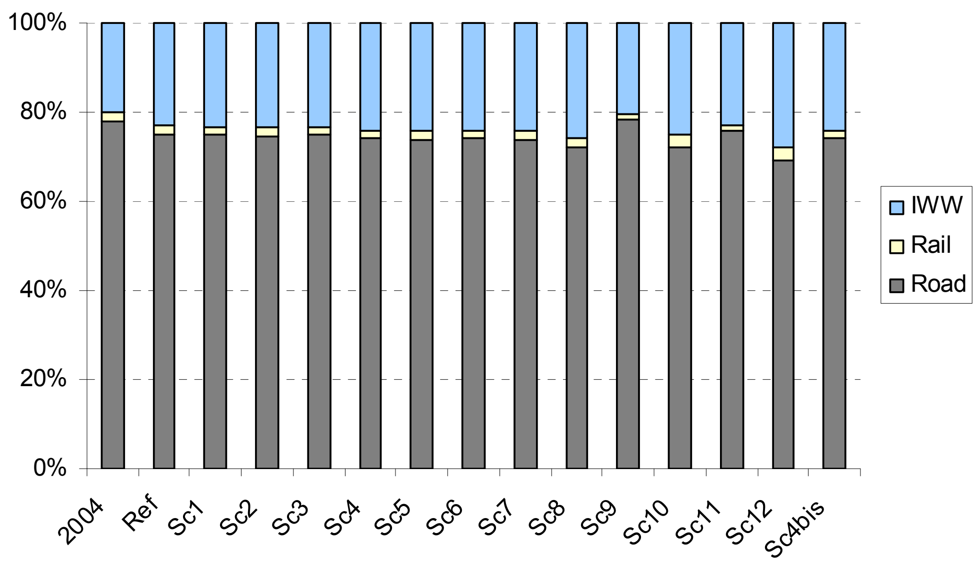
Source: own composition based on simulations with the new freight model for Flanders

Figure 30: Region of Antwerp (NUTS-3) excl. Port of Antwerp



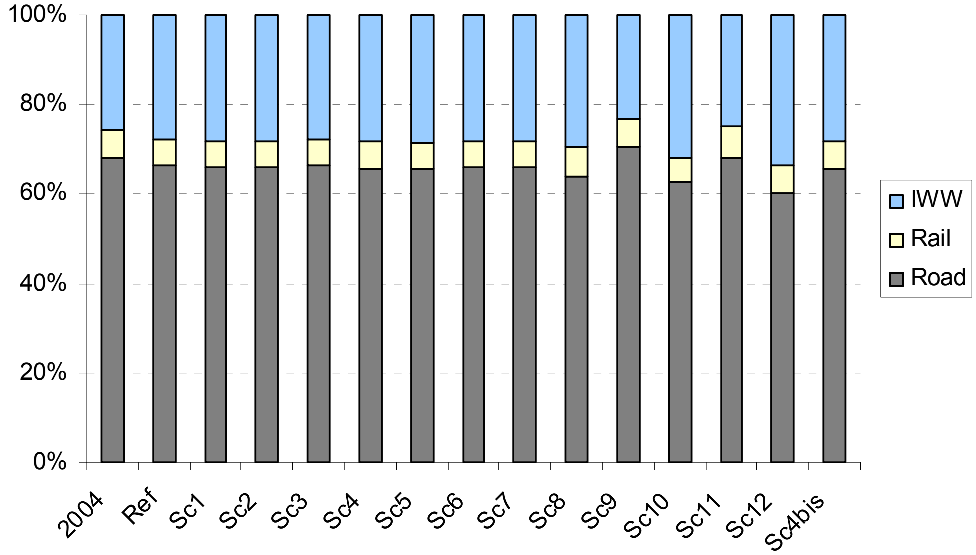
Source: own composition based on simulations with the new freight model for Flanders

Figure 31: Region of Turnhout (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

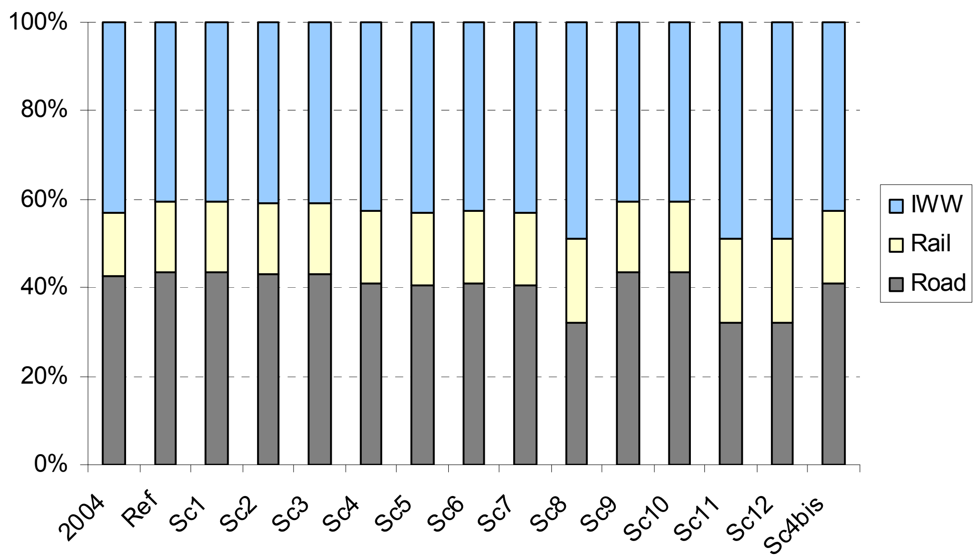
Figure 32: Region of Hasselt (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

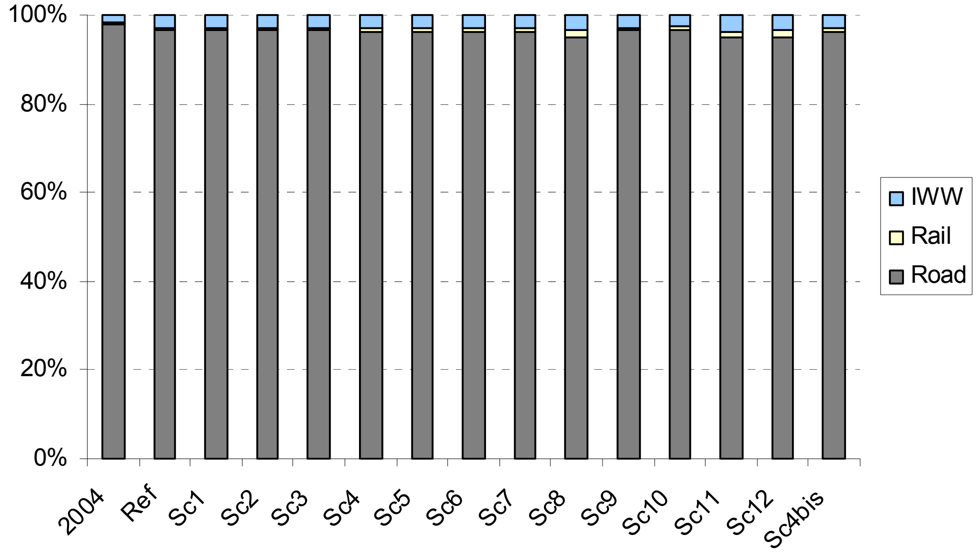
Outgoing flows

Figure 33: Port of Antwerp



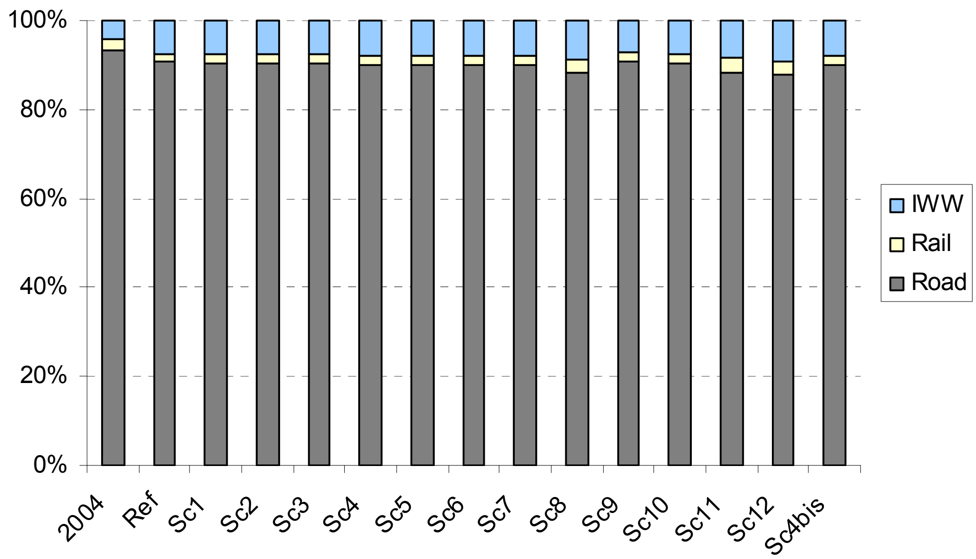
Source: own composition based on simulations with the new freight model for Flanders

Figure 34: Region of Antwerp (NUTS-3) excl. Port of Antwerp



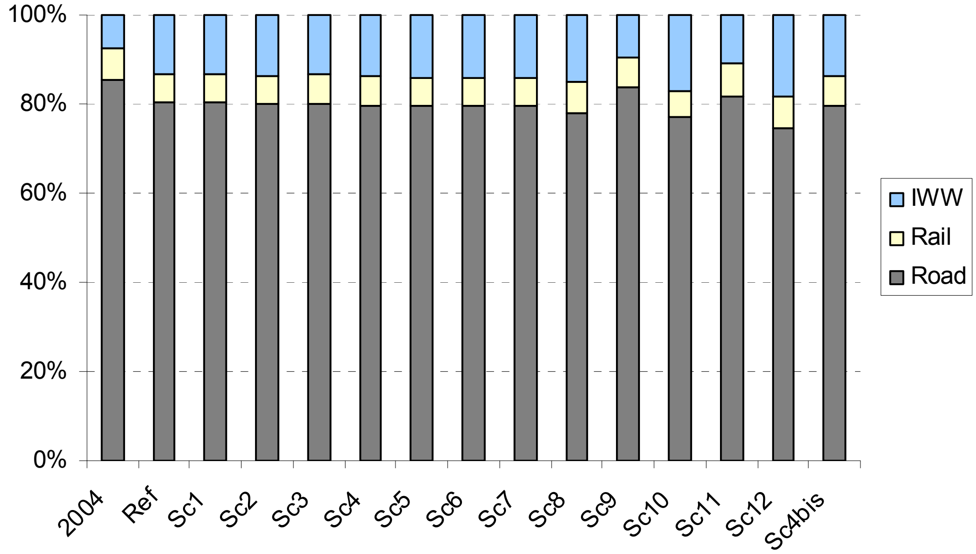
Source: own composition based on simulations with the new freight model for Flanders

Figure 35: Region of Turnhout (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

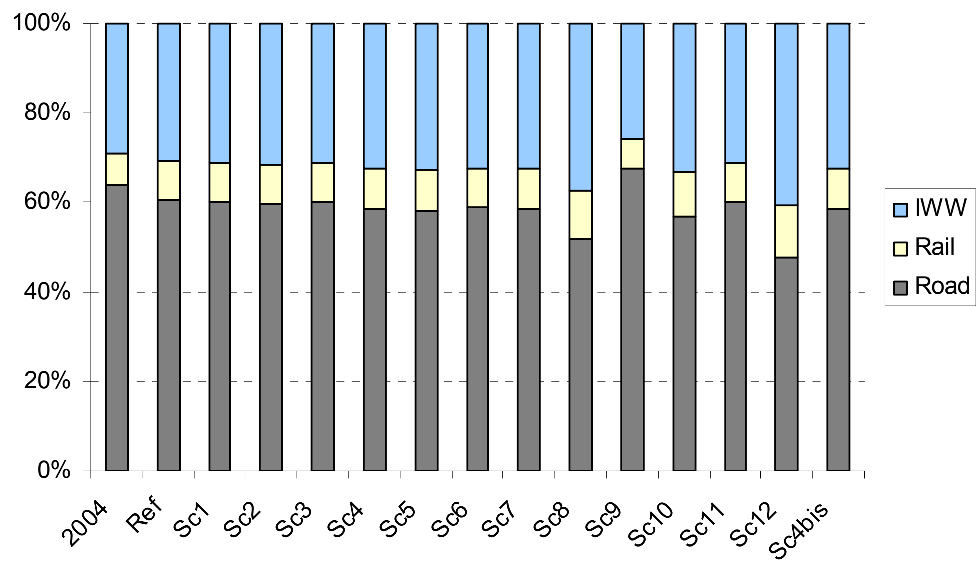
Figure 36: Region of Hasselt (NUTS-3)



Source: own composition based on simulations with the new freight model for Flanders

Region Antwerpen, Mechelen, Turnhout, Sint-Niklaas and port of Antwerp

Figure 37: Mode split (region Antwerpen, Mechelen, Turnhout, Sint-Niklaas and port of Antwerp)



Source: own composition based on Freight model Flanders

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