FINAL REPORT

Social cost-benefit analysis

Iron Rhine

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AUTHORS:

E. Delhaye (TML)
G. De Ceuster (TML)
K. Vanherle (TML)
T. Breemersch (TML)
S. Proost (K.U.Leuven)
M. Chen (TNO)
J. Van Meijeren (TNO)
T. Groen (TNO)
M. Snelders (TNO)

TRANSPORT & MOBILITY LEUVEN
VITAL DECOSTERSTRAAT 67A BUS 0001
3000 LEUVEN
BELGIUM
+32 (16) 31.77.30
http:\\www.tmleuven.be

TNO
Business Unit Mobility and Logistics
VAN MOURIK BROEKMANWEG 6
2628 XE DELFT
THE NETHERLANDS
+31 (15) 269.68.32
http:\\www.tno.nl

The SCBA project is advised by a steering group with various expertise. The steering group consists of the following individuals. TML and TNO would like to thank them for their most valuable input.

FOD Mobiliteit en Vervoer (BE)
Joan Peeters - chairman

Ministerie van Verkeer en Waterstaat (NL)
Frank van Heijst - co-chairman

COD
Gust Blauwens
Taco van Hoek

Infrabel (BE)
Adelin De Waele
Peter Meys

ProRail (NL)
Roland Nijssen

DB Netz (DE)
Albrecht Hinzen

Samenvatting

Aanleiding en achtergrond

Wat is de IJzeren Rijn?

De IJzeren Rijn is een spoorlijn die de haven van Antwerpen verbindt met het Duitse Ruhrgebied. België heeft in 1998 Nederland gevraagd de IJzeren Rijn weer in gebruik te mogen gaan nemen. Reden hiervoor is de toename van het goederenvervoer tussen de Antwerpse haven en het Duitse achterland. De huidige route naar Duitsland, de Montzenroute, is voor sommige bestemmingen circa 50 kilometer langer dan de IJzeren Rijn en bevat een aantal hellingen dat het moeilijk maakt om met zware treinen te rijden.

In deze studie bekijken we de maatschappelijke kosten en baten van het reactiveren van de IJzeren Rijn spoorverbinding. We onderzoeken twee mogelijke tracés voor de IJzeren Rijn: het historische tracé en als alternatief het A52 tracé. Onderstaande figuur toont beide tracés en de Montzenroute. Tevens onderzoeken we alternatieven zónder elektrificatie (dus uitsluitend voor diesellocs) en mét elektrificatie (dus ook geschikt voor elektrische locs).

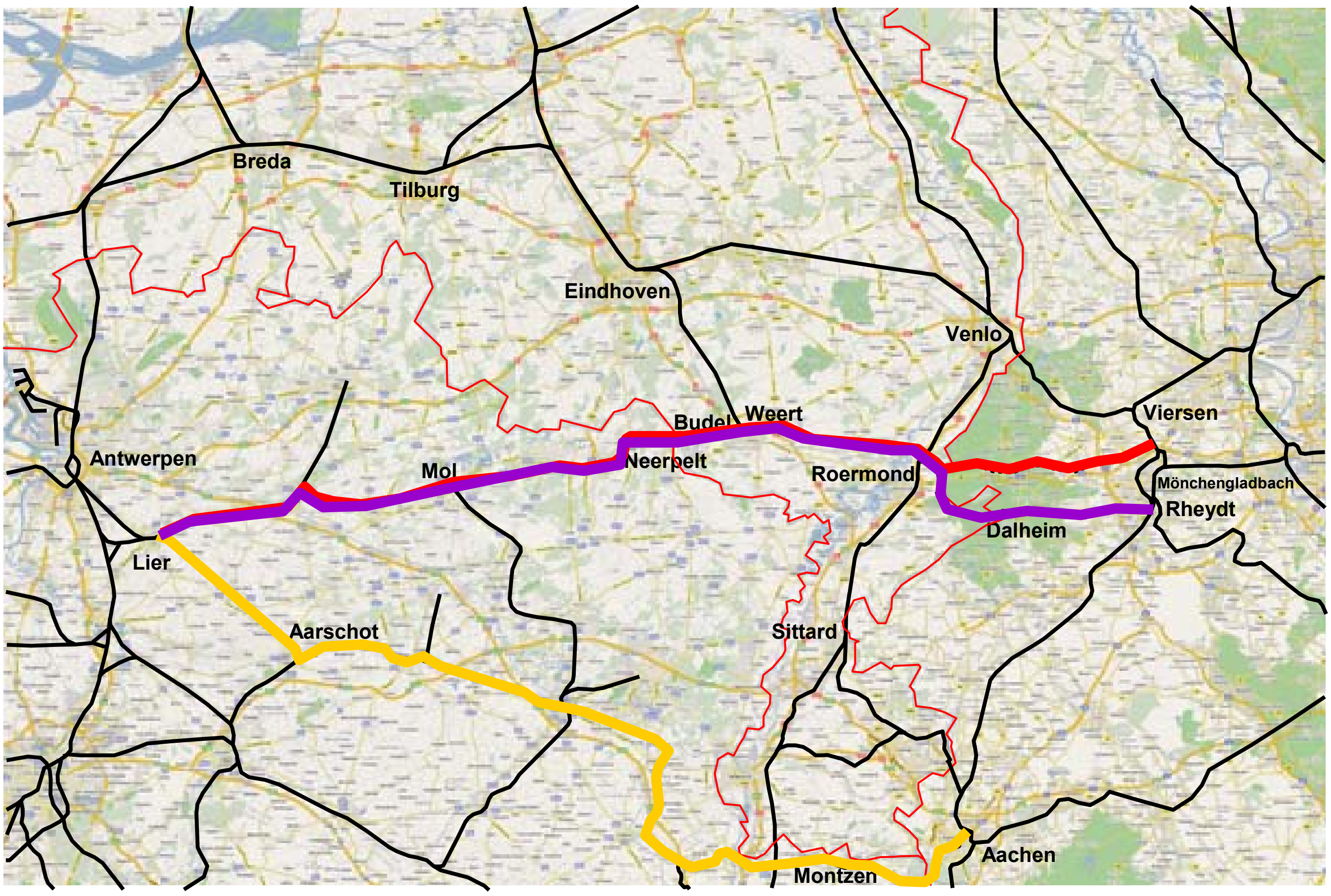
Waarom deze studie?

Op 6 juli 2006 hebben de Belgische Staatssecretaris voor Overheidsbedrijven en de Nederlandse Minister van Verkeer en Waterstaat beslist om diverse studies naar de reactivering van de IJzeren Rijn te laten uitvoeren. Één van die studies is deze maatschappelijke kosten-batenanalyse.

Wat is een maatschappelijke kosten-batenanalyse?

In een MKBA worden op systematische wijze de maatschappelijke kosten en baten die verbonden zijn aan een project, geïnventariseerd. Het woord 'maatschappelijk' geeft aan dat kosten en baten geanalyseerd en gewaardeerd worden vanuit het standpunt van de samenleving in zijn geheel. Niet alleen financieel-economische effecten worden in de beschouwing betrokken, maar ook allerlei andere zaken waaraan de samenleving waarde toekent, zoals milieu, mobiliteit en veiligheid.

Figuur 1: Projectalternatieven voor de IJzeren Rijn: historisch tracé (paars) en A52 variant (rood). De Montzenroute is aangegeven in het geel.



Economische scenario's

In een kosten-batenanalyse wordt de vergelijking gemaakt tussen een nulalternatief en een projectalternatief. Deze vergelijking wordt gemaakt voor twee economische achtergrondscenario's (2A en 2B). Beide scenario's gaan uit van dezelfde economische groei (2,3 % tot 2020 en 2,0 % voor de periode 2020-2030), maar verschillen in het gevoerde transportbeleid. In 2B veronderstellen we een extra belasting voor alle transportmodi en een verbetering in de kosten en reistijden voor het spoorvervoer.

Nulalternatief en projectalternatieven

Het nulalternatief in deze studie is de situatie zonder de reactivatie van de IJzeren Rijn. We veronderstellen wel dat alle voorziene investeringen, zoals de Liefkenshoek treintunnel en de tweede spoorlink naar de haven van Antwerpen uitgevoerd zijn. In het nulalternatief gaat al het treinverkeer van de haven van Antwerpen naar Duitsland over de Montzenroute. De Montzenroute is dubbelsporig en sinds eind 2008 volledig geëlektrificeerd. In het referentiescenario wordt één bijkomende investering voorzien voor de Montzenroute, namelijk een vrije kruising bij Aarschot. Verder zijn er in het nulalternatief geen capaciteitsproblemen op de Montzenroute.

Er zijn vier projectalternatieven in deze studie. Onderstaande tabel geeft een overzicht van de projectalternatieven.

Tabel 1: Overzicht van de bestudeerde alternatieven

	Nulalternatief	IJzeren Rijn historisch tracé diesel	IJzeren Rijn A52 tracé diesel	IJzeren Rijn historisch tracé geëlektrificeerd	IJzeren Rijn A52 tracé geëlektrificeerd
Achtergrond scenario 2A	X	X	X	X	X
Achtergrond scenario 2B	X	X			

De projectalternatieven verschillen wat betreft de route (zie ook bovenstaande figuur) en in de voorziene tractie (diesel versus elektrisch). Om de vergelijking zo eenvoudig mogelijk te maken, veronderstellen we dat alle IJzeren Rijn varianten gebruiksklaar zijn in 2015.

Het projectalternatief '**IJzeren Rijn – historisch tracé**' is het alternatief dat in september 2001 gekozen is door de Ministers van verkeer van België, Nederland en Duitsland en dat bevestigd is in de internationale arbitrage. Dit alternatief omvat het historische tracé van de IJzeren Rijn van Antwerpen via Lier, Mol en Neerpelt naar de Belgisch-Nederlandse grens. Vanaf de grens bij Budel gaat het tracé via Weert en Roermond naar de Duitse grens bij Vlodrop. Enkel te Roemond wordt afgeweken van het historische tracé (dat dwars door de stad voerde), op vraag van Nederland. Het nieuwe tracé takt even ten noordwesten van Roermond uit en buigt dan via een nieuw tracé, gebundeld met de bestaande autosnelweg A73-Zuid, zuidoostelijk om Roermond. Daarna sluit dit nieuwe spoorgedeelte weer aan op het historisch tracé, dat vervolgens, eveneens op vraag van Nederland, in een ruim 6 km lange tunnel onder het natuurgebied De Meinweg wordt gevoerd. In Duitsland wordt het bestaande historische tracé gevolgd, via Dalheim, Wegberg en Mönchengladbach-Rheindahlen tot Rheydt.

In het projectalternatief '**IJzeren Rijn - A52 variant**' verandert er niets aan de situatie in België, maar wel in Nederland en Duitsland. De idee is om met een nieuwe spoorlijn de snelwegen N280 en A52 te volgen tussen Roermond en Mönchengladbach. Dit veronderstelt een investering in een enkelspoorbaan tussen Roermond en Mönchengladbach voor ongeveer 7 km in Nederland en voor ongeveer 28 km dubbelspoor in Duitsland. De totale lengte van deze variant is korter dan het historisch tracé en het nationaal park "De Meinweg" wordt dan niet meer doorkruist. Aan de andere kant worden wel enkele andere beschermingsgebieden doorkruist aan beide kanten van de Nederlands-Duitse grens.

De IJzeren Rijn is voorzien als een diesel lijn en is maar deels geëlektrificeerd. We hebben ook twee alternatieven onderzocht waarbij de lijnen volledig geëlektrificeerd worden.

Voor alle tracés veronderstellen we een maximumcapaciteit van 72 treinen per dag – beide richtingen samen, zoals vastgesteld in het COD (*Commissie van Onafhankelijke Deskundigen*) advies van 8 juni 2007.

De effecten van de IJzeren Rijn

<u>Wat zijn de transporteffecten van de IJzeren Rijn?</u>

De ingebruikname van de IJzeren Rijn heeft gevolgen voor het spoor- en wegverkeer en voor de binnenvaart. Voor het goederenvervoer onderscheiden we vier effecten:

Ten eerste zorgt de ingebruikname van de IJzeren Rijn ervoor dat het totale **spoorvervoer** over de IJzeren Rijn en de Montzenroute tussen België en Duitsland in 2030 stijgt van 14,3 naar 15,5 miljoen ton in het alternatief "IJzeren Rijn – historisch tracé" en naar 17,2 miljoen ton in het alternatief "IJzeren Rijn – A52 tracé". Deze toename van het spoorvervoer over de IJzeren Rijn en de Montzenroute van 1,2 tot 2,9 miljoen ton is grotendeels afkomstig van andere spoorlijnen (0,97 tot 2,63 miljoen ton); de rest is afkomstig van andere vervoersmodaliteiten: 0,15 tot 0,25 miljoen ton komt van het wegvervoer.

In beide tracé-alternatieven kiest het meeste spoorverkeer de IJzeren Rijn boven de Montzenroute omdat voor het meeste transport de IJzeren Rijn iets goedkoper is omdat ze korter is en zwaardere treinen toelaat. Merk op dat geen enkele variant van de IJzeren Rijn veel extra treinverkeer genereert, maar eerder bestaand verkeer aantrekt van de Montzenroute. Onderstaande tabel vat de effecten voor het spoorverkeer in 2030 samen.

Tabel 2: Totale goederenstromen via de IJzeren Rijn en de Montzenroute per scenario (in miljoen ton), 2030

Gemeten op het spoorvak Budel - Weert (IJzeren Rijn) en Montzen - Aken-West (Montzenroute).
B=België, D=Duitsland.

	2005	2030 2A					2030 2B	
		Geen IJR	Hist. IJR	Geëlectr. hist. IJR	IJR via A52	Geëlectr. IJR via A52	Geen IJR	Hist. IJR
B-D IJzeren Rijn			5,3	6,1	6,2	6,9		1,9
D-B IJzeren Rijn			4,0	4,9	5,2	5,8		0,5
Totaal IJzeren Rijn			9,3	11,0	11,4	12,7		2,5
B-D Montzenroute	4,4	7,6	2,8	2,1	2,7	2,0	8,3	6,9
D-B Montzenroute	3,8	6,8	3,4	2,4	3,1	2,5	7,5	7,4
Totaal Montzenroute	8,2	14,3	6,2	4,5	5,8	4,5	15,7	14,3
Totaal beide routes	8,2	14,3	15,5	15,5	17,2	17,2	15,7	16,7
Index beide routes	100	172	190	190	209	210	191	204
Extra spoorvervoer t.o.v. situatie zonder IJR	-	-	1,2	1,2	2,9	2,9	-	1,0
* Andere spoorlijnen	-	-	0,97	0,90	2,63	2,53	-	0,995
* Wegvervoer	-	-	0,15	0,20	0,18	0,25	-	0,003
* Binnenvaart	-	-	0,08	0,10	0,09	0,12	-	0,002

Ten tweede genereert de extra beprijzing van vrachtvervoer over de weg en de effecten van de liberalisering van het spoor (zoals verondersteld in achtergrondscenario 2B) geen grote effecten voor het spoorvervoer: scenario 2B geeft niet veel meer spoorvervoer dan scenario 2A.

Ten derde heeft het type tractie (diesel versus elektrisch) beperkte invloed op het verwachte vervoer over de IJzeren Rijn: 9,3 miljoen ton op het historische tracé met dieseltractie versus 11.0 miljoen ton op het historisch tracé met elektrische tractie (in 2030). Het spoorvervoer op de Montzenroute daalt dan evenveel, zodat per saldo het spoorvervoer in de corridor ondanks elektrificatie van de IJzeren Rijn ongewijzigd blijft.

Ten vierde zorgt de ingebruikname van de IJzeren Rijn niet voor een grote verandering in de samenstelling van het verkeer. Met andere woorden, **de IJzeren Rijn trekt voornamelijk spoorvervoer van andere spoorroutes aan, en haalt maar zeer beperkt vervoer weg van de weg of de binnenvaart.**

Het effect op het **wegverkeer** is klein: in 2030 daalt het aantal vrachtwagen-km met 0,44 à 1,09 miljoen in België, dat is minder dan 0,01 % van het totale wegvoervoer in België (11 miljard vrachtwagen-km in 2030). Het aantal vrachtwagen-km daalt met 0,20 à 0,28 in Nederland en met 2,01 à 5,59 in Duitsland (cijfers afhankelijk van het gekozen alternatief).

De **binnenvaart** daalt met 0,27 à 0,67 miljoen ton-km in België, met 1,08 à 1,48 in Nederland en met 2,93 à 8,15 in Duitsland (cijfers voor 2030). Merk op dat in Nederland het effect op de binnenvaart groter is dan op de weg. Het effect in Duitsland is het hoogste voor zowel wegvervoer als binnenvaart omdat de afstanden er groter zijn.

De effecten op het **personenvervoer** zijn minimaal. Voor het spoor zijn ze minimaal omdat de IJzeren Rijn niet bedoeld is voor het vervoer van reizigers en omdat de interferentie van de goederentreinen met de reizigerstreinen beperkt is. De effecten voor het autoverkeer zijn minimaal omdat de effecten op congestie klein zijn, en dat komt weer omdat de effecten voor het vrachtvervoer over de weg minimaal zijn.

<u>Wat zijn de baten en de kosten?</u>

De ingebruikname van de IJzeren Rijn leidt tot
- effecten op de goederen spoormarkt
- effecten voor de samenleving wat betreft milieu, geluid, ongevallen, etc. door de bouw en het gebruik van de IJzeren Rijn
- effecten voor het reizigersverkeer op het spoor
- effecten op het wegverkeer
- effecten op de binnenvaart
- effecten voor de overheid
- effecten op andere markten

Verder werden voor deze kosten-batenanalyse volgende veronderstellingen gemaakt
- de kosten en baten zijn berekend voor de periode 2015-2030. Vanaf 2030 worden alle stromen constant verondersteld over de tijd.
- er worden twee verschillende discontovoeten gebruikt om de toekomstige kosten en baten te vergelijken met de investeringskosten: 4 % (Belgische aanpak) en 2,5-4-5,5 % afhankelijk van het type kosten of baten (Nederlandse aanpak).
- de kosten en de baten worden toegekend aan België, Nederland, Duitsland en andere landen op basis van het grondgebied (niet op basis van wie zou moeten betalen).

Wat betreft de **effecten op de goederen spoormarkt** onderscheiden we het effect voor de consument, de operator en de infrastructuurbeheerder . Voor de consument wordt het vervoer tussen Antwerpen en Duitsland goedkoper door de kortere vervoersafstand. Dit zorgt voor een baat voor de consumenten in elk projectalternatief. De baat is groter als de lijn geëlektrificeerd is omdat dit vervoer goedkoper is, en ze is ook groter voor het A52 tracé omdat deze korter is dan het historische tracé.

In een perfect concurrentiele markt is er geen winst voor de operator (het spoorvervoerbedrijf).
De infrastructuurbeheerder heeft op het historische tracé minder inkomsten uit de infrastructuurvergoeding omdat de IJzeren Rijn korter is en de infrastructuurvergoeding een vergoeding is per trein-km. De stijging in het totale spoorvervoer is niet groot genoeg om dit verschil in afstand te compenseren. Aan de

andere kant is er ook een effect op de onderhouds- en vervangingskosten. Deze kosten zijn afhankelijk van het volume; ze dalen op de Montzenroute en stijgen op de IJzeren Rijn. In het algemeen domineert het effect van het onderhouden van een extra spoorlijn en zijn er dus extra kosten, vooral aan het onderhoud van de Meinwegtunnel in Nederland. Het A52 tracé kent minder onderhoudskosten.

Door de bouw en het gebruik zelf van de IJzeren Rijn zijn er ook **effecten voor de samenleving** wat betreft emissies, geluid, ongevallen, recreatie, vibraties, leefomgeving, landschap ecologie, bodem en water en landbouw. Omdat het treinverkeer toeneemt, is er een stijging van de emissies van spoorvervoer en dus een kostenpost. Voor geluid is er een baat omdat de projectalternatieven met IJzeren Rijn geluidsschermen voorzien die ervoor zorgen dat het geluid daalt ten opzichte van het nulalternatief. Voor ongevallen (op overwegen) is er een baat, ondanks het stijgende spoorvervoer, omdat in het projectalternatief een aantal overwegen wordt vervangen door ongelijkvloerse kruisingen die dus veiliger worden. Het effect op recreatie is negatief omdat er recreatiemogelijkheid verloren gaat en de ecologie verstoord wordt. Vibraties (trillingen als gevolg van het treinverkeer) hangen af van het vervoersvolume. De vibraties dalen dus langs de Montzenroute en stijgen langs de IJzeren Rijn. Het totale effect hangt af van het aantal treinen op beide routes. De effecten op landschap, leefomgeving en landbouw zijn zeer klein, of nul. Ecologie is enkel negatief in België omdat België vooralsnog geen natuurcompensatieplan heeft uitgewerkt. Voor bodem en water zien we een baat omdat voorafgaand aan de aanleg van nieuwe IJzeren Rijn trajectgedeelten de bodem gesaneerd wordt.

Het **effect voor het reizigersverkeer** op het spoor is klein, maar negatief. Een deel van het spoor van de IJzeren Rijn wordt immers gedeeld met het reizigersverkeer. De extra goederentreinen door de heractivatie van de IJzeren Rijn zorgen voor extra vertragingen bij het reizigersverkeer met gemiddeld met een halve minuut per trein.

Voor het **wegverkeer** onderscheiden we de effecten voor de weggebruikers en de effecten voor de samenleving. Omdat er door de IJzeren Rijn minder vrachtwagens op de weg zijn, is er minder congestie en dus een baat voor de weggebruikers. Bovendien wordt er door de ingebruikname van de IJzeren Rijn een aantal overwegen omgebouwd tot ongelijkvloerse kruisingen waardoor er een tijdswinst is voor het wegverkeer. Omdat er minder vrachtwagens rijden, dalen de emissies, de geluidsoverlast, het aantal ongevallen en de schade aan de wegen. Dit is een kleine baat voor de samenleving.

Ook voor de **binnenvaart** maken we een onderscheid voor de effecten voor de binnenscheepvaarders en de effecten voor de samenleving. Door de daling in scheepvaart is er een daling in emissies en dus een kleine baat voor de samenleving.

De **overheid** verliest belastingsinkomsten en betaalt de investeringskosten. Het efficiëntieverlies dat optreedt omdat de investeringskosten betaald worden met arbeidsbelasting de zogenaamde *"marginal costs of public funds"* is niet meegerekend.

De mogelijke **effecten op andere markten** zoals op de haven van Antwerpen en Rotterdam worden hier enkel pro memorie meegenomen.

De tabel op de volgende bladzijde geeft als voorbeeld het resultaat van de kosten-batenanalyse voor het projectalternatief "IJzeren Rijn – historisch tracé" waarbij met een discontovoet van 4% is gerekend. De heringebruikname van de IJzeren Rijn – historisch tracé leidt tot een netto maatschappelijk verlies voor de drie landen samen van 461,70 miljoen euro (netto actuele/contante waarde). Wanneer een discontovoet van 2,5-4-5,5% wordt gebruikt, daalt het nettoverlies tot 510,52 miljoen euro. Dit is omdat bij een hogere disconteringsvoet de investeringskosten in de nabije toekomst hierdoor dalen en dit is belangrijker dan de daling in baten in de verre toekomst.

Gevoeligheidsanalyse

Er zijn vier gevoeligheidsanalyses uitgevoerd:

- Een gevoeligheidsanalyse waarbij de spoorlijn 5 jaar later gebruiksklaar is, toont aan dat de precieze startdatum de algemene conclusies niet wezenlijk verandert; wel wordt het nettoverlies daardoor kleiner.
- Een gevoeligheidsanalyse waarbij de emissies anders worden gealloceerd aan de landen geeft grotere netto kosten voor zowel Nederland, België als Duitsland. Dit zijn kosten die eerder werden gealloceerd aan andere landen, namelijk de landen waar de luchtkwaliteit ook vermindert door de ingebruikname van de IJzeren Rijn.
- Een gevoeligheidsanalyse met hogere externe kosten voor emissies laat een groter nettoverlies blijken.
- Een gevoeligheidsanalyse met een hoger transportvolume vermindert de netto contante waarde van het project. Dit paradoxale resultaat is te wijten aan de zeer hoge milieukosten op de IJzeren Rijn, die tot dieseltractie beperkt is: bij stijgend transportvolume doen de bijkomende milieukosten de bijkomende transportbaat teniet.

Conclusies

De 5 projectalternatieven voor de IJzeren Rijn (historisch tracé, A52-alternatief, diesel, geëlektrificeerd, achtergrondscenario) leiden allemaal tot negatieve baten (dus netto kosten) voor de samenleving: voor België, Nederland, Duitsland en de andere landen tezamen. De netto contant gemaakte kosten voor de samenleving variëren van circa 335 tot 530 miljoen euro. Daarvoor is een investering door de drie landen nodig van 440 tot 680 miljoen euro, de netto actuele waarde van de benodigde investering van rond de 590 tot 750 miljoen euro.

De belangrijkste reden hiervoor is dat de IJzeren Rijn voornamelijk spoorverkeer aantrekt van de Montzenroute, terwijl er nog capaciteit over is op deze route. Hierdoor is de winst voor de gebruikers door het veranderen van route maar minimaal. Bovendien haalt de IJzeren Rijn niet veel vrachtverkeer van de weg en is er dus maar een kleine verbetering wat betreft congestie op de weg. Zelfs als de groei van de spoorverkeer tussen Antwerpen en Duitsland groter is dan verwacht door de modellen, blijven de baten te klein voor de grote investeringskosten.

Indien men toch de IJzeren Rijn wil aanleggen, dan zijn de verliezen voor de samenleving het kleinst wanneer men voor de variant "IJzeren Rijn – A52 tracé – geëlektrificeerd" kiest. Merk op dat de hoogte van de investering (480 miljoen €) voor de A52 gebaseerd is op de IVV studie, terwijl de investering door DB Netz geschat wordt op 500 à 900 miljoen €.

Tabel 3: Maatschappelijke kosten-batenanalyse: overzicht, scenario "Historische IJzeren Rijn – 2A", NPV voor 2007, miljoen euro$_{2007}$, discontovoet 4%

		Totaal	In België	In Nederland	In Duitsland	In andere landen
Directe effecten op de spoormarkt goederenvervoer						
Directe effecten op gebruikers	Consumenten surplus	94,21	48,40	0,00	32,83	12,98
Directe effecten voor de infrastructuurmanager	Infrastructuurvergoeding	-6,85	-19,92	20,62	-7,56	NA
	Kosten vernieuwing	-15,90	0,00	-15,90	NA	NA
	Kosten onderhoud	31,29	91,34	-60,05	NA	NA
Externe effecten gerelateerd aan de bouw en het gebruik van de spoorweg						
Effecten op de samenleving	Emissies	-138,20	-19,28	-10,48	-39,00	-69,44
	Geluid	24,79	8,12	3,29	13,39	NA
	Ongevallen	16,94	11,75	3,83	1,36	NA
	Externe veiligheid	-0,01	NA	-0,01	NA	NA
	Recreatie	-5,63	-0,41	-3,14	-2,08	0,00
	Trillingen	0,12	0,65	-0,77	0,24	0,00
	Loss of living environment	0,00	0,00	0,00	0,00	0,00
	Landschap	0,00	0,00	0,00	0,00	0,00
	Ecologie	-3,48	-3,48	0,00	0,00	0,00
	Bodem en water	3,00	0,00	3,00	0,00	0,00
	landbouw	0,00	0,00	0,00	0,00	0,00
Effecten op reizigersvervoer spoor						
	Vertraging	-7,12	PM	-7,12	0,00	0,00
Effecten voor het wegverkeer						
Indirect effect voor weggebruikers	Tijdsverlies files	18,73	4,40	2,35	11,98	NA
	Tijdsverlies spoorovergangen	12,71	7,46	4,40	0,86	NA
	Taksen	-8,71	-0,98	-0,58	-7,15	NA
Effecten op de samenleving	Emissies	2,89	0,37	0,22	1,51	0,81
	Geluid	1,67	0,21	0,34	1,12	NA
	Ongevallen	1,80	0,58	0,18	1,04	NA
	Slijtage wegdek	2,11	0,30	0,13	1,68	NA
Effect voor de binnenvaart						
Indirect effect voor binnenvaart gebruikers	Taksen	-0,07	-0,01	0,00	-0,06	0,00
Effect op de samenleving	Emissies	0,48	0,03	0,06	0,22	0,18
Effecten voor de overheid						
Indirect effect	MCPF correctie	PM	PM	PM	PM	PM
Effecten op andere sectoren						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAAL		**24,80**	**129,54**	**-59,64**	**10,39**	**-55,48**
Effecten voor de overheid						
Direct effect	Investeringskosten	-486,51	-0,90	-391,04	-94,56	0,00
TOTAAL		**-461,70**	**128,63**	**-450,69**	**-84,17**	**-55,48**

Een overzicht van de resultaten van alle varianten is te vinden in de volgende tabel.

Tabel 4: Overzicht van de resultaten in alle varianten, NPV voor 2007, miljoen euro$_{2007}$

Alternatief	**Disconto-voet**	**Totaal**	**In België**	**In Nederland**	**In Duitsland**	**In andere landen**
IJzeren Rijn historisch tracé diesel – 2A	4%	-461,70	128,63	-450,69	-84,17	-55,48
	2,5-4-5,5%	-510,52	118,31	-497,42	-96,28	-35,13
IJzeren Rijn historisch tracé diesel – 2B	4%	-432,78	92,86	-428,80	-78,75	-18,08
	2,5-4-5,5%	-492,02	89,36	-476,15	-92,98	-12,26
IJzeren Rijn historisch tracé geëlektrificeerd – 2A	4%	-404,88	125,04	-497,07	-53,81	20,96
	2,5-4-5,5%	-530,88	95,40	-551,78	-88,16	13,66
IJzeren Rijn A52 tracé diesel – 2A	4%	-440,23	144,17	-204,16	-325,02	-55,23
	2,5-4-5,5%	-503,64	128,81	-229,13	-369,19	-34,13
IJzeren Rijn A52 tracé geëlektrificeerd - 2A	4%	-335,93	144,78	-235,46	-281,39	36,15
	2,5-4-5,5%	-486,05	107,03	-267,10	-350,53	24,55
Gevoeligheidsanalyses op IJzeren Rijn Verschil met historisch tracé diesel – 2A	**Disconto-voet**	**Totaal**	**In België**	**In Nederland**	**In Duitsland**	**In andere landen**
Hogere externe kosten voor emissies	4%	-241,14	-33,90	-18,36	-65,63	-123,26
	2,5-4-5,5%	-154,02	-21,50	-11,77	-41,90	-78,85
Andere allocatie van emissies aan landen	4%	-20,98	-30,81	-38,28	-20,35	68,46
	2,5-4-5,5%	-13,41	-19,58	-24,67	-12,97	43,82
Startdatum 2020 i.p.v. 2015	4%	125,92	-9,08	115,38	14,27	5,35
	2,5-4-5,5%	115,95	-9,78	111,42	9,73	4,58
Hogere transportvolumes (20%)	4%	-3,98	13,60	-7,74	1,25	-11,10
	2,5-4-5,5%	-3,83	10,24	-7,68	0,64	-7,03

Zusammenfassung

Hintergrund

Was ist der 'Eiserne Rhein'?

Der Eiserne Rhein ist eine Bahnlinie, die den Hafen von Antwerpen in Belgien mit dem Ruhrgebiet in Deutschland verbindet. Belgien hatte im Jahre 1998 die Niederlande aufgefordert die Bahnlinie des Eisernen Rhein wieder in Betrieb zu nehmen. Der Grund dafür war der Anstieg des Güterverkehrs vom Hafen von Antwerpen zum Ruhrgebiet. Die derzeitige Strecke nach Deutschland, die Strecke über Montzen, ist für einige Zielorte bis zu 50 km länger als der Eiserne Rhein. Außerdem hat die derzeit genutzte Strecke über Montzen auch mehrere Steigungen, die das Fahren schwerer Züge erschwert.

In dieser Studie wurden die volkswirtschaftlichen Kosten und Nutzen einer Wiederinbetriebnahme des Eisernen Rheins analysiert. Zwei mögliche Varianten wurden dabei für den Eisernen Rhein in Betracht gezogen: die historische Strecke und, als Alternative, die A52-Variante. Die nachstehende Abbildung zeigt beide Varianten zusammen mit der derzeit genutzten Strecke über Montzen. Es wurden außerdem die zwei Alternativen mit Elektrifizierung (also nur zugänglich für Diesellokomotiven) und ohne Elektrifizierung (also auch zugänglich für Elektrolokomotiven) untersucht.

Der Beweggrund für diese Studie?

Der Belgische Staatssekretär und der Niederländische Verkehrsminister haben am 6. Juli 2006 beschlossen mehrere Studien zur Wiederinbetriebnahme des Eisernen Rheins auszuschreiben. Eine dieser Studien war eine Volkswirtschaftliche Kostennutzenanalyse.

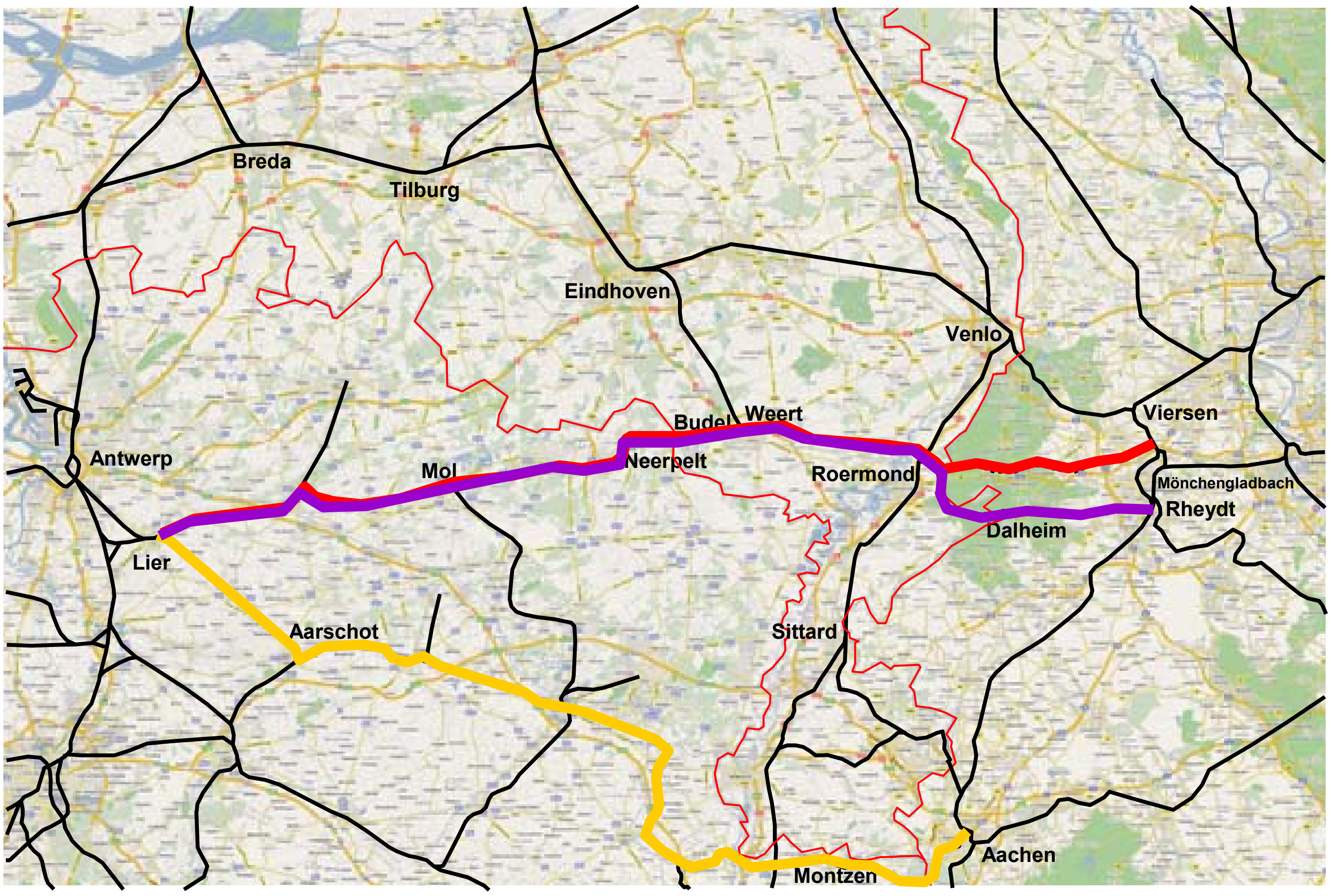
Was ist eine Volkswirtschaftliche Kostennutzenanalyse?

Bei einer Volkswirtschaftlichen Kostennutzenanalyse werden die die volkswirtschaftlichen Kosten und Nutzen eines Projekts auf systematische Weise erfasst. Der Ausdruck 'Volkswirtschaftlich' deutet an, dass die Kosten und Nutzen vom Standpunkt der Gesellschaft in der Gesamtheit analysiert und berechnet werden. Daher werden nicht nur finanzielle und wirtschaftliche Effekte berücksichtigt, sondern auch andere Elemente, die einen Wert für die Gesellschaft haben, wie z.B. Umwelt, Mobilität und Sicherheit.

Wirtschaftliche Szenarien

Bei einer Volkswirtschaftlichen Kostennutzenanalyse wird ein Referenz-Szenario mit einer Projektvariante verglichen. Dieser Vergleich wird für zwei verschiedene wirtschaftliche Szenarien (2A und 2B) durchgeführt. Beide Szenarien basieren zwar auf dem gleichen angenommenen Wirtschaftswachstum (2,3% bis 2020 und 2,0% für den Zeitraum 2020-2030), unterscheiden sich aber im Bezug auf die verkehrspolitischen Strategien. Im Szenario 2B wird eine zusätzliche Gebühr für alle Verkehrsträger und Verbesserungen der Eisenbahn-Infrastruktur bezüglich Kosten und Reisezeit angenommen.

Abbildung 1: Projektalternativen für den Eisernen Rhein: Historische Strecke (lila) und A52-Variante (rot). Die Strecke über Montzen ist in gelb angedeutet.



Das Referenz-Szenario und die Projektvarianten

Das Referenz-Szenario in dieser Studie ist die erwartete zukünftige Situation ohne Wiederinbetriebnahme des Eisernen Rheins. Es wird weiterhin angenommen, dass alle vorhergesehenen Infrastrukturinvestitionen, z.B. der Liefkenshoek-Bahntunnel und die zweite Bahnverbindung zum Hafen von Antwerpen, durchgeführt werden. Im Referenz-Szenario wird überwiegend die Strecke über Montzen für den Güterverkehr genutzt. Im Referenz-Szenario wird eine zusätzliche Investition für die Strecke über Montzen eingeplant, und zwar ein Eisenbahnüberwerfungsbauwerk in Aarschot.

Es werden vier Projektvarianten in dieser Studie analysiert. Die nachstehende Tabelle gibt eine Übersicht über alle untersuchten Projektvarianten.

Tabelle 1: Übersicht der untersuchten Varianten

	Referenz-Szenario	Eiserner Rhein historische Strecke Diesel	Eiserner Rhein A52-Variante Diesel	Eiserner Rhein Historische Strecke Elektrifiziert	Eiserner Rhein A52-Variante Elektrifiziert
Szenario 2A	X	X	X	X	X
Szenario 2B	X	X			

Die Projektvarianten unterscheiden sich bezüglich der Trasse (siehe auch Abbildung oben) und der vorhergesehenen Traktionsart der Lokomotiven (Diesel oder Elektrisch). Um den Vergleich der Varianten zu vereinfachen wird angenommen, dass alle Varianten des Eisernen Rheins ab 2015 benutzt werden können.

Die Projektvariante **'Historischer Eiserner Rhein'** ist die Strecke, die im September 2001 von den Verkehrsministerien Belgiens, der Niederlande und Deutschlands beschlossen wurde. Diese Variante besteht aus der modernisierten Trasse des Eisernen Rheins von Antwerpen über Lier, Mol und Neerpelt zur Belgisch-Niederländischen Grenze. Von der Grenze in der Nähe von Budel verläuft die Strecke über Weert und Roermond in Richtung der Deutschen Grenze bei Vlodrop. Diese Strecke weicht nur in Roermond von der historischen Trasse ab (sie verlief direkt durch das Ortszentrum), welches eine Forderung der Niederlande war. Die neue Trasse schwenkt im Nord-Westen von Roermond ab und verläuft dann über eine neue Strecke parallel zur vorhandenen A73 Autobahn südöstlich um Roermond herum. Danach mündet die Strecke wieder in die ursprüngliche Trasse, die anschließend, wieder einer Forderung der Niederlande nachkommend, einen 6 km langen Tunnel unterhalb des Naturschutzgebiets 'De Meinweg' nutzt. Innerhalb von Deutschland wird die historische Trasse beibehalten, über Dalheim, Wegberg und Mönchengladbach-Rheindahlen bis Rheydt.

Bei der Projektvariante **'Eiserner Rhein - A52 Variante**' ändert sich nichts an der Situation in Belgien, jedoch in den Niederlanden und in Deutschland. Diese Variante beinhaltet eine Streckenführung parallel zu den Autobahnen N280 und A52 mit einer neuen ca. 7 km langen eingleisigen Bahnlinie zwischen Roermond und der deutschen Grenze und einer ca. 28 km langen zweigleisigen Neubaustrecke in Deutschland. Die Gesamtlänge dieser Variante ist geringer als die der historischen Strecke und darüber hinaus quert sie das Niederländische Naturschutzgebiets 'De Meinweg' nicht. Andererseits quert sie jedoch andere Naturschutzgebiete entlang der Niederländisch-Deutschen Grenze.

Der Eiserne Rhein wird voraussichtlich als Dieselstrecke betrieben und ist nur teilweise elektrifiziert. In dieser Studie wurde jedoch auch die Variante, dass die gesamte Strecke elektrifiziert ist, untersucht.

Für alle Alternativen wurde eine maximale Kapazität von 72 Zügen pro Tag angenommen - für beide Fahrtrichtungen - gemäß der Vorgabe der COD (*Commissie van Onafhankelijke Deskundigen/Kommission unabhängiger Experten*) vom 8. Juni 2007.

Die Auswirkungen der Wiederinbetriebnahme des Eisernen Rheins

Was sind die verkehrlichen Auswirkungen des Eisernen Rheins?

Die Wiederinbetriebnahme des Eisernen Rheins hat Konsequenzen für Schienen- und Straßenverkehr und auch für die Binnenschifffahrt. Bezüglich des Güterverkehrs wurde zwischen vier Auswirkungen unterschieden:

Erstens erhöht die Wiederinbetriebnahme des Eisernen Rheins den gesamten **Schienengüterverkehr** über den Eisernen Rhein und die Strecke über Montzen zwischen Belgien und Deutschland von 14,3 auf 15,5 Millionen Tonnen für die Alternative "Historischer Eiserner Rhein" und auf 17,2 Millionen Tonnen für die Alternative "Eiserner Rhein über A52". Dieser Anstieg im Schienengüterverkehr im Bereich von 1,2 bis 2,9 Millionen Tonnen auf dem Eisernen Rhein und der Strecke über Montzen stammt hauptsächlich von anderen Bahnlinien (zwischen 0,97 und 2,63 Millionen Tonnen); der Rest kommt von anderen Verkehrsträgern: 0,15 bis 0,25 Millionen Tonnen kommen vom Straßengüterverkehr.

In beiden Projektvarianten wird der Eiserne Rhein aufgrund der geringeren Transportkosten, da die Strecke des Eisernen Rhein kürzer und mit schwereren Zügen befahrbar ist, der Strecke über Montzen vom Schienengüterverkehr vorgezogen. Keine der Projektvariantenverursacht zusätzlichen Schienengüterverkehr, sondern verlagert vielmehr den Grossteil des Verkehrs von der Strecke über Montzen auf den Eisernen Rhein. Die nachstehende Tabelle zeigt eine Zusammenfassung der Auswirkungen auf den Schienengüterverkehr im Jahr 2030.

Tabelle 2: auf dem Eisernen Rhein und der Strecke über Montzen für die Szenarien (in Millionen Tonnen), 2030

Erfasst für die Bahn Linien Budel - Weert (Eiserner Rhein) und Montzen - Aachen-West (Strecke über Montzen). B=Belgien, D=Deutschland.

	2005	2030 2A					2030 2B	
		Kein ER	Hist. ER	Elektr. hist. ER	ER A52	Elektr. ER A52	Kein IR	Hist. ER
B-D Eiserner Rhein			5,3	6,1	6,2	6,9		1,9
D-B Eiserner Rhein			4,0	4,9	5,2	5,8		0,5
Gesamt Eiserner Rhein			9,3	11,0	11,4	12,7		2,5
B-D Strecke über Montzen	4,4	7,6	2,8	2,1	2,7	2,0	8,3	6,9
D-B Strecke über Montzen	3,8	6,8	3,4	2,4	3,1	2,5	7,5	7,4
Gesamt Strecke über Montzen	8,2	14,3	6,2	4,5	5,8	4,5	15,7	14,3
Gesamt beide Linien	8,2	14,3	15,5	15,5	17,2	17,2	15,7	16,7
Index beide Linien	100	172	190	190	209	210	191	204
Zusätzlicher Bahn-verkehr für Situation ohne ER	-	-	1,2	1,2	2,9	2,9	-	1,0
* Andere Bahnlinien	-	-	0,97	0,90	2,63	2,53	-	0,995
* Straßenverkehr	-	-	0,15	0,20	0,18	0,25	-	0,003
* Binnenschifffahrt	-	-	0,08	0,10	0,09	0,12	-	0,002

Zweitens rufen die zusätzlichen Kosten durch den Straßengüterverkehr und die Auswirkungen der Liberalisierung des Schienenverkehrs (wie im Szenario 2B angenommen) keine großen Auswirkungen auf den Schienengüterverkehr hervor: Szenario 2B führt nicht zu erheblich mehr Schienengüterverkehr als Szenario 2A.

Drittens hat die Traktionsart (Diesel oder Elektrische Traktion) nur einen begrenzten Einfluss auf die erwartete Güterverkehrsmenge auf dem Eisernen Rhein: 9,3 Millionen Tonnen auf der historischen Strecke mit Dieseltraktion und 11,0 Millionen Tonnen auf der historischen Strecke mit Elektrischer Traktion. Der Schienengüterverkehr auf der Strecke über Montzen nimmt um den gleichen Betrag ab, so dass trotz Elektrifizierung des Eisernen Rheins die gleiche Gütermenge im Korridor transportiert wird.

Viertens führt die Wiederinbetriebnahme des Eisernen Rheins nicht zu einem großen Unterschied im Modal-split der Verkehrsträger. In anderen Worten, **der Eiserne Rhein zieht nur Verkehr von anderen Bahnlinien auf sich, jedoch nur sehr begrenzt vom Straßenverkehr oder der Binnenschifffahrt**.

Die Auswirkungen auf den **Straßengüterverkehr** sind begrenzt: die LKW-Transporte verringern sich um ca. 0,44 auf 1,09 Millionen LKW-km in Belgien im Jahr 2030, weniger als 0,01 % des gesamten Straßengüterverkehrs in Belgien (11 000 Millionen LKW-km in 2030), um 0,20 auf 0,28 Millionen LKW-km in den Niederlanden, und um 2,01 auf 5,59 Millionen LKW-km in Deutschland (abhängig von der gewählten Projektvariante).

Der **Binnenschiffsverkehr** verringert sich um 0,27 auf 0,67 Millionen Tonnen-km in Belgien, um 1,08 zu 1,48 Millionen Tonnen-km in den Niederlanden und um 2,93 zu 8,15 Millionen Tonnen-km in Deutschland (Werte für 2030). Für die Niederlande sind die Auswirkungen auf die Binnenschifffahrt größer als die Auswirkungen auf den Straßengüterverkehr. In Deutschland sind die Auswirkungen auf Straßengüter- und Binnenschiffsverkehr am größten, da dort die Entfernungen auch am größten sind.

Die Auswirkungen auf den **Personenverkehr** sind minimal, da der Eiserne Rhein nur für Güterverkehr bestimmt ist und da die Interferenz zwischen Güter- und Personenzügen begrenzt ist. Die Auswirkungen auf den PKW-Verkehr sind auch minimal, da die Auswirkungen auf Verkehrsstaus gering sind, wegen der minimalen Auswirkungen vom Straßengüterverkehr.

<u>Was sind die Kosten und die Nutzen?</u>

Die Wiederinbetriebnahme des Eisernen Rheins führt zu:
- Auswirkungen auf den Schienengüterverkehrmarkt
- volkswirtschaftliche Auswirkungen bezüglich Umwelt, Schallbelastung, Unfälle, etc. durch den Bau und die Benutzung des Eisernen Rheins
- Auswirkungen auf den Schienenpersonenverkehr
- Auswirkungen auf den Straßenverkehr
- Auswirkungen auf die Binnenschifffahrt
- Auswirkungen für die Regierung
- Auswirkungen auf andere Märkte

Des Weiteren wird das folgende angenommen als Grundlage für die Kostennutzenanalyse:
- Die Kosten und Nutzen wurden berechnet für den Zeitraum 2015-2030. Von 2030 an sind alle Cash Flows konstant.
- Zwei verschiedene Zinssätze wurden benutzt um zukünftige Kosten und Nutzen mit den Investitionskosten zu vergleichen: 4% (Belgischer Methode) und 2.5-4-5,5% abhängig von der Art von Kosten oder von Nutzen (Holländische Methode).
- Die Kosten und Nutzen werden Belgien, den Niederlanden, Deutschland und anderen Ländern zugeordnet basierend auf der Fläche (und nicht auf Basis der Kostenträger)

Bezüglich der **Auswirkungen auf den Schienengüterverkehrmarkt** kann unterschieden werden zwischen den Auswirkungen für die Verbraucher, die Verkehrsdienstleister und Infrastrukturbetreiber. Die Kosten für die Beförderung zwischen Antwerpen und Deutschland werden für die Verbraucher aufgrund der kürzeren Entfernung geringer. Dies erzeugt einen Gewinn für die Verbraucher in allen Projektvarianten. Dieser Gewinn ist größer wenn die Strecke elektrifiziert ist, da die Transportkosten dann geringer sind, und größer für die A52-Variante, da diese kürzer als die historische Strecke ist.

In einem perfekten Wettbewerbsmarkt entsteht kein Gewinn für den Verkehrsdienstleister.

Der Infrastrukturbetreiber erwirtschaftet weniger Gewinn mittels Infrastrukturgebühren auf der historischen Strecke, da der Eiserne Rhein kürzer ist und die Gebühren pro Zug-km erhoben werden. Der Anstieg in Gesamt-Schienenverkehr ist nicht groß genug um die Minderung in der Entfernung auszugleichen. Auf der anderen Seite gibt es jedoch auch Auswirkungen auf Wartungs- und Wiederherstellungskosten. Diese Kosten hängen vom Verkehrsvolumen ab; sie nehmen auf der Strecke über Montzen ab und auf dem Eisernen Rhein zu. Im Allgemeinen dominieren die Auswirkungen der Wartung einer zusätzlichen Bahnlinie und daher erhöhen sich die Kosten, besonders für die Wartung des Tunnels unter dem Naturschutzgebiet "De Meinweg" in den Niederlanden. Die A52-Variante hat kleinere Wartungskosten, da sie kürzer ist.

Durch den Bau und den Betrieb des Eisernen Rheins selbst entstehen auch volkswirtschaftliche Auswirkungen bezüglich Abgase, Schallbelästigung, Unfälle, Freizeitaktivitäten, Erschütterungen, Flora, Fauna, Landschaft, Umweltschutz, Boden, Grundwasser und Landwirtschaft. Wenn der Schienenverkehr zunimmt, steigen auch die Abgasmengen an, und führen daher zu zusätzlichen Kosten. Für Schall gibt es einen Nutzeneffekt, da die Projektalternative Eiserner Rhein Schallschutzwände vorsieht, wodurch der Schall abnimmt. Für Unfälle (auf Bahnübergängen) gibt es auch Nutzeneffekte, trotz des Anstiegs des Schienenverkehrs, da in der Projektalternative einige Bahnübergang mit Schranken versehen werden und daher sicherer werden. Die Auswirkungen auf Freizeitaktivitäten sind negativ und führen zum Verlust einiger Gebiete. Erschütterungen (durch Schienenverkehr) hängen vom Verkehrsvolumen ab. Daher nehmen Erschütterungen entlang der Strecke über Montzen ab und entlang des Eisernen Rheins zu. Die Gesamtauswirkungen hängen von der Anzahl der Züge auf beiden Strecken ab. Die Auswirkungen auf Flora, Fauna, Landschaft, Landwirtschaft sind entweder sehr gering oder nicht vorhanden. Die Auswirkungen bezüglich des Umweltschutzes sind nur in Belgien negativ, da Belgien - im Moment - keinen Plan für Ausgleichsmaßnahmen hat. Für Boden und Grundwasser wird Nutzen vorhergesehen, da der Boden vor dem Bau der neuen Trasse gereinigt wird.

Die **Auswirkungen für Bahnreisende** sind gering, aber negativ. Auf einen Teil des Eisernen Rheins wird die Strecke auch vom Personenverkehr genutzt. Die zusätzlichen Güterzüge aufgrund der Wiederinbetriebnahme des Eisernen Rheins führen zu zusätzlichen Verspätungen im Personenverkehr von durchschnittlich 30 Sekunden pro Zug.

Für den **Straßenverkehr** wird unterschieden zwischen Auswirkungen auf Verkehrsteilnehmer und volkswirtschaftlichen Auswirkungen. Da die Wiederinbetriebnahme des Eisernen Rheins zu weniger LKWs auf den Strassen führt, verringern sich Staus, und daher gibt es einen Nutzen für Verkehrsteilnehmer. Darüber hinaus gibt es Zeitgewinne für den Straßenverkehr durch die Neugestaltung einiger Bahnübergänge. Da weniger LKWs auf den Strassen sind, verringern sich Abgase, Lärmbelästigung, Unfälle und Straßenschäden. Dies ist ein geringer volkswirtschaftlicher Nutzen.

Auch für die **Binnenschifffahrt** wird unterschieden zwischen Auswirkungen auf die Reedereien und volkswirtschaftlichen Auswirkungen. Durch den Rückgang der Binnenschifffahrt kommt es zu einer Abnahme der Abgase und daher entsteht ein geringer volkswirtschaftlicher Nutzen.

Die **Regierungen** verlieren Steuereinnahmen und übernehmen Investitionskosten. Die Leistungsminderung durch die Zahlung der Investitionen mit Steuern aus der Einkommenssteuer, die so genannten *"marginal costs of public funds"*, wurde nicht berücksichtigt.

Der Infrastrukturbetreibererwirtschaftet weniger Gewinn mittels Infrastrukturgebühren auf der historischen Strecke, da der Eiserne Rhein kürzer ist und die Gebühren pro Zug-km erhoben werden. Der Anstieg in Gesamt-Schienenverkehr ist nicht groß genug um die Minderung in der Entfernung auszugleichen. Auf der anderen Seite gibt es jedoch auch Auswirkungen auf Wartungs- und Wiederherstellungskosten. Diese Kosten hängen vom Verkehrsvolumen ab; sie nehmen auf der Strecke über Montzen ab und auf dem Eisernen Rhein zu. Im Allgemeinen dominieren die Auswirkungen der Wartung einer zusätzlichen Bahnlinie und daher erhöhen sich die Kosten, besonders für die Wartung des Tunnels unter dem Naturschutzgebiet "De Meinweg" in den Niederlanden. Die A52-Variante hat kleinere Wartungskosten, da sie kürzer ist.

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Für den **Straßenverkehr** wird unterschieden zwischen Auswirkungen auf Verkehrsteilnehmer und volkswirtschaftlichen Auswirkungen. Da die Wiederinbetriebnahme des Eisernen Rheins zu weniger LKWs auf den Strassen führt, verringern sich Staus, und daher gibt es einen Nutzen für Verkehrsteilnehmer. Darüber hinaus gibt es Zeitgewinne für den Straßenverkehr durch die Neugestaltung einiger Bahnübergänge. Da weniger LKWs auf den Strassen sind, verringern sich Abgase, Lärmbelästigung, Unfälle und Straßenschäden. Dies ist ein geringer volkswirtschaftlicher Nutzen.

Auch für die **Binnenschifffahrt** wird unterschieden zwischen Auswirkungen auf die Reedereien und volkswirtschaftlichen Auswirkungen. Durch den Rückgang der Binnenschifffahrt kommt es zu einer Abnahme der Abgase und daher entsteht ein geringer volkswirtschaftlicher Nutzen.

Die **Regierungen** verlieren Steuereinnahmen und übernehmen Investitionskosten. Die Leistungsminderung durch die Zahlung der Investitionen mit Steuern aus der Einkommenssteuer, die so genannten *"marginal costs of public funds"*, wurde nicht berücksichtigt.

Die Tabelle auf der folgenden Seite zeigt als Beispiel die Ergebnisse der Kostennutzenanalyse für die Projektalternative "Eiserner Rhein – historische Strecke" mit einem Zinssatz von 4%. Die Wiederinbetriebnahme des Eisernen Rheins führt insgesamt zu einem volkswirtschaftlichen Verlust von insgesamt 461,70 Millionen Euro für alle drei Länder zusammen. Dieser Betrag verringert sich auf 510,52 Millionen Euro, wenn ein Zinssatz von 2,5-4-5,5% benutzt wird. Dies hängt damit zusammen, dass bei einem höheren Zinssatz sich die Investitionskosten in näherer Zukunft verringern, und dies ist wichtiger als eine Verringerung des Nutzens in weiterer Zukunft.

Sensitivitätsanalyse

Vier Sensitivitätsanalysen wurden durchgeführt:

- Eine Sensitivitätsanalyse, in der die Projektvarianten erst 5 Jahre später in Betrieb genommen wird, zeigt, dass das genaue Anfangsdatum die hauptsächliche Schlussfolgerung nicht ändert; die Bruttoverluste verringern sich.
- Eine Sensitivitätsanalyse, in der die Abgase auf eine unterschiedliche Weise zugeordnet werden, führt zu größeren Bruttoverlusten für die Niederlande, Belgien und Deutschland. Dies sind die Kosten, die vorher anderen Ländern zugeordnet wurden, nämlich die Länder, in denen die Luftqualität aufgrund der Wiederinbetriebnahme des Eisernen Rheins abnimmt.
- Eine Sensitivitätsanalyse mit höheren externen Kosten für Abgase führt zu größeren Bruttoverlusten.
- Eine Sensitivitätsanalyse mit einem höheren Verkehrsvolumen verringert den Kapitalwert der Projekte. Dieses paradoxe Ergebnis kann durch die sehr hohen Umweltkosten durch die Dieseltraktion auf der Strecke des Eisernen Rheins erklärt werden: wenn das Verkehrsvolumen zunimmt, steigen die Umweltkosten, was für die verkehrlichen Gewinne kompensiert.

Schlussfolgerung

Die 4 Projektvarianten, die bezüglich Eiserner Rhein untersucht wurden (historische Strecke, A52-Variante, jeweils mit Diesel- oder Elektrischer Traktion;) führen alle zu einem negativen volkswirtschaftlichen Nutzen für Belgien, die Niederlande, Deutschland und die anderen Länder. Der Kapitalwert der volkswirtschaftlichen Kosten liegt im Bereich von ca. 335 bis 530 Millionen Euro. Dafür ist eine Investition von ca. 440 bis 680 Millionen Euro von den 3 Ländern nötig, was einen Kapitalwert einer Investition von ca. 590 bis 750 Millionen Euro darstellt.

Der Hauptgrund für das schlechte Ergebnis dieses Projektes ist die Tatsache, dass hauptsächlich der Verkehr von der Strecke über Montzen, die den Kapazitätsgrenzwert noch nicht erreicht hat, verlagert wird. Die Kosteneinsparung durch den Wechsel zwischen den beiden Linien ist für die Endnutzer begrenzt und führt nur zu einer geringen Abnahme von Staus auf der Strasse. Selbst wenn der Anstieg des Schienengüterverkehrs von Antwerpen nach Deutschland viel größer als im Modell angenommen wird, ist der Nutzen zu gering um die hohen Investitionskosten auszugleichen.

Falls das Projekt jedoch trotzdem durchgeführt werden soll, kann unter Vernachlässigung der Kosten der volkswirtschaftliche Nutzen vergrößert werden, indem der Beginn des Projekts verzögert wird, der gesamte Eiserne Rhein elektrifiziert wird, und die A52-Variante gewählt wird. Die Abschätzung der Investitionskosten (480 Millionen €) für diese A52-Variante basiert auf der IVV-Studie. DB Netz schätzt zurzeit, dass die Investitionskosten 500 bis 900 Millionen € betragen würden.

Tabelle 3: Volkswirtschaftliche Kostennutzenanalyse: Übersicht, Szenario "Historischer Eiserner Rhein – 2A" Kapitalwert für 2007, Millionen Euro$_{2007}$, Zinssatz 4%

		Total	In Belgien	In den Nieder-landen	In Deutsch-land	In andere-ren Län-dern
Direkte Auswirkungen auf den Schienengüterverkehrsmarkt						
Direkte Auswirkungen auf Nutzer	Konsumentenrente	94,21	48,40	0,00	32,83	12,98
Direkte Auswirkungen auf Infra-strukturbetreiber	Infrastrukturgebühren	-6,85	-19,92	20,62	-7,56	NA
	Schuldumwandlung	-15,90	0,00	-15,90	NA	NA
	Wartungskosten	31,29	91,34	-60,05	NA	NA
Externe Auswirkungen bezüglich Bau und Benutzung der Bahnlinie						
Volkswirtschaftliche Auswirkungen	Abgase	-138,20	-19,28	-10,48	-39,00	-69,44
	Schall	24,79	8,12	3,29	13,39	NA
	Unfälle	16,94	11,75	3,83	1,36	NA
	Sicherheit	-0,01	NA	-0,01	NA	NA
	Erholung	-5,63	-0,41	-3,14	-2,08	0,00
	Erschütterung	0,12	0,65	-0,77	0,24	0,00
	Verlust von Flora und Fauna	0,00	0,00	0,00	0,00	0,00
	Landschaft	0,00	0,00	0,00	0,00	0,00
	Umweltschutz	-3,48	-3,48	0,00	0,00	0,00
	Boden und Grundwasser	3,00	0,00	3,00	0,00	0,00
	Landwirtschaft	0,00	0,00	0,00	0,00	0,00
Auswirkungen auf den Schienenpersonenverkehr						
	Verspätungen	-7,12	PM	-7,12	0,00	0,00
Auswirkungen auf den Straßenverkehr						
Indirekte Auswirkung für Ver-kehrsteilnehmer	Zeitverlust durch Stau	18,73	4,40	2,35	11,98	NA
	Zeitverlust durch Bahnüber-gänge	12,71	7,46	4,40	0,86	NA
	Steuern	-8,71	-0,98	-0,58	-7,15	NA
Volkswirtschaftliche Auswirkungen	Abgase	2,89	0,37	0,22	1,51	0,81
	Schall	1,67	0,21	0,34	1,12	NA
	Unfälle	1,80	0,58	0,18	1,04	NA
	Straßenschäden	2,11	0,30	0,13	1,68	NA
Auswirkungen auf die Binnenschifffahrt						
Indirekte Auswirkungen auf Nutzer	Steuern	-0,07	-0,01	0,00	-0,06	0,00
Volkswirtschaftliche Auswirkungen	Abgase	0,48	0,03	0,06	0,22	0,18
Auswirkungen auf die Regierung						
Indirekte Auswirkungen	MCPF Korrigierung	PM	PM	PM	PM	PM
Auswirkungen auf andere Sektoren						
Indirekte Auswirkungen		PM	PM	PM	PM	PM
ZWISCHENSUMME		**24,80**	**129,54**	**-59,64**	**10,39**	**-55,48**
Auswirkungen auf die Regierung						
Direkte Auswirkungen	Investitionskosten	-486,51	-0,90	-391,04	-94,56	0,00
GESAMT		**-461,70**	**128,63**	**-450,69**	**-84,17**	**-55,48**

Die nachstehende Tabelle zeigt eine Übersicht der Ergebnisse für alle Varianten.

Tabelle 4: Übersicht der Ergebnisse für all Varianten, Kapitalwert für 2007, Millionen Euro$_{2007}$

Alternative	**Rabattsatz**	**Gesamt**	**In Belgien**	**In den Nieder-landen**	**In Deutsch-land**	**In ande-ren Län-dern**
Eiserner Rhein historische Strecke Diesel – 2A	4%	-461,70	128,63	-450,69	-84,17	-55,48
	2,5-4-5,5%	-510,52	118,31	-497,42	-96,28	-35,13
Eiserner Rhein historische Strecke Diesel – 2B	4%	-432,78	92,86	-428,80	-78,75	-18,08
	2,5-4-5,5%	-492,02	89,36	-476,15	-92,98	-12,26
Eiserner Rhein historische Strecke Elektro – 2A	4%	-404,88	125,04	-497,07	-53,81	20,96
	2,5-4-5,5%	-530,88	95,40	-551,78	-88,16	13,66
Eiserner Rhein über A52 Diesel – 2A	4%	-440,23	144,17	-204,16	-325,02	-55,23
	2,5-4-5,5%	-503,64	128,81	-229,13	-369,19	-34,13
Eiserner Rhein über A52 Diesel – 2B	4%	-335,93	144,78	-235,46	-281,39	36,15
	2,5-4-5,5%	-486,05	107,03	-267,10	-350,53	24,55
Sensitivitätsanalyse für den Eisernen Rhein, Unterschied gegenüber der historischer Strecke mit Dieseltraktion – 2A	**Rabattsatz**	**Gesamt**	**In Belgien**	**In den Nieder-landen**	**In Deutsch-land**	**In ande-ren Län-dern**
Höhere externe Kosten für Abgase	4%	-241,14	-33,90	-18,36	-65,63	-123,26
	2,5-4-5,5%	-154,02	-21,50	-11,77	-41,90	-78,85
Unterschiedliche Zuordnung von Abgasen	4%	-20,98	-30,81	-38,28	-20,35	68,46
	2,5-4-5,5%	-13,41	-19,58	-24,67	-12,97	43,82
Projekt Beginn 2020 (nicht 2015)	4%	125,92	-9,08	115,38	14,27	5,35
	2,5-4-5,5%	115,95	-9,78	111,42	9,73	4,58
Höheres Verkehrsvolumen (20%)	4%	-3,98	13,60	-7,74	1,25	-11,10
	2,5-4-5,5%	-3,83	10,24	-7,68	0,64	-7,03

Résumé

Motivation et informations sur le fond

Qu'est-ce que le Rhin d'Acier?

Le Rhin d'Acier est une ligne de chemin de fer qui relie le port d'Anvers à la région allemande de la Ruhr. En 1998, la Belgique a demandé aux Pays-Bas l'autorisation de remettre le Rhin d'Acier en service. La raison de cette demande résidait dans l'amplification des transports de marchandises entre la région portuaire anversoise et l'arrière-pays allemand. La route actuelle qui nous relie avec l'Allemagne, la route Montzen, est plus longue que le Rhin d'Acier d'environ 50 kilomètres et comprend en outre un certain nombre de côtes qui compliquent la circulation de trains lourds.

Dans le cadre de cette étude, nous examinerons le coût et le bénéfice sociaux d'une réactivation de la liaison ferroviaire Rhin d'Acier. Nous étudierons deux tracés possibles pour le Rhin d'Acier : le tracé historique et, en guise d'alternative, le tracé A52. La figure ci-dessous illustre les deux tracés et la route Montzen. Nous étudierons aussi les alternatives sans électrification (donc exclusivement destinées aux locomotives au diesel) et avec électrification (donc aussi appropriée pour les locomotives électriques).

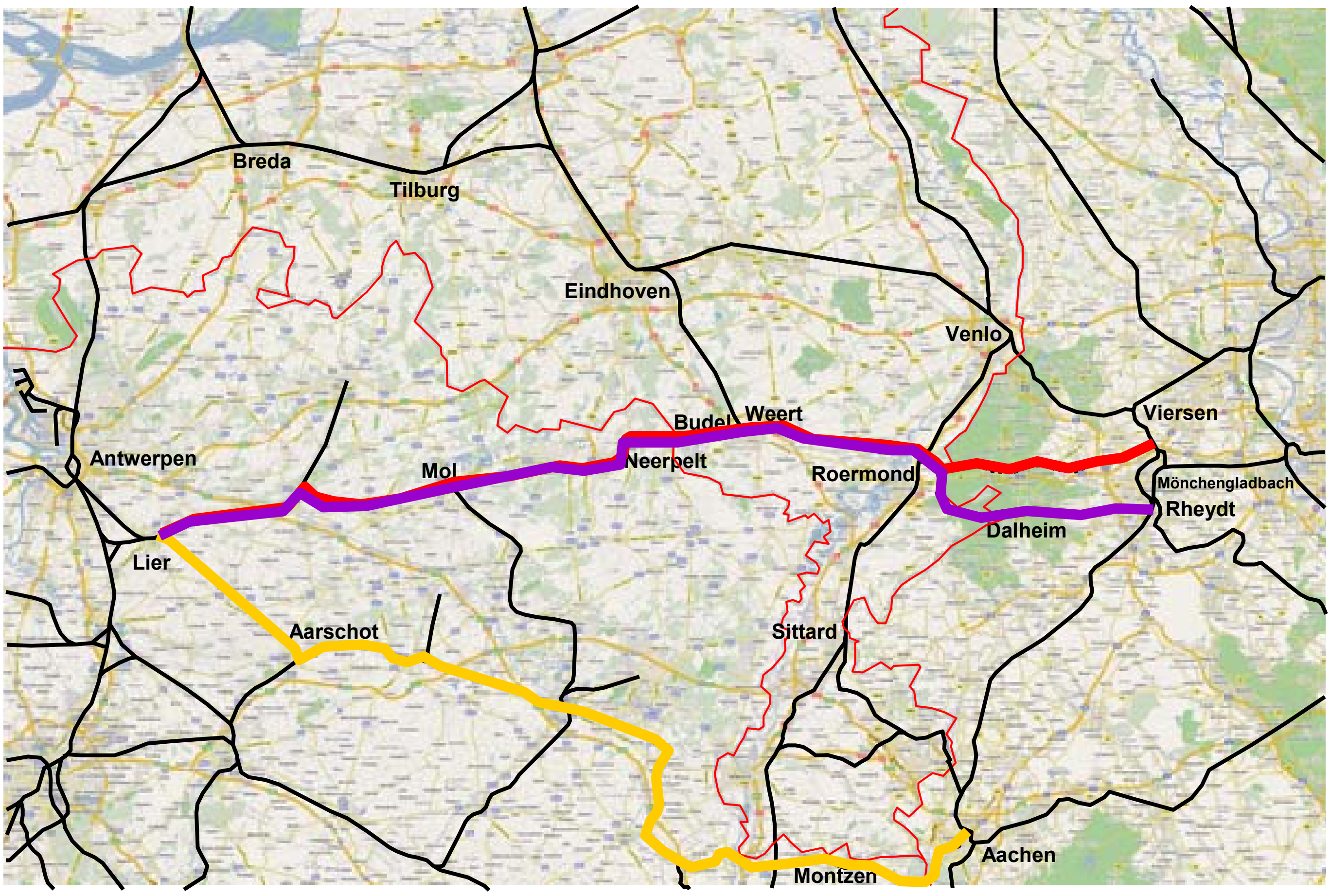
Pourquoi cette étude?

Le 6 juillet 2006, le secrétaire d'Etat des Entreprises publiques et le ministre néerlandais du Transport et des Travaux publics ont décidé de faire procéder à diverses études en matière de réactivation du Rhin d'Acier. L'une de ces études est la présente analyse des coûts et bénéfices sociaux.

Qu'est-ce qu'une analyse des coûts et bénéfices sociaux?

Une analyse des coûts et bénéfices sociaux étudie de façon systématique les coûts et avantages sociaux liés à un projet. Le terme « sociaux » indique que les coûts et bénéfices sont analysés et appréciés du point de vue de la société dans son ensemble. L'étude ne prend pas seulement les effets financiers et économiques en considération, mais aussi divers autres facteurs auxquels la société attache une valeur, comme l'environnement, la mobilité et la sécurité.

Figure 1 : Alternatives pour le Rhin d'Acier : tracé historique (en violet) et variante A52 (en rouge). La route Montzen est indiquée en jaune.



<u>Scénarios économiques</u>

Une analyse des coûts et bénéfices établit une comparaison entre une alternative zéro et une alternative de projet. Cette comparaison est réalisée pour deux scénarios économiques (2A et 2B). Les deux scénarios partent de la même croissance économique (2,3 % jusqu'en 2020 et 2,0 % pour la période 2020-2030), mais diffèrent en termes de politique en matière de transport. Dans le cas du scénario 2B, nous supposons l'existence d'une charge supplémentaire pour tous les modes de transport et d'une amélioration au niveau des coûts et des durées des trajets pour les transports ferroviaires.

<u>Alternative zéro et alternatives de projet</u>

L'alternative zéro dans cette étude est la situation sans la réactivation du Rhin d'Acier. Nous partons toutefois du principe que tous les investissements prévus, comme par exemple le tunnel de chemin de fer Liefkenshoek et le second lien ferroviaire vers le port d'Anvers, ont été exécutés. Dans l'alternative zéro, la totalité du trafic ferroviaire entre le port d'Anvers et l'Allemagne transite par la route Montzen. La route Montzen est une liaison à double voie et a été intégralement électrifiée depuis la fin de l'année 2008. Le scénario de référence prévoit un investissement supplémentaire pour la route Montzen, à savoir un croisement libre dans la région d'Aarschot. Dans l'alternative zéro il y a aucune autre problème de capacité sur la route Montzen.

Cette étude prévoit quatre alternatives de projet. Le tableau ci-dessous propose un sommaire des alternatives de projet.

Tableau 1 : Sommaire des alternatives étudiées

	Alternative zéro	Rhin d'acier, tracé historique diesel	Rhin d'Acier, tracé A52 diesel	Rhin d'Acier, tracé historique électrifié	Rhin d'Acier, tracé A52 électrifié
Scénario 2A	X	X	X	X	X
Scénario 2B	X	X			

Les alternatives de projet diffèrent en ce qui concerne la route (voir aussi la figure ci-dessus) et la traction prévue (diesel contre électricité). Pour simplifier la comparaison dans toute la mesure du possible, nous supposons que toutes les variantes du Rhin d'Acier seront prêtes à être mises en service en 2015.

L'alternative de projet **« Rhin d'Acier - tracé historique »** est l'alternative qui a été choisie en septembre 2001 par les ministres du Transport de la Belgique, des Pays-Bas et de l'Allemagne et qui a été confirmée dans le cadre de l'arbitrage international. Cette alternative comprend le tracé historique du Rhin d'Acier d'Anvers à la frontière belgo-néerlandaise en passant par Lier, Mol et Neerpelt. A partir de la frontière dans le région de Budel, le tracé rejoint la frontière allemande à proximité de Vlodrop en passant par Weert et Roermond. Le seul écart par rapport au tracé historique (qui traversait totalement le centre urbain) se situe à Roermond, ceci à la demande des Pays-Bas. Le nouveau tracé est dérivé au nord-ouest de Roermond et suit alors l'autoroute A73-Zuid existante, contournant Roermond par le sud-est. Ensuite, ce nouveau tracé rejoint à nouveau le tracé historique, qui traverse ensuite, également à la demande des Pays-Bas, la zone naturelle De Meinweg dans le cadre d'un tunnel d'une longueur de quelque 6 km. En Allemagne, le projet suit le tracé historique par Dalheim, Wegberg et Mönchengladbach-Rheindahlen jusqu'à Rheydt.

Dans le cadre de l'alternative de projet **« Rhin d'Acier – variante A52 »**, la situation en Belgique ne fait l'objet d'aucun changement, mais des modifications sont par contre prévues aux Pays-Bas et en Allemagne. L'idée consiste à construire une nouvelle ligne ferroviaire qui suivrait les autoroutes N280 et A52 entre Roermond et Mönchengladbach. Ce projet suppose un investissement dans une ligne à voie unique entre Roermond et Mönchengladbach sur environ 7 km aux Pays-Bas, ainsi qu'une double voie sur environ 28 km en Allemagne. La longueur totale de cette variante est inférieure à celle du tracé historique et la voie ne traverse pas le parc national « De Meinweg ». D'un autre côté, le tracé traverserait plusieurs autres zones protégées de part et d'autre de la frontière entre les Pays-Bas et l'Allemagne.

Le Rhin d'Acier est prévu comme une ligne diesel, qui n'est que partiellement électrifiée. Nous avons dès lors aussi étudié deux alternatives prévoyant l'électrification intégrale des lignes.

Pour tous les tracés, nous supposons une capacité maximale de 72 trains par jour, les deux sens confondus, comme le prévoient les recommandations de la COD (*Commissie van Onafhankelijke Deskundigen/Commission des Experts indépendants*) du 8 juin 2007.

Les effets du Rhin d'Acier

Quels seront les effets du Rhin d'Acier en termes de transport?

La mise en service du Rhin d'Acier comportera des conséquences pour le trafic ferroviaire, le trafic routier et la navigation intérieure. Nous distinguons quatre effets en ce qui concerne les transports de marchandises :

En premier lieu, la mise en service du Rhin d'Acier entraînera dès 2030 une augmentation de la totalité des **transports ferroviaires** entre la Belgique et l'Allemagne par le Rhin d'Acier et par la route Montzen de 14,3 à 15,5 millions de tonnes dans le cadre de l'alternative « Rhin d'Acier – tracé historique » et à 17,2 millions de tonnes dans l'alternative « Rhin d'Acier – tracé A52 ». Cette augmentation des transports ferroviaires par le Rhin d'Acier et la route Montzen de 1,2 à 2,9 millions de tonnes proviendra en majeure parie d'autres lignes de chemin de fer (de 0,97 à 2,63 millions de tonnes), le reste étant généré par d'autres modalités de transport : de 0,15 à 0,25 million de tonnes proviendra des transports routiers.

Dans les deux alternatives en matière de tracé, la majorité du trafic ferroviaire opte pour le Rhin d'Acier au détriment de la route Montzen parce que le Rhin d'Acier est quelque peu plus avantageux suite à son tracé plus court et à sa capacité à accepter des trains plus lourds. Il convient de noter qu'aucune variante du Rhin d'Acier ne génère beaucoup de trafic ferroviaire supplémentaire, mais attire plutôt un trafic existant sur la route Montzen. Le tableau ci-dessous résume les effets pour le trafic ferroviaire en 2030.

Tableau 2 : Flux total de marchandises via le Rhin d'Acier et la route Montzen par scénario (en millions de tonnes), 2030

Mesuré sur le tracé ferroviaire Budel - Weert (Rhin d'Acier) et le tracé Montzen - Aix-la-Chapelle-West (route Montzen).

B=Belgique, D=Allemagne.

	2005	**2030 2A**					**2030 2B**	
		Pas de RA	**RA hist.**	**RA hist. électr.**	**RA via A52**	**RA électr. via A52**	**Pas de RA**	**RA hist.**
B-D Rhin d'Acier			5,3	6,1	6,2	6,9		1,9
D-B Rhin d'Acier			4,0	4,9	5,2	5,8		0,5
Total Rhin d'Acier			9,3	11,0	11,4	12,7		2,5
B-D route Montzen	4,4	7,6	2,8	2,1	2,7	2,0	8,3	6,9
D-B route Montzen	3,8	6,8	3,4	2,4	3,1	2,5	7,5	7,4
Total route Montzen	8,2	14,3	6,2	4,5	5,8	4,5	15,7	14,3
Total deux routes	8,2	14,3	15,5	15,5	17,2	17,2	15,7	16,7
Index deux routes	100	172	190	190	209	210	191	204
Trafic ferroviaire supplémentaire par rapport à la situation sans RA	-	-	1,2	1,2	2,9	2,9	-	1,0
* Autres lignes ferroviaires	-	-	0,97	0,90	2,63	2,53	-	0,995
* Transport routier	-	-	0,15	0,20	0,18	0,25	-	0,003
* Navigation intérieure	-	-	0,08	0,10	0,09	0,12	-	0,002

En second lieu, le coût supplémentaire des transports de marchandises par la route et les effets de la libéralisation du chemin de fer (telle qu'elle est supposée dans le scénario 2B) n'entraîneront aucun effet considérable pour le transport ferroviaire : le scénario 2B ne générera pas beaucoup plus de transports ferroviaires que le scénario 2A.

En troisième lieu, le type de traction (diesel contre électricité) n'exercera qu'une influence limitée sur les transports prévus par le Rhin d'Acier : 9,3 millions de tonnes sur le tracé historique à traction diesel contre 11,0 millions de tonnes sur le tracé historique à traction électrique (en 2030). Les transports ferroviaires par la route Montzen chuteront néanmoins, le solde du trafic ferroviaire restant donc inchangé dans ce corridor malgré l'électrification du Rhin d'Acier.

Quatrièmement, la mise en service du Rhin d'Acier n'entraînera aucune modification importante au niveau de la composition du trafic. Autrement dit, **le Rhin d'Acier attirera principalement du trafic ferroviaire d'autres lignes de chemin de fer et n'entraînera qu'une réduction très limitée des transports routiers ou des transports effectués par navigation intérieure.**

Les effets sur les **transports routiers** seront limités : en 2030 le nombre de km par camion chutera de 0,44 à 1,09 million en Belgique, soit moins de 0,01 % de la totalité des transports routiers en Belgique (11 milliards de km par camion en 2030). Le nombre de km par camion chutera de 0,20 à 0,28 aux Pays-Bas et de 2,01 à 5,59 en Allemagne (chiffres fonction de l'alternative choisie).

La **navigation intérieure** chutera de 0,27 à 0,67 million de tonnes/km en Belgique, de 1,08 à 1,48 aux Pays-Bas et de 2,93 à 8,15 en Allemagne (chiffres pour 2030). Il convient de noter que les effets sur la navigation intérieure seront supérieurs aux effets sur les transports routiers aux Pays-Bas. Les effets seront les plus marqués en Allemagne, tant pour les transports routiers que pour la navigation intérieure, parce que les distances sont plus considérables dans ce pays.

Les effets sur les **transports de personnes** seront minimaux. Ils seront minimaux en ce qui concerne le chemin de fer parce que le Rhin d'Acier n'est pas destiné au transport de voyageurs et parce que l'interférence des trains de marchandises avec les trains de voyageurs est limitée. Les effets pour la circulation routière seront minimaux parce que les effets sur la congestion sont limités, ceci étant dû à son tour aux effets minimaux sur les transports de marchandises par la route.

<u>Quels sont les bénéfices et les coûts?</u>

La mise en service du Rhin d'acier débouchera sur

- des effets sur le marché des transports de marchandises par chemin de fer
- des effets sur la société en ce qui concerne l'environnement, le bruit, les accidents, etc. suite à la construction et à l'utilisation du Rhin d'Acier
- des effets sur les trafics de voyageurs par chemin de fer
- des effets sur la circulation routière
- des effets sur la navigation intérieure
- des effets pour les pouvoirs publics
- des effets sur d'autres marchés

La présente analyse des coûts et bénéfice a en outre été réalisée sur base des suppositions suivantes

- les coûts et bénéfices sont calculés pour la période 2015-2030. A partie de 2030, tous les flux seront supposés être constants dans le temps.
- deux taux d'escompte différents ont été utilisés pour comparer les coûts et bénéfices au coût d'investissement : 4 % (approche belge) et 2.5-4- 5,5 % selon le type des coûts ou d'avantages (approche néerlandaise).
- les coûts et bénéfices sont attribués à la Belgique, aux Pays-Bas, à l'Allemagne et aux autres pays sur base du territoire (et pas sur base de la question de savoir qui devrait payer quoi).

En ce qui concerne les **effets sur le marché des transports de marchandises par chemin de fer**, nous distinguons les effets pour le consommateur, pour l'opérateur et pour le gestionnaire des infrastructures. Pour le consommateur, les transports entre Anvers et l'Allemagne seront moins coûteux suite au raccourcissement de la distance de transport. Cet effet génère un bénéfice pour les consommateurs pour toutes les alternatives. Le bénéfice est plus élevé si la ligne est électrifiée, parce que ce mode de transport est moins coûteux et il est aussi plus important pour le tracé A52 parce qu'il est plus court que le tracé historique.

Dans un marché parfaitement concurrentiel, il n'y a aucun bénéfice pour l'opérateur (l'entreprise de gestion des transports ferroviaires).
Le gestionnaire des infrastructures bénéfice de moins de revenus sur le tracé historique parce que le Rhin d'Acier est plus court et que l'indemnité pour la gestion des infrastructures est une indemnité basée sur le facteur train/km. L'augmentation du volume total des transports par chemin de fer n'est pas suffisamment importante pour compenser cette différence en nombre de kilomètres. D'un autre côté, il y a aussi un effet sur les coûts d'entretien et de remplacement. Ces coûts sont fonction du volume; ils enregistrent une baisse sur la route Montzen et une augmentation sur le Rhin d'Acier. L'effet de l'entretien d'une nouvelle ligne de chemin de fer domine en général et il y a donc des coûts supplémentaires, principalement au niveau de l'entretien du tunnel Meinweg aux Pays-Bas. Le tracé A52 génère moins de frais d'entretien.

Suite à la construction et à l'usage même du Rhin d'Acier, il y a aussi des **effets pour la société** en ce qui concerne les émissions, le bruit, les accidents, la récréation, les vibrations, l'environnement de vie, le paysage, l'écologie, le sol, l'eau et l'agriculture. Compte tenu de l'augmentation du trafic ferroviaire, il y a une augmentation des émissions dues au trafic ferroviaire et donc un poste de coûts. En ce qui concerne le bruit, il y a un bénéfice parce que les alternatives de projet pour le Rhin d'Acier prévoient des écrans d'insonorisation veillant à ce que le bruit diminue en comparaison à l'alternative zéro. En ce qui concerne les accidents (aux passages à niveau), il y a un bénéfice malgré l'augmentation des transports ferroviaires parce que l'alternative de projet prévoit le remplacement d'un certain nombre de passages à niveau par des passages souterrains, amplifiant donc ainsi la sécurité. L'effet sur les espaces de récréation est négatif parce que le projet entraîne la perte de possibilités de récréation et perturbe l'écologie. Les vibrations (suite au trafic ferroviaire) seront fonction du volume des transports. Les vibrations diminueront donc le long de la route Montzen et augmenteront le long du Rhin d'Acier. L'effet total sera fonction du nombre de trains sur les deux routes. Les effets sur le paysage, l'environnement de vie et l'agriculture seront très limités, voire inexistants. L'écologie n'est négative qu'en Belgique parce que la Belgique n'a pas encore établi de plan de compensation en matière de nature à ce jour. En ce qui concerne le sol et l'eau, nous percevons un bénéfice parce que le sol fera l'objet d'un assainissement sur certaines parties du trajet avant la construction du Rhin d'Acier.

Les **effets pour le trafic de voyageurs** par chemin de fer sont limités, mais négatifs. Une partie du Rhin d'Acier sera en effet partagée avec le trafic de voyageurs. Les trains de marchandises supplémentaires découlant de la réactivation du Rhin d'Acier engendreront donc des retards supplémentaires pour les voyageurs à raison d'une demi-minute par train en moyenne.

En ce qui concerne la **circulation routière**, nous distinguons des effets pour les usagers de la route et des effets pour la société. Compte tenu du fait que l'existence du Rhin d'Acier entraîne une diminution du nombre de camions sur la route, la congestion sera moindre, ce qui représente donc un bénéfice pour les usagers de la route. La mise en service du Rhin d'Acier implique en outre la transformation d'un certain nombre de passages à niveau par des passages souterrains, entreprise qui se traduira par un gain de temps pour les usagers de la route. La diminution du nombre de camions entraînera une chute des émissions, des nuisances sonores, du nombre d'accidents et des dégâts causés à la voierie. Il s'agit là d'un petit bénéfice pour la société.

De même, nous faisons la distinction entre les effets pour les mariniers et les effets pour la société en ce qui concerne la **navigation intérieure**. La diminution de la navigation entraîne une chute des émissions et représente donc un petit bénéfice pour la société.

Les **pouvoirs publics** perdront des revenus fiscaux et paieront les coûts d'investissement. La perte d'efficacité engendrée parce que les coûts d'investissement sont payés par un impôt sur le travail, les *« marginal costs of public funds »,* n'a pas été prise en compte.

Les **effets possibles sur d'autres marchés**, comme les ports d'Anvers et de Rotterdam, sont repris exclusivement pour mémoire.

Le tableau à la page suivante fournit en guise d'exemple le résultat de l'analyse des coûts et bénéfices pour l'alternative de projet « Rhin d'Acier – tracé historique » sur base d'un taux d'escompte de 4%. La remise en service du Rhin d'Acier – tracé historique débouchera sur une perte sociale nette pour les trois pays réunis de 461,70 millions d'euros (valeur nette actuelle / constante). Lorsque nous appliquons un taux d'escompte de 2,5-4-5,5%, la perte nette chute à 510,52 millions d'euros, ceci parce qu'en présence d'un taux d'escompte supérieur , les coûts d'investissement chuteront dans un proche avenir, ce qui est plus important qu'une chute des bénéfices dans un avenir lointain.

<u>Analyses de sensibilité</u>

Quatre analyses de sensibilité ont été effectuées :

- Une analyse de sensibilité prévoyant une mise en service de la ligne de chemin de fer après 5 ans démontre que la date de départ précise ne modifie pas significativement les conclusions générales; la perte nette est par contre réduite.
- Une analyse de sensibilité dans le cadre de laquelle les émissions sont allouées différemment aux pays entraîne un coût net supérieur, tant pour les Pays-Bas et la Belgique que pour l'Allemagne. Il s'agit de coûts ayant été alloués antérieurement à d'autres pays, à savoir les pays où la qualité de l'air diminue suite à la mise en service du Rhin d'Acier.
- Une analyse de sensibilité impliquant des coûts externes supérieurs en termes d'émissions démontre une plus grande perte nette.
- Une analyse de sensibilité impliquant un volume de transport plus élevé diminue la valeur nette constante du projet. Ce résultat paradoxal est dû aux coûts environnementaux très élevés le long

du Rhin d'Acier, qui est limité à une traction au diesel : en cas d'élévation du volume des transports, les coûts environnementaux supplémentaires annulent le bénéfice supplémentaire en termes de transport.

Conclusions

Les 5 alternatives pour le Rhin d'Acier (tracé historique, alternative A52, diesel, voie électrifiée, scénario) débouchent toutes sur des bénéfices négatifs (donc des coûts nets) pour la société en Belgique, aux Pays-Bas, en Allemagne et dans les autres pays. Les coûts nets constants pour la société varient d'environ 335 à 530 millions d'euros. Le projet requiert donc un investissement par les trois pays de 440 à 680 millions d'euros, la valeur nette actuelle des investissements nécessaires s'élevant à un montant de 590 à 750 millions d'euros.

La principale raison réside dans le fait que le Rhin d'Acier attirera principalement du trafic ferroviaire de la route Montzen, alors que celle-ci offre encore de la capacité. Le bénéfice d'un changement de route n'est donc que minimal pour les usagers. Le Rhin d'Acier ne diminuera en outre pas significativement les transports de marchandises par la route et il n'y aura donc qu'une amélioration limitée en termes de congestion du réseau routier. Même si l'accroissement du trafic ferroviaire entre Anvers et l'Allemagne devait être plus important que prévu, les bénéfices resteraient trop réduits en comparaison aux coûts d'investissement considérables.

Si l'on souhaite malgré tout procéder à l'aménagement du Rhin d'Acier, les pertes pour la société seraient les plus réduites en optant pour la variante « Rhin d'acier – tracé A52 électrifié ». Il convient de noter que l'ampleur de l'investissement (480 millions €) pour le tracé A52 est basée sur l'étude IVV, tandis que DB Netz évalue aujourd'hui l'investissement à un montant de 500 à 900 millions €.

Tableau 3 : Analyse des coûts et bénéfices sociaux : sommaire du scénario « Rhin d'Acier historique – 2A », valeur NPV pour 2007, millions d'euros$_{2007}$, taux d'escompte 4%

		Total	En Belgique	Aux Pays-Bas	En Allemagne	Dans d'autres pays
Effets directs sur le marché des transports de marchandises par chemin de fer						
Effets directs pour les usagers	Surplus consommateurs	94,21	48,40	0,00	32,83	12,98
Effets directs pour le gestionnaire des infrastructures	Indemnité pour infrastructures	-6,85	-19,92	20,62	-7,56	NA
	Frais renouvellements	-15,90	0,00	-15,90	NA	NA
	Frais d'entretien	31,29	91,34	-60,05	NA	NA
Effets externes liés à la construction et l'exploitation de la voie de chemin de fer						
Effets pour la société	Emissions	-138,20	-19,28	-10,48	-39,00	-69,44
	Bruit	24,79	8,12	3,29	13,39	NA
	Accidents	16,94	11,75	3,83	1,36	NA
	Sécurité externe	-0,01	NA	-0,01	NA	NA
	Récréation	-5,63	-0,41	-3,14	-2,08	0,00
	Vibrations	0,12	0,65	-0,77	0,24	0,00
	Perte d'environnement de vie	0,00	0,00	0,00	0,00	0,00
	Paysage	0,00	0,00	0,00	0,00	0,00
	Ecologie	-3,48	-3,48	0,00	0,00	0,00
	Sol et eau	3,00	0,00	3,00	0,00	0,00
	Agriculture	0,00	0,00	0,00	0,00	0,00
Effets pour les voyageurs des chemins de fer						
	Retards	-7,12	PM	-7,12	0,00	0,00
Effets pour la circulation routière						
Effet indirect pour les usagers de la route	Pertes de temps files	18,73	4,40	2,35	11,98	NA
	Pertes de temps passages à niveau	12,71	7,46	4,40	0,86	NA
	Taxes	-8,71	-0,98	-0,58	-7,15	NA
Effets pour la société	Emissions	2,89	0,37	0,22	1,51	0,81
	Bruit	1,67	0,21	0,34	1,12	NA
	Accidents	1,80	0,58	0,18	1,04	NA
	Usure revêtement routier	2,11	0,30	0,13	1,68	NA
Effets pour la navigation intérieure						
Effets indirects pour les usagers de la navigation intérieure	Taxes	-0,07	-0,01	0,00	-0,06	0,00
Effets pour la société	Emissions	0,48	0,03	0,06	0,22	0,18
Effets pour les pouvoirs publics						
Effet indirect	Correction MCPF	PM	PM	PM	PM	PM
Effets pour d'autres secteurs						
Effet indirect		PM	PM	PM	PM	PM
SOUS-TOTAL		**24,80**	**129,54**	**-59,64**	**10,39**	**-55,48**
Effets pour les pouvoirs publics						
Effet direct	Coût d'investissement	-486,51	-0,90	-391,04	-94,56	0,00
TOTAL		**-461,70**	**128,63**	**-450,69**	**-84,17**	**-55,48**

Vous trouverez un sommaire des résultats de toutes les variantes dans le tableau suivant.

Tableau 4 : Sommaire des résultats de toutes les variantes, valeur NPV pour 2007, millions d'euros$_{2007}$

Alternative	**Taux d'escompte**	**Total**	**En Belgique**	**Aux Pays-Bas**	**En Allemagne**	**Dans d'autres pays**
Rhin d'Acier – tracé historique diesel – 2A	4%	-461,70	128,63	-450,69	-84,17	-55,48
	2,5-4-5,5%	-510,52	118,31	-497,42	-96,28	-35,13
Rhin d'Acier – tracé historique diesel – 2B	4%	-432,78	92,86	-428,80	-78,75	-18,08
	2,5-4-5,5%	-492,02	89,36	-476,15	-92,98	-12,26
Rhin d'Acier – tracé historique électrifié – 2A	4%	-404,88	125,04	-497,07	-53,81	20,96
	2,5-4-5,5%	-530,88	95,40	-551,78	-88,16	13,66
Rhin d'Acier – tracé A52 diesel – 2A	4%	-440,23	144,17	-204,16	-325,02	-55,23
	2,5-4-5,5%	-503,64	128,81	-229,13	-369,19	-34,13
Rhin d'Acier – tracé A52 électrifié - 2A	4%	-335,93	144,78	-235,46	-281,39	36,15
	2,5-4-5,5%	-486,05	107,03	-267,10	-350,53	24,55
Analyses de sensibilité quant au Rhin d'Acier Différences par rapport au tracé historique diesel – 2A	**Taux d'escompte**	**Total**	**En Belgique**	**Aux Pays-Bas**	**En Allemagne**	**Dans d'autres pays**
Coûts externes plus élevés suite à des émissions	4%	-241,14	-33,90	-18,36	-65,63	-123,26
	2,5-4-5,5%	-154,02	-21,50	-11,77	-41,90	-78,85
Allocation différente des émissions à des pays	4%	-20,98	-30,81	-38,28	-20,35	68,46
	2,5-4-5,5%	-13,41	-19,58	-24,67	-12,97	43,82
Date de départ 2020 au lieu de 2015	4%	125,92	-9,08	115,38	14,27	5,35
	2,5-4-5,5%	115,95	-9,78	111,42	9,73	4,58
Volumes de transport plus importants (20%)	4%	-3,98	13,60	-7,74	1,25	-11,10
	2,5-4-5,5%	-241,14	-33,90	-18,36	-65,63	-123,26

Executive summary

Motivation and background

What is the Iron Rhine?

The Iron Rhine is a railway line connecting the port of Antwerp with the German Ruhr area. In 1998, Belgium asked the Netherlands to reactivate the Iron Rhine. The argumentation for this was the expansion of freight transport from the port of Antwerp to the German Ruhr area. The current route to Germany, the Montzen route, is up to 50 km longer than the Iron Rhine for some destinations and contains some slopes which make it difficult to drive heavy trains.

In this study we consider the social costs and benefits of the reactivation of the Iron Rhine rail connection. We consider two possible routings for the Iron Rhine: the historical line and, as an alternative, the A52 line. The figure below shows both lines and the Montzen line. We also consider the alternative without electrification (so only accessible for diesel locs) and with electrification (so also accessible for electric locs).

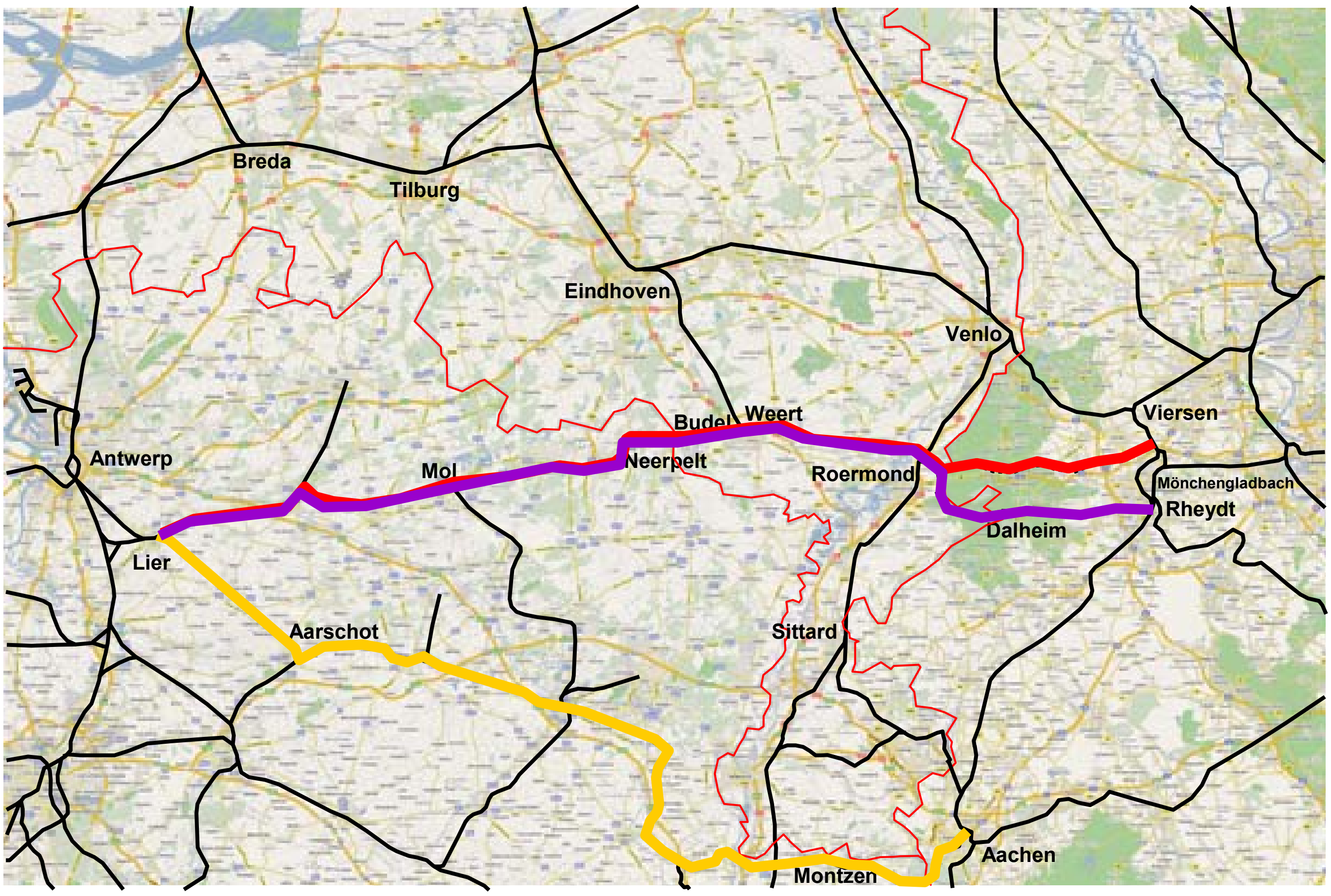
The reason for this study?

On 6 July 2006 the Belgian Secretary of State for Public Enterprise and the Dutch Minister of Transport, Public Works and Water Management decided to authorize different studies on the reactivation of the Iron Rhine. One of these studies is this social cost-benefit analysis (SCBA).

What is a social cost-benefit analysis?

In a SCBA the social costs and benefits connected to a project are inventoried in a systematic way. The word 'social' indicates that the costs and benefits are being analysed and valued from the viewpoint of society as a whole. Not only financial-economic effects are being analysed, but also other items which have a value for society, such as environment, mobility and safety.

Figure 1: Project alternatives for the Iron Rhine: historic route (purple) and A52 variant (red). The Montzen route is indicated in yellow.



Economic scenarios

In a social cost-benefit analysis a comparison is made between the reference alternative and a project alternative. This comparison is made for two economic background scenarios (2A and 2B). Both scenarios assume the same economic growth (2.3% until 2020 and 2.0 % for the period 2020-2030), but differ in the executed transport policy. In 2B we assume an additional tax for all transport modes and improvements in the costs and travel times for rail transport.

Reference alternative and project alternative

The reference alternative in this analysis is the expected future situation without reactivation of the Iron Rhine. We do assume that all foreseen investments, for example the Liefkenshoek train tunnel and the second rail link to the port of Antwerp are executed. In the reference alternative all train transport from the port of Antwerp towards Germany predominantly uses the existing Montzen route. The Montzen route is a double track route, fully electrified since the end of 2008. In the reference scenario, one extra investment is foreseen on the Montzen route, a grade separated junction in Aarschot. Apart from this, there are no capacity restraints on the Montzenroute.

There are four project alternatives in this study. The table below gives an overview of all project alternatives.

Table 1: Overview of the alternatives studied

	Reference alternative	Iron Rhine historical route diesel	Iron Rhine via A52 diesel	Iron Rhine historical route electrified	Iron Rhine via A52 electrified
Background scenario 2A	X	X	X	X	X
Background scenario 2B	X	X			

The project alternatives differ with respect to their route (see also the figure above) and in the foreseen traction (diesel versus electric). In order to make the comparison as easy as possible, we assume that all Iron Rhine variants are ready to use in 2015.

The project alternative '**Historical Iron Rhine**' is the alternative that was chosen in September 2001 by the Ministries of Transport of Belgium, the Netherlands and Germany and was confirmed in the International Arbitration. This alternative consists of the modernised historical trajectory of the Iron Rhine from Antwerp via Lier, Mol and Neerpelt to the Belgian-Dutch border. From the border near Budel, the route passes via Weert and Roermond towards the German border near Vlodrop. Only in Roermond there is a deviation from the historical trajectory (that went straight trough the city), on the demand of the Netherlands. The new track deviates at the north-west of Roermond and then bends via a new track, joining the existing motorway A73-South, around the South-East of Roermond. After that the new track reconnects to the historical trajectory, which subsequently, again at the request of the Netherlands, enters a 6 km long tunnel under the natural area 'De Meinweg'. In Germany, the historical trajectory is followed, via Dalheim, Wegberg and Mönchengladbach-Rheindahlen until Rheydt.

In the project alternative **'Iron Rhine - A52 variant'** nothing changes to the situation in Belgium, but it does in the Netherlands and in Germany. The idea is to follow the motorways N280 and A52 with a new railway track between Roermond and Mönchengladbach. This requires an investment in new single track between Roermond and Mönchengladbach for about 7 km in the Netherlands and about 28 km double track in Germany. The total track length of this variant is shorter than the historical line and it does not cross the national park "De Meinweg". On the other hand, it does cross protection areas near both sides of the Dutch-German border.

The Iron Rhine is foreseen as a diesel line and is only partly electrified. We also investigated two variants in which the Lines are completely electrified.

For all alternatives we assume a maximum capacity of 72 trains per day – both directions taken together, as stated in the advice of the COD (*Commissie van Onafhankelijke Deskundigen/Commission of Independent Experts*) of June, 8 2007.

The effects of the reactivation of the Iron Rhine

<u>What are the effects on transport of the Iron Rhine?</u>

The reactivation of the Iron Rhine has consequences for rail- and road transport and for inland waterways. For freight traffic we distinguish four effects:

Firstly, the reactivation of the Iron Rhine increases total **rail transport** via the Iron Rhine and the Montzen route between Belgium and Germany from 14.3 to 15.5 million tonne in 2030 in the alternative "Historical Iron Rhine" and to 17.2 million tonne in the alternative "Iron Rhine via A52". This increase in rail transport varying between 1.2 and 2.9 million tonne on the Iron Rhine and the Montzen originates for the larges part from other rail lines (between 0.97 and 2.63 million tonne); the remainder comes from other transport modes: 0.15 till 0.25 million tonne comes from road transport.

In both trajectory alternatives the majority of the rail transport prefers the Iron Rhine over the Montzen route because for most transport the Iron Rhine is cheaper because it is shorter and allows for heavier trains. Note that none of the alternatives of the Iron Rhine generate a lot of additional rail traffic, but rather attracts existing rail traffic from the Montzen Line. The table below summarizes the effects for rail traffic in 2030.

Table 2: Total freight transport via the Iron Rhine and the Montzen route per scenario (in million tonne), 2030

Measured on the rail track Budel-Weert (Iron Rhine) and Montzen-Aachen (Montzen route). B=Belgium, G=Germany.

	2005	2030 2A					2030 2B	
		No IR	Hist. IR	Electr. hist. IJR	IR via A52	Electr. IR via A52	No IR	Hist. IR
B-G Iron Rhine			5.3	6.1	6.2	6.9		1.9
G-B Iron Rhine			4.0	4.9	5.2	5.8		0.5
Total Iron Rhine			9.3	11.0	11.4	12.7		2.5
B-G Montzenroute	4.4	7.6	2.8	2.1	2.7	2.0	8.3	6.9
G-B Montzenroute	3.8	6.8	3.4	2.4	3.1	2.5	7.5	7.4
Total Montzenroute	8.2	14.3	6.2	4.5	5.8	4.5	15.7	14.3
Total both lines	8.2	14.3	15.5	15.5	17.2	17.2	15.7	16.7
Index both lines	100	172	190	190	209	210	191	204
Additional rail traffic wrt situation without IR	-	-	1.2	1.2	2.9	2.9	-	1.0
* Other rail lines	-	-	0.97	0.90	2.63	2.53	-	0.995
* Road transport	-	-	0.15	0.20	0.18	0.25	-	0.003
* Inland Waterways	-	-	0.08	0.10	0.09	0.12	-	0.002

Secondly, the additional pricing of road freight transport and the effects of the liberalisation of the railways (as assumed in background scenario 2B) does not generate large effects for rail transport: scenario 2B does not lead to much more rail transport than scenario 2A.

Thirdly, the type of traction (diesel versus electric) only has a limited influence on the expected transport on the Iron Rhine: 9.3 million tonne on the historical line with diesel traction versus 11.0 million tonne on the historical line with electric traction (in 2030). The rail transport on the Montzen route decreases with the same amount which balances out to an equal amount of rail transport on the corridor in spite of the electrification of the Iron Rhine.

Fourthly, the reactivation of the Iron Rhine does not result in a big change in the composition of transport. In other words, **the Iron Rhine mainly attracks rail transport from other rail routes, and only a limited amount from road or inland waterways.**

The effect on **road transport** is limited: in 2030 the number of trucks decreases with about 0.44 up to 1.09 million truck-km in Belgium, which is less than 0.01 % of the total road transport in Belgium (11 000 million truck-km in 2030). The number of trucks decreases with 0.20 up to 0.28 in the Netherlands and with 2.01 up to 5.59 in Germany (figures depend on the chosen alternative).

Inland waterways decrease with 0.27 up to 0.67 million tonne-km in Belgium, with 1.08 up to 1.48 in the Netherlands and with 2.93 up to 8.15 in Germany (figures for 2030). Notice that for the Netherlands the effect on inland waterways is larger than for the road. The effect in Germany is the largest for road as for inland waterway transport because the distances are larger.

The effects on **passenger transport** are minimal. They are minimal for rail because the Iron Rhine is not meant for passenger transport and because the interference between freight transport with passenger trains is limited. The effects for car transport are minimal because the effect on congestion is small, and this is because the effects for road freight are minimal.

What are the benefits and the costs?

The reactivation of the Iron Rhine leads to

- effects on the freight rail market
- effects for society with respect to environment, noise, accidents, etc. by the construction and the use of the Iron Rhine
- effects on passenger rail transport
- effects on road transport
- effects on inland waterways
- effects for the government
- effects on other markets

Furthermore the following assumptions are made for this cost-benefit analysis

- the costs and benefits are calculated for the period 2015-2030. From 2030 onwards all flows are assumed constant over time.
- two different discount rates are used to compare future costs and benefits with the investment cost: 4 % (Belgian approach) and 2,5-4-5,5 % depending on the type of costs or benefits (Dutch approach)
- the costs and benefits are assigned to Belgium, the Netherlands, Germany and other countries based on area (not based on who should pay).

With respect to the **effects on the freight rail market** we distinguish the effect for the consumer, the operator and the infrastructure manager. For the consumer transport between Antwerp and Germany becomes cheaper because of the shorter distance. This generates a benefit for the consumer in each project alternative. The benefit is larger if the line is electrified as transport is than cheaper and it is also larger for the A52 route as this is shorter than the historical line.

In a perfect competitive market there is no profit for the operator.

The infrastructure manager has less revenue on the historical track from the infrastructure fee as the Iron Rhine is shorter and the infrastructure fee is a fee per train-km. The increase in total rail transport is not large enough to compensate for the difference in distance. On the other hand, there is also an effect on the maintenance and replacement costs. These costs depends on the volume; they decrease on the Montzen route and increase on the Iron Rhine. In general, the effect of the maintenance of an additional rail track dominates and hence costs increase, especially on the maintenance of the tunnel under the "Meinweg" in the Netherlands. The A52 track has less maintenance costs.

By the construction and the use of the Iron Rhine itself there are also **effects for society** with respect to emissions, noise, accidents, recreation, vibration, living environment, landscape, ecology, soil and water and agriculture. As rail transport increases, emissions from rail transport increase and hence create a cost. For noise there is a benefit as in the project alternatives with the Iron Rhine noise screens are foreseen which makes that noise decreases with respect to the reference alternative. For accidents (on crossings) there is a benefit, despite the increase in rail transport, as in the project alternative some level crossings are replaced by grade separated junctions and hence become safer. The effect on recreation is negative as there is a loss in recreation possibilities and as ecology gets disturbed. Vibrations (as a consequence of rail transport) depend on the transport volume. Hence, vibrations decrease along the Montzen Route and increase along the Iron Rhine. The total effect depends on the number of trains on both routes. The effects on landscape, living environment and agriculture are either very small or zero. Ecology is only negative in Belgium as Belgium has – for the moment – no nature compensation plan. For soil and water we foresee a benefit as before the construction of the new tracks for the Iron Rhine the soil will be sanitized.

The **effect for rail passengers** is small, but negative. For part of the Iron Rhine track is shared with passenger transport. The additional freight trains due to the reactivation of the Iron Rhine cause additional delays in passenger transport with an average of half a minute per train.

For **road transport** we distinguish the effects for road users and the effects for society. Because the reactivation of the Iron Rhine leads to less trucks on the road, there is less congestion and hence a benefit for the road users. Moreover, because of the reactivation of the Iron Rhine some level crossings are rebuilt into grade separated junctions which create a time gain for road transport. Because there are less trucks, emissions, noise, accidents and road damage decrease. This is a small benefit for the society.

Also for **inland waterways** we make a distinction between the effects for the shippers and the effects for society. Because of the decrease in inland shipping there is a decrease in emissions and hence a small benefit for society.

The **government** loses tax revenue and pays for the investment costs. The efficiency loss that occurs because the investment costs are paid with taxes on labour, the so-called *"marginal costs of public funds"*, is not calculated.

The possible **effects on other markets** such as for the port of Antwerp and Rotterdam are only taken up pro memoria.

The table on the next page shows as an example the result for the cost-benefit analysis for the project alternative "Iron Rhine – historical route" using a discount rate of 4%. The reactivation of the Iron Rhine – historical line leads to a net social loss for the three countries together of 461.70 million euro (net present value). If a discount rate of 2.5-4-5.5% is used, the net loss decreases to 510.52 million euro. This is because with a higher discount rate the investment costs in the near future decrease and this is more important than the decrease of the benefits further in the future.

Sensitivity analysis

Four sensitivity analyses are conducted:

- A sensitivity analysis, in which the rail track is operational 5 years later, shows that the exact starting date does not alter the main conclusions; the net loss does decrease.
- A sensitivity analysis in which the emissions are allocated in a different way results in a larger net loss for the Netherlands, Belgium and Germany. These are the costs which were allocated before to other countries, this is the countries in which the air quality also decreases because of the reactivation of the Iron Rhine.
- A sensitivity analysis with higher external costs for emissions leads to a larger net loss.
- A sensitivity analyses with a higher transport volume decreases the net present value of the project. This paradoxal result is due to the very high environmental costs on the Iron Rhine, which is limited to diesel traction: when the transport volumes rise, the increasing environmental costs will offset the transport benefits.

Conclusions

The 5 project alternatives for the Iron Rhine (historical route, A52 route, diesel, electrified, background scenario) all lead to negative benefits (so net costs) for the society: for Belgium, The Netherlands, Germany and the other countries together. The net present value of the costs to society varies from 335 to 530 million euro. For this, an investment of 440 to 680 million is need by the 3 countries, which is the net present value of an investment of about 590 to 750 million euro.

The major reason why the project performs so poorly is that it mainly substitutes rail traffic on the existing Montzen route that has not yet reached its capacity limits. The user cost advantage of switching between the two lines is limited and there is only a small reduction of congestion on the road. These small benefits can never compensate the large investment cost. Even if the growth of rail traffic from Antwerp to Germany is much stronger than expected by the models, the benefits are too small to compensate the large investment cost.

If one wants to take on the project anyway, society's losses are minimized when the start of the project is delayed, when one electrifies the whole Iron Rhine and when one selects the A52 route. Note that the estimate of the investment costs (480 million €) for this variant is based on the IVV study, while DB Netz estimates the investment costs amounting to about 500 up to 900 million €.

Table 3: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2007}$, discount rate 4%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	94.21	48.40	0.00	32.83	12.98
Direct effect on infrastructure manager	Infrastructure fee	-6.85	-19.92	20.62	-7.56	NA
	Costs renewal	-15.90	0.00	-15.90	NA	NA
	Costs maintenance	31.29	91.34	-60.05	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-138.20	-19.28	-10.48	-39.00	-69.44
	Noise	24.79	8.12	3.29	13.39	NA
	Accidents	16.94	11.75	3.83	1.36	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-5.63	-0.41	-3.14	-2.08	0.00
	Vibrations	0.12	0.65	-0.77	0.24	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.48	-3.48	0.00	0.00	0.00
	Soil and water	3.00	0.00	3.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-7.12	PM	-7.12	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	18.73	4.40	2.35	11.98	NA
	Time at crossings	12.71	7.46	4.40	0.86	NA
	Taxes paid	-8.71	-0.98	-0.58	-7.15	NA
Effect on society	Emissions	2.89	0.37	0.22	1.51	0.81
	Noise	1.67	0.21	0.34	1.12	NA
	Accidents	1.80	0.58	0.18	1.04	NA
	Wear & tear	2.11	0.30	0.13	1.68	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.07	-0.01	0.00	-0.06	0.00
Effect on society	Emissions	0.48	0.03	0.06	0.22	0.18
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**24.80**	**129.54**	**-59.64**	**10.39**	**-55.48**
Effects on the government						
Direct effect	Investment costs	-486.51	-0.90	-391.04	-94.56	0.00
TOTAL		**-461.70**	**128.63**	**-450.69**	**-84.17**	**-55.48**

An overview of the results of all variants can be found in the following table.

Table 4: Overview of the results of all variants, NPV for 2007, million euro$_{2007}$

Alternative	Discount rate	Total	In Belgium	In the Nether-lands	In Germany	In other countries
Historical Iron Rhine– 2A	4%	-461.70	128.63	-450.69	-84.17	-55.48
	2.5-4-5.5%	-510.52	118.31	-497.42	-96.28	-35.13
Historical Iron Rhine – 2B	4%	-432.78	92.86	-428.80	-78.75	-18.08
	2.5-4-5.5%	-492.02	89.36	-476.15	-92.98	-12.26
Electrified historical Iron Rhine – 2A	4%	-404.88	125.04	-497.07	-53.81	20.96
	2.5-4-5.5%	-530.88	95.40	-551.78	-88.16	13.66
Iron Rhine via A52 – 2A	4%	-440.23	144.17	-204.16	-325.02	-55.23
	2.5-4-5.5%	-503.64	128.81	-229.13	-369.19	-34.13
Electrified Iron Rhine via A52 – 2A	4%	-335.93	144.78	-235.46	-281.39	36.15
	2.5-4-5.5%	-486.05	107.03	-267.10	-350.53	24.55
Sensitivity analysis on Iron Rhine Difference with Historical Iron Rhine – 2A	**Discount rate**	**Total**	**In Belgium**	**In the Nether-lands**	**In Germany**	**In other countries**
Higher external costs for emissions	4%	-241.14	-33.90	-18.36	-65.63	-123.26
	2.5-4-5.5%	-154.02	-21.50	-11.77	-41.90	-78.85
Different allocation of emissions to countries	4%	-20.98	-30.81	-38.28	-20.35	68.46
	2.5-4-5.5%	-13.41	-19.58	-24.67	-12.97	43.82
Starting date of 2020 instead of 2015	4%	125.92	-9.08	115.38	14.27	5.35
	2.5-4-5.5%	115.95	-9.78	111.42	9.73	4.58
Higher transport volumes (20%)	4%	-3.98	13.60	-7.74	1.25	-11.10
	2.5-4-5.5%	-3.83	10.24	-7.68	0.64	-7.03

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Figure 36: Railway network around Aarschot [289]

I Introduction

I.1. Background

Belgium wants to reactivate the Iron Rhine, which has been out of service since 1991. The Iron Rhine is the rail-link between Antwerp (Belgium) and Duisburg (Germany), via Weert and Roermond in The Netherlands.

In 1998, Belgium asked The Netherlands to reopen the Iron Rhine. The main reason was the foreseen expansion of freight transport from the Antwerp port to the German Ruhr area. Since Belgium and The Netherlands did not come to an agreement about e.g. the total cost, the division of the costs and the risks, they finally decided to bring this conflict in 2002 to the Permanent Court of Arbitration (PCA) in Den Haag. The PCA published its decision in May 2005.

On 6 July 2006 the Belgian Secretary of State for Public Enterprise and the Dutch Minister (Transport, Public Works and Water Management) reached an agreement on the further works and activities on development of the reactivation of the Iron Rhine. They also established a Commission of Independent Experts (*Commissie van Onafhankelijke Deskundigen - COD*) to supervise those activities, and to make an advice, based on the result of those activities, on the division of the costs between Belgium and The Netherlands. One element of that agreement was the order to make new actual freight traffic forecasts, and this social cost benefit analysis (SCBA), in which we compare a reference alternative with project alternatives.

During the course of the study, a steering group has been established. The steering group consisted of representatives from FOD Mobiliteit en Vervoer (BE, chaiman), Ministerie van Verkeer en Waterstaat (NL, co-chairman), Bundesministerium für Verkehr, Bau und Stadtentwicklung (DE), two members of the COD, ProRail (NL), Infrabel (BE), DB Netz (DE), and the consultants.

I.2. Scope of the study

In a SCBA, the development with a project is compared with the so-called reference alternative – this is the development without the project. In this SCBA the reference alternative is the situation without reactivation of the Iron Rhine.

In the project alternative the Iron Rhine is in use again for freight transport. We consider four project alternatives. The first two differ in the route chosen for the reactivation and the third and fourth differ with respect to the possible choice of traction. We also consider 2 background scenarios, which describe the economic and transport policy background.

The table below gives an overview of the studied variants, as they were decided by the steering group on 5 June 2008.

Table 5: Overview of studied variants

	Zero alternative	Historical Iron Rhine	Iron Rhine via A52	Electrified historical Iron Rhine	Electrified Iron Rhine via A52
Background scenario 2A	x	x	x	x	x
Background scenario 2B	x	x			

I.2.1. The reference alternative

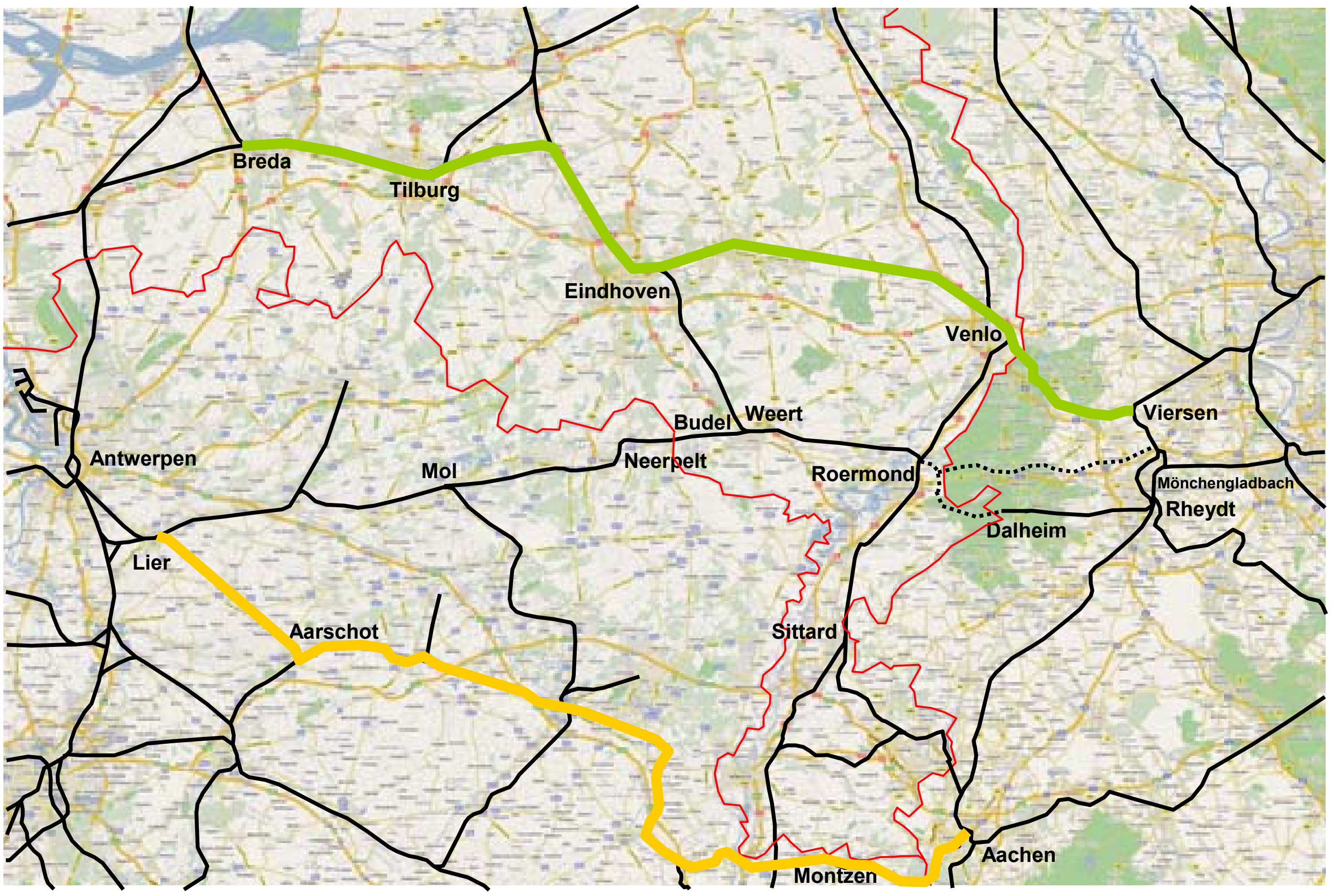
The reference alternative in this analysis is the expected future situation without reactivation of the Iron Rhine. In this situation, the traffic from Antwerp towards Germany will be predominantly using the existing Montzen route (yellow in the figure below). In The Netherlands, the track the closest to the Iron Rhine is the Brabant route (green).

The missing links in the Iron Rhine are indicated with dots – there are several alternative tracks possible.

The Montzen route is a double track route, which is fully electrified since the end of 2008. One extra investment in Aarschot, located on the Montzen route is foreseen in the reference scenario. This investment will not be needed when the Iron Rhine is operational. Apart from this, there are no capacity restraints on the Montzenroute.

Also, some investments are foreseen on the Iron Rhine track in both Belgium and The Netherlands, even without reactivation of the Iron Rhine for freight transport. Examples are e.g. the building of some noise screens and the removal of a level crossing, both needed due to the passenger transport traffic on parts of the Iron Rhine

Figure 2: Track of the and Montzen route (yellow) and Brabant route (green)
The dotted lines indicate the possible new or renewed tracks that are included in the different project variants.



In our analysis, we assumed that the planned railway projects below will be realised by the time the Iron Rhine will be build. For the Netherlands, these are the project included in the MIT plan, for Belgium this is the "*meerjaren investeringsplan 2001-2012*"[1]. The most relevant project for the Iron Rhine are:

- Betuweroute (The Netherlands)
- Sloelijn (The Netherlands)
- Liefkenshoekspoortunnel (Belgium)
- Tweede Havenontsluiting Antwerpen (Belgium)

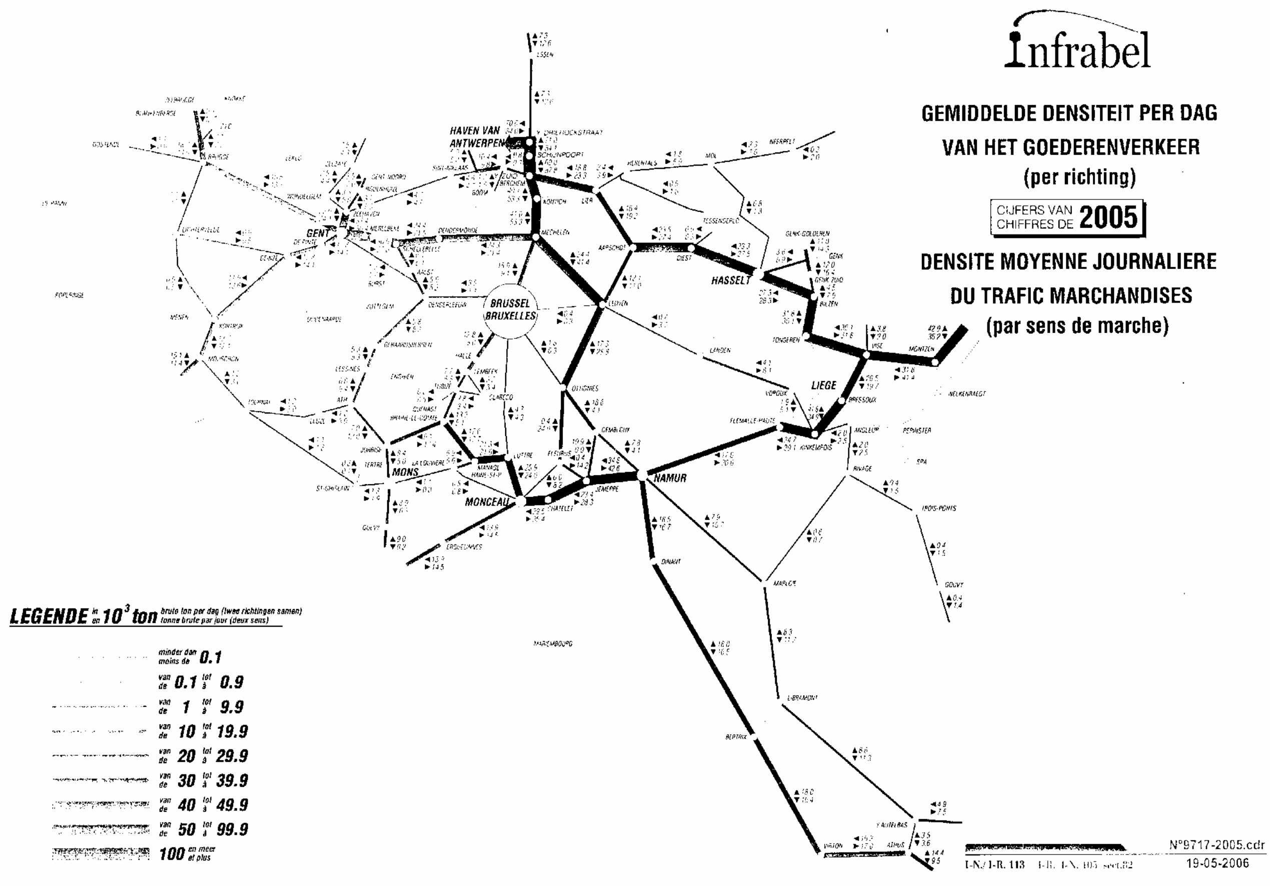
We assume that the connection Roosendaal-Antwerpen ("VERA" or "Lijn 11") and the Sloeboog will not be build.

The Montzen route is the international freight track in Belgium that has the largest amount of traffic: daily 120 trains, yearly loaded with 8.2 million tons of goods. About 40% of the traffic is related to the Ports of Antwerp or Zeebrugge. In Germany, 20% of the Montzen trains heads to the North, 80% to the South.

The figure below gives an idea of the freight transport by rail in Belgium.

[1] Published in the Staatsblad of 26 March 2002, actualised for 2004-2007 in the contract with Infrabel (Staatsblad of 22 September 2005) and for 2005-2007 in the annex to the contract (Staatsblad of 29 November 2006).

Figure 3: Freight rail network and tonnes of goods loaded per section in Belgium in 2005
Source: Infrabel



I.2.2. Project alternative 1: Historical Iron Rhine

This paragraph describes the variant "historical Iron Rhine"[2].

I.2.2.1. Trajectory

The Iron Rhine is the historic railway line that runs from the Antwerp area to the Ruhrgebiet in Germany. Total length of this line is about 141 km (Lier to Rheydt). Total length from Antwerp to Duisburg is about 214 km. In Belgium the line runs from Antwerp via Lier, Herentals, Geel, Mol, Lommel, Neerpelt on to the border community of Hamont. The length of this line amounts to approximately 96 km in Belgium (72 km for the part Lier-border). After crossing the Belgian/Dutch border, the line continues through the South of The Netherlands. There are different project alternatives for the routing in The Netherlands according to the "Comparative cross-border study on the Iron Rhine (2001)".

The first project alternative is the alternative that in September 2001 was chosen by the Ministers of Transport of Belgium, The Netherlands and Germany and was confirmed in the international arbitrage.

[2] Though we name this "historical Iron Rhine", the routing diverts somewhat from the ancient Iron Rhine: there is a diversion around Roermond and the building of the Meinweg tunnel.

This alternative consists of the modernised historical trajectory from Lier in Belgium via Weert and Roermond in The Netherlands and via Dalheim to Rheydt in Germany.

In **Belgium**, the existing track Antwerp – Lier – Budel is used. This is a double electrified track up to Herentals, double non-electrified track up to Mol, and from then on a single non-electrified track toward the Belgian-Dutch border in Budel. The part up to Neerpelt is also used as a passenger transport line (1 train per hour per direction), plus freight-trains to the zinc-factory in Budel (NL) (1 train every day in both directions).

The **Dutch part** of the trajectory will be modernised in conformity with "variant A3-plus" that was examined in the Trajectnota/MER[3] of 2001. Variant A3-plus consists of the historical trajectory of the Iron Rhine from the Belgian border near Budel to the German border near Dalheim, via Weert, Roermond and the Meinweg area.

The track between Budel and Weert is a single non-electrified track, recently renewed. At the moment no freight trains travel here. No passenger transport exists.

The part between Weert and Roermond is an electrified, double track, which is also used by passenger transport (30 minute frequency per direction).

At Roermond there is a planned deviation from the historical trajectory to the North of Roermond and the track then continues around Roermond via a new trajectory, bundled with the existing A73-South, to the south-east of Roermond. After that, the A3-variant reconnects to the historical trajectory, passing via a tunnel through the nature area Meinweg. The line then crosses the Dutch-German border near Dalheim. The part between the Roermond area and Germany is a single track. The total length of the Dutch part is about 48 km.

The renewed Iron Rhine will have a capacity of 72 trains/days both directions together (ProRail and Infrabel, 2007). See Annex T: Advice 2007 "Commissie Onafhankelijke Deskundigen IJzeren Rijn" on page 298 for more details.

From the border onwards the line continues in **Germany,** amounting to about 21 km, via Dalheim on to Rheydt (part of the city Mönchengladbach) where the line joins the German railway network to Duisburg. According to DB Netz, it is unrealistic to consider a single track for Iron Rhine in Germany. Double tracks (or partial double tracks) are needed to handle 72 freight-trains/day (sum of both directions) with a good operational service level in combination with the existing passenger service (1 train per hour per direction). So, rail lines in Germany are two-track lines that have a capacity of 288 trains/day.

[3] TCE, Transport Consultants and Engineers (Witteveen+Bos/DE-Consult) (2001): *"Trajectnota/MER IJzeren Rijn Hoofdrapport deel B: Achtergronden"*

Figure 4 shows the routing of this historical trajectory of the Iron Rhine in purple and the Montzenroute in yellow.

Figure 4: Track of the project alternative "historical Iron Rhine" (purple)
The dotted lines indicate the possible new or renewed tracks that are included in the different project variants.

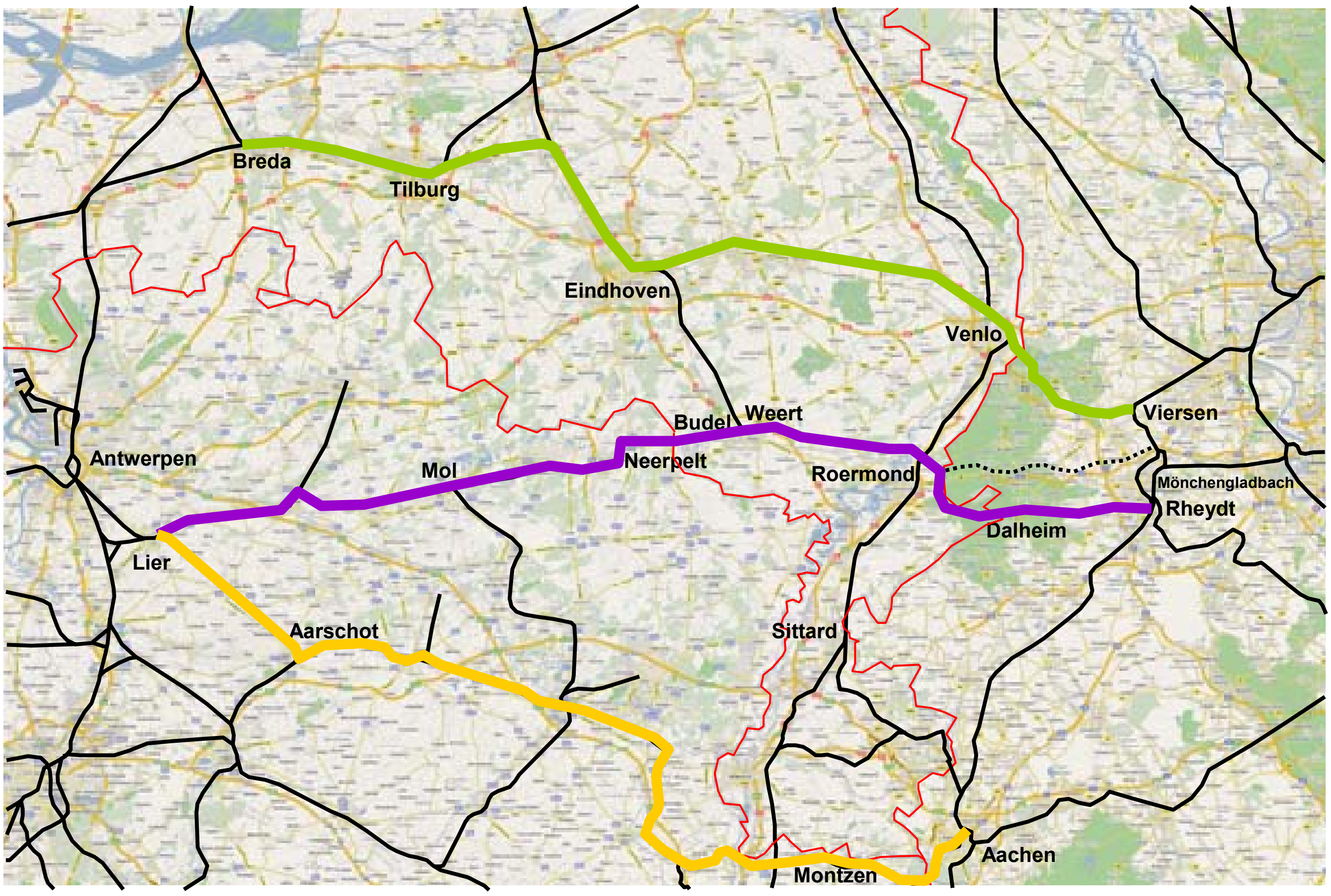


Figure 5 and Table 6 show some geographical, technical and operational properties of the historical trajectory of the Iron Rhine.

Figure 5: Historical track of the Iron Rhine; properties of the track

Source: Comparative Cross-Border Study on the Ion Rhine (2001)

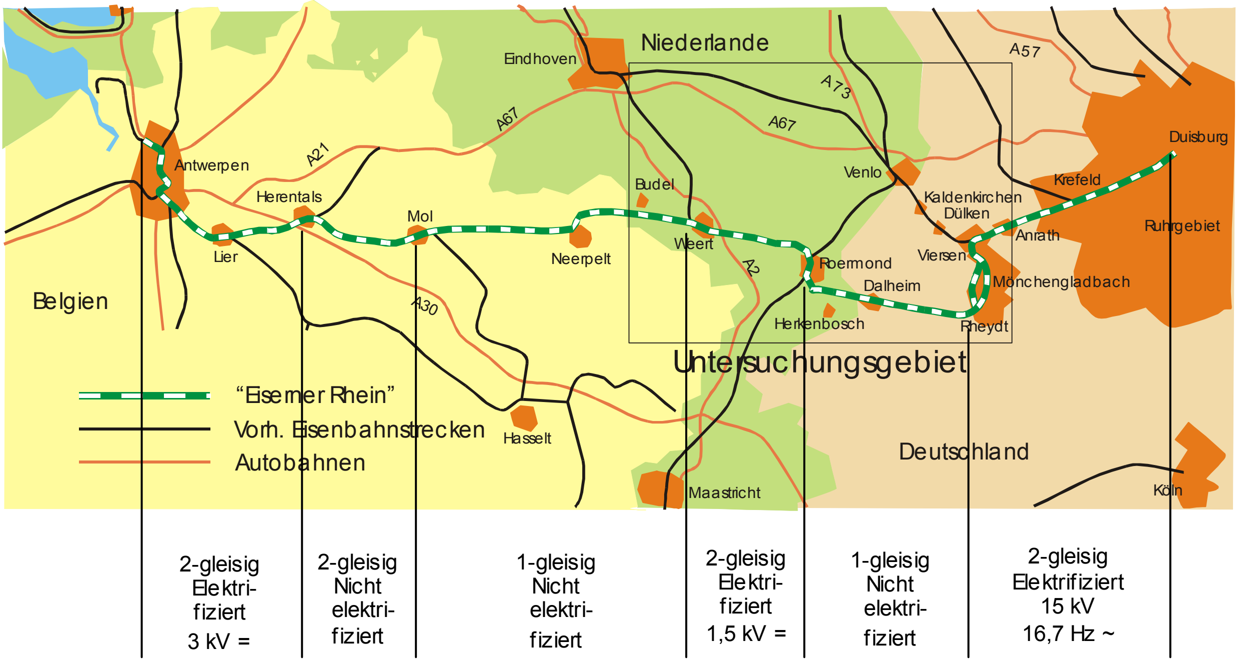


Table 6: Technical and operational properties of the historical track of the Iron Rhine

Source: Comparative Cross-Border Study on the Ion Rhine (2001)

Section	**Length (km)**	**Number of tracks**	**Electrified (E) or not (nE)**
Belgium			
Lier - Herentals	18	2	E (3 kV =)
Herentals - Mol	20	2	nE
Mol - Neerpelt	24	1	nE
Neerpelt - Budel	10	1	nE
The Netherlands			
Budel - Weert	12	1	nE
Weert - Roermond	20	2	E (1,5 kV =)
Roermond - Dalheim	16	1	nE
Germany			
Dalheim - Rheydt Gbf	21	1	nE
TOTAL per country			
Belgium	72	34 km - 1 track; 38 km - 2 tracks	E: 18 km; nE: 54 km
The Netherlands	48	28 km - 1 track; 20 km - 2 tracks	E: 20 km; nE: 28 km
Germany	21	21 km - 1 track	nE: 21 km

I.2.2.2. Start exploitation Iron Rhine

For practical reasons the steering group has chosen to work with a starting date of **2015** in the basic SCBA, and to investigate the effects of a starting date in **2020** in a sensitivity analysis.

This practical choice means in no way to express any idea of the more or less probability of any starting date. For the starting date, the Dutch and Belgian authorities have different opinions. The steering group was unable to agree upon the planning and therefore could not conclude anything on the probability of the starting dates.

In September 2006, an overall planning for the Dutch part of the project was established giving 2 possible starting dates for the exploitation of the Iron Rhine in The Netherlands: 2015 or 2018, both with different risk levels. The probability of each starting date could at that moment, preceding to the start of the actualisation studies, not be established.

In May 2008, the Dutch rail manager ProRail stated that, according to recent insights in the decision-process (including the judicial process), the starting date of 2015 is not realistic. ProRail is by Dutch law (management concession) uniquely appointed to execute the preparation and building process of any rail-line in The Netherlands.

I.2.3. Project alternative 2: Iron Rhine via A52

An alternative for the historical line is the so-called A52 variant. The situation in **Belgium** does not change in this variant but it does in The Netherlands and in Germany. The idea is to follow the motorways N280 and A52 between Roermond and Mönchengladbach. This requires an investment in new single railway track between Roermond and Mönchengladbach for about 7 km in **The Netherlands** (along the existing N280) and about 28 km of double track in Germany (along the existing BAB 52).

In **Germany**, the A52 variant attaches north of Mönchengladbach to the Viersen-Rheydt link. In this SCBA we assume that both northbound and southbound connection curves are foreseen. According to DB Netz, it is unrealistic to consider a single track for a new constructed line of Iron Rhine in Germany. The German side will not invest in a new line with a low capacity (i.e. of 72 trains per day); so if a new line shall be constructed, it will be a two-track electrified line of high capacity in Germany.

The total track length is shorter than the historical line and it does not cross the national park "De Meinweg". On the other hand, it does cross protection areas near both sides of the Dutch - German border.

The Iron Rhine via A52 will compete with the Montzen route, similar to the historical line, but also has the possibility to compete with the Brabant route.

In order to facilitate the comparison with the historical line, we also assume that this line will be in use in 2015 (and 2020 in a sensitivity analysis).

Figure 6: Track of the project alternative "Iron Rhine via A52" (red)

The dotted lines indicate the possible new or renewed tracks that are included in the different project variants.

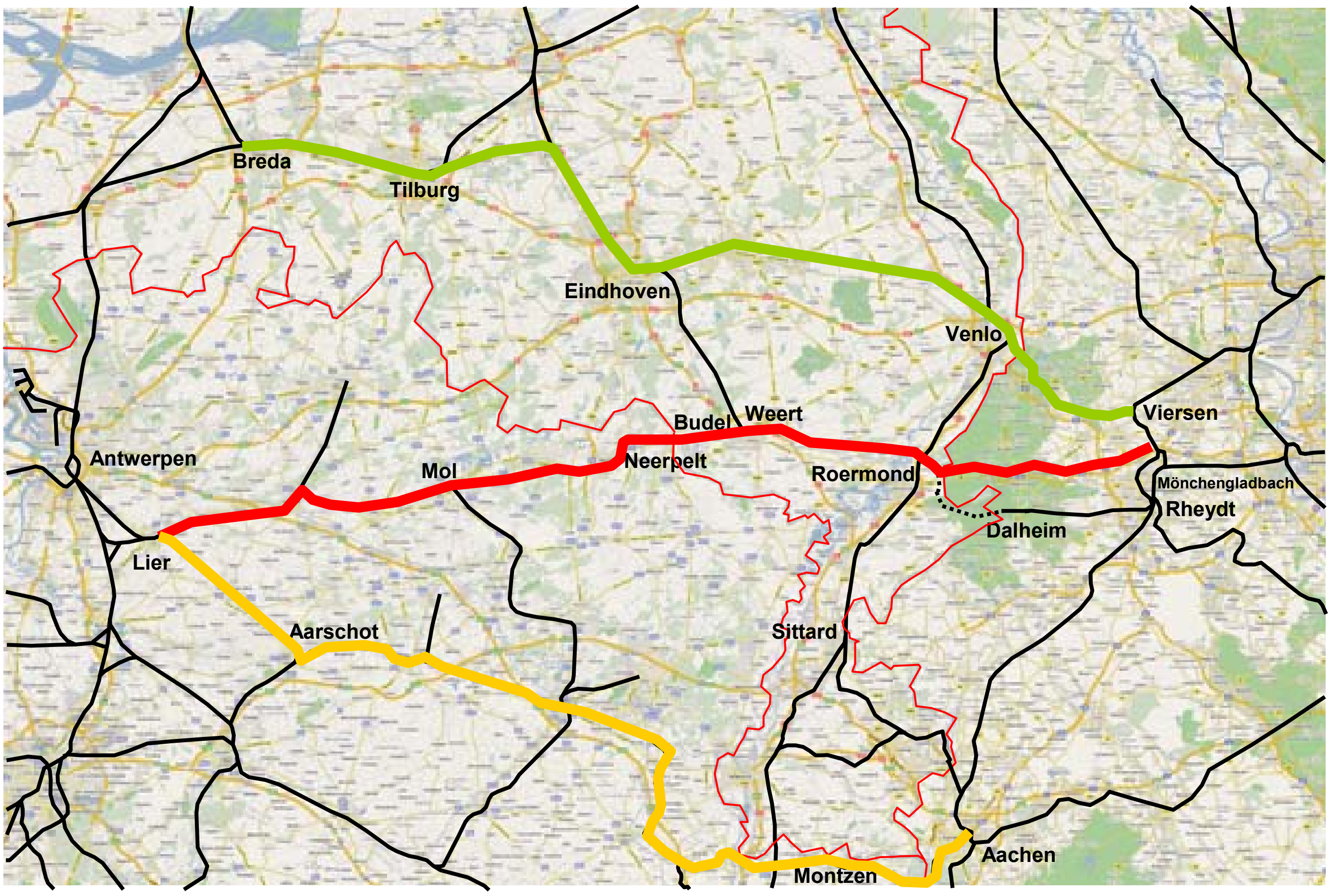


Figure 7 shows a detail of both the historical line in black and the A52 variant in red.

Figure 7: Iron Rhine: historical line versus A52 variant
Source: Eiserner Rhein, Eisenbahnverbindung zwischen Antwerp und Nordrhein-Westfalen. Trassenvergleich: A40 Variante, Historische Trasse, A52 Variante. http://www.mbv.nrw.de

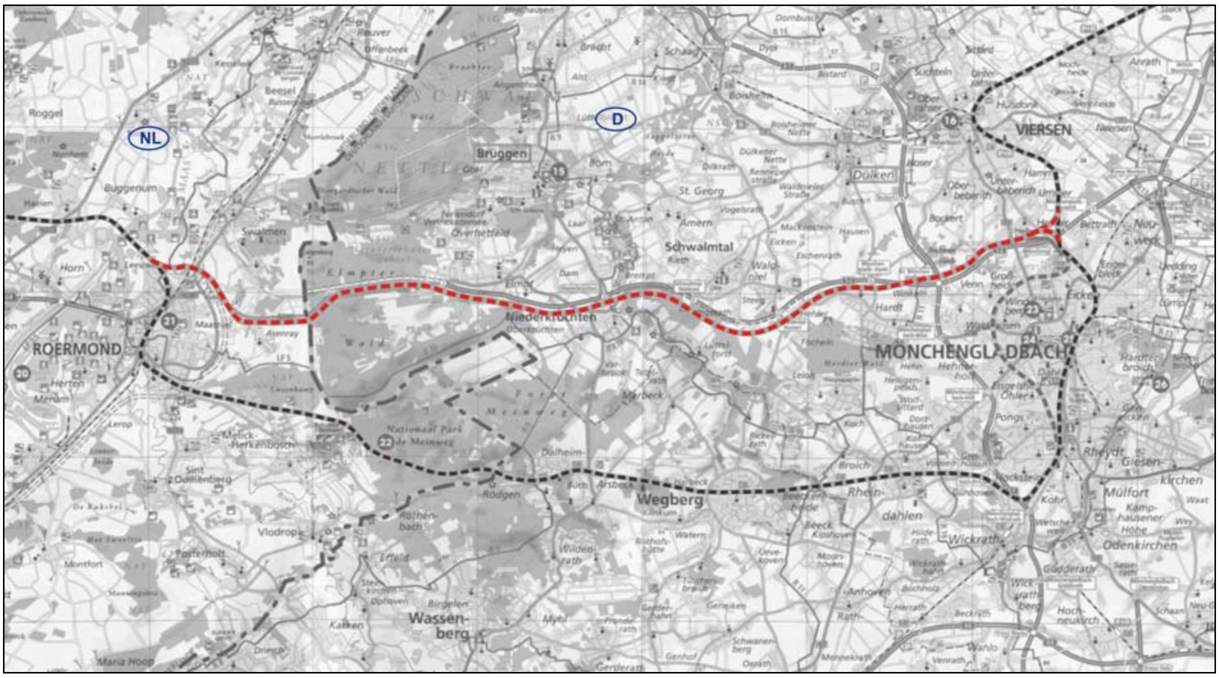


Table 7: Technical and operational properties of the A52-variant of the Iron Rhine
Note: Sections from Lier to Roermond are the same as in the historical trajectory

Section	Length (km)	Number of tracks	Electrified (E) or not (nE)
Belgium			
Lier - Herentals	18	2	E (3 kV =)
Herentals - Mol	20	2	nE
Mol - Neerpelt	24	1	nE
Neerpelt - Budel	10	1	nE
The Netherlands			
Budel - Weert	12	1	nE
Weert - Roermond	20	2	E (1,5 kV =)
Roermond - DE/NL border	6	1	nE
Germany			
DE/NL border - connection to Viersen-Mönchengladbach line	28	2	nE
TOTAL per country			
Belgium	72	34 km - 1 track; 38 km - 2 tracks	E: 18 km; nE: 54 km
The Netherlands	38	18 km - 1 track; 20 km - 2 tracks	E: 20 km; nE: 18 km
Germany	28	28 km - 2 track	E: 28 km

I.2.4. Project alternative 3: Electrified historical Iron Rhine

This is the same as alternative 1, but now with a full electrified route between Antwerp and Germany. Therefore some 95 km of railway (see Table 6 on page 61 must be electrified, and 2 "neutral zones" have to be build, allowing the electric locs to switch to another voltage.

In Belgium, some 54 km (Herentals – Budel) need to be electrified. In The Netherlands this is the part Budel – Weert and Roermond – Dalheim (28 km). In Germany, the track to electrify is 21 km long.

I.2.5. Project alternative 4: Electrified Iron Rhine via A52

This is the same as alternative 2, but now with a full electrified route between Antwerp and Germany. Therefore some 66 km of existing railway (54 km in Belgium, 12 km in The Netherlands, see Table 7 on page 64) plus about 35 km of new railway (approximately from Roermond to the Viersen-Mönchengladbach line) must be electrified, and 2 "neutral zone's" have to be build, allowing the electric locs to switch to another voltage.

I.2.6. Overview

In the table below, an overview of all 4 variants can be found.

Table 8: Technical and operational properties of all variants of the Iron Rhine

Historical Iron Rhine				
Section	**Length (km)**	**Tracks (#)**	**Non electrified (nE)**	**Electrified (E)**
Belgium				
Lier - Herentals	18	2	E (3 kV =)	E (3 kV =)
Herentals - Mol	20	2	nE	E (3 kV =)
Mol - Neerpelt	24	1	nE	E (3 kV =)
Neerpelt - Budel	10	1	nE	E (3 kV =)
The Netherlands				
Budel - Weert	12	1	nE	E (1.5 kV =)
Weert - Roermond	20	2	E (1.5 kV =)	E (1.5 kV =)
Roermond - Dalheim	16	1	nE	E (1.5 kV =) E (15 kV ≈)
Germany				
Dalheim - Rheydt Gbf	21	1	nE	E (15 kV ≈)
TOTAL per country				
Belgium	72	1: 34 km 2: 38 km	E: 18 km nE: 54 km	E: 72 km
The Netherlands	48	1: 28 km 2: 20 km	E: 20 km nE: 28 km	E: 48 km
Germany	21	1: 21 km	nE: 21 km	E: 21 km
INVESTMENT costs per country (million €$_{2007}$) Net values taking into account avoided investments in the reference scenario				
Belgium			-46	-6
The Netherlands			514	563.3
Germany			120	150

Iron Rhine via A52				
Section	**Length (km)**	**Tracks (#)**	**Non electrified (nE)**	**Electrified (E)**
Belgium				
Lier - Herentals	18	2	E (3 kV =)	E (3 kV =)
Herentals - Mol	20	2	nE	E (3 kV =)
Mol - Neerpelt	24	1	nE	E (3 kV =)
Neerpelt - Budel	10	1	nE	E (3 kV =)
The Netherlands				
Budel - Weert	12	1	nE	E (1.5 kV =)
Weert - Roermond	20	2	E (1.5 kV =)	E (1.5 kV =)
Roermond - DE/NL border	6	1	nE	E (1.5 kV =) E (15 kV ≈)
Germany				
DE/NL border - connection to Viersen-Mönchengladbach line	28	2	nE	E (15 kV ≈)
TOTAL per country				
Belgium	72	1: 34 km 2: 38 km	E: 18 km nE: 54 km	E: 72 km
The Netherlands	38	1: 18 km 2: 20 km	E: 20 km nE: 18 km	E: 38 km
Germany	28	2: 28 km	E: 28 km	E: 28 km
INVESTMENT costs per country (million $€_{2007}$) Net values taking into account avoided investments in the reference scenario				
Belgium			-46	-6
The Netherlands			240	455
Germany			277	480

I.2.7. The background scenarios 2A and 2B

In order to make transport forecasts, certain assumptions have to be made about future developments. These include the following:

1. socio-economic developments
2. policy options (e.g. infrastructure and pricing)
3. autonomous developments in the transport market

In this part of the Iron Rhine project, 2 scenarios are selected out of the many variants that have been calculated in the preceding Iron Rhine traffic forecast study[4]. These 2 scenarios are based on a combination of an economic scenarios and a transport policy scenario.

- Scenario 2A: This scenario has a moderate economic growth and some moderate policy options derived from the European Commissions transport plans.
- Scenario 2B: This scenario also has a moderate economic growth. It has more extended transport policy options, wherein further effects of the liberalization of the rail market are foreseen in combination with a toll on the European motorways.

[4] "Vervoerprognoses IJzeren Rijn" by TML/TNO, May 2007, www.prorail.nl/Publiek/Infraprojecten/Limburg/IJzeren%20Rijn/Pages/Actualiseringfase.aspx

Both scenarios are also used by the EC in projects like TEN-STAC[5] and ASSESS[6].

In Table 9 below, a summary is given of the assumptions in the 2 scenarios.

A full description can be found in "Annex A: Background scenario" on page 178. In this annex also more specific information can be found on sources and assumption used.

Table 9: Overview assumptions in the two scenario's 2A and 2B

	Scenario 2A	**Scenario 2B**
Yearly growth GDP in % (EU25) between 2005 and 2020	2.3%	2.3%
Yearly growth GDP in % (EU25) between 2005 en 2030	2.0%	2.0%
Increase of road and rail capacity until 2020	All planned projects, including Liefkenshoek rail tunnel and second rail connexion to the port of Antwerp.	
Increased capacity for roads after 2020	Capacity growth = (Share of personal transport in passenger car units * yearly population growth) + (share of transport of goods in passenger car units * yearly growth in BPP).	
Increased capacity of rail after 2020	No new infrastructure, however there are no capacity problems.	
Rail Infrastructure charges	€ 3.30 / train-kilometre	
Internalisation of external costs (all modes) – for rail by means of usage compensa-tion, for road and internal waterways by means of a tax	German electronic toll (0.15 €/vehicle-km) applied to Europe.	Extra charge of 0.15 €/vehicle-km by 2030 for trucks, 0.01 €/tonne-km for rail by 2030, similar extra charges for cars, busses, inland ships and air transport
Far-reaching impact of track liberalisation – partially by means of usage compensa-tion	No	Decreased rail transport times by 19% and rail costs by 5%.

[5] TEN-STAC: Traffic Forecasts and Analyses of Corridors on the Trans-European transport Network has been done by NEA and has been used to improve the Trans-European transport Network (TEN), website: www.nea.nl/ten-stac.
[6] De Ceuster G. et al (2005), ASSESS Final Report, DG TREN, European Commission.

II Transport forecasts

II.1. Introduction

This part of the report details the methodology and the results for the freight transport forecasts. The objective of this method is to determine what will be the demand for freight transport by mode and by route with and without the Iron Rhine in 2020 and 2030.

Two background scenarios have been calculated. For both scenarios the economical scenario is the same and the difference is made by the policy assumptions. In the 2A scenario a moderate transportation policy is assumed where in 2B an extended transport policy is applied. The main additions in scenario 2B compared to 2A are the far-reaching liberalization of the rail market and the internalization of external costs.

For scenario 2A, 4 variants have been calculated: the historical Iron Rhine variant, the A52 variant and the electrification variants of both. For 2B, only the historical Iron Rhine variant has been taken into account.

The approach of the transport forecast is described in chapter II.2, followed by a more detailed description by section. The results of the forecast are shown in chapter II.3 (page 79).

Note that 2 previous studies have been performed to estimate the impact of the Iron Rhine on the transport volumes:

- "Vervoerprognoses IJzeren Rijn" by TML/TNO, May 2007
- "Vervoerprognoses IJzeren Rijn" by NEA/UA, April 2007

A comparison of this study with these ones can be found in "Annex I: Comparison of the TRANS-TOOLS results and the Port of Antwerp scenario" on page 229.

This forecasting exercise is a follow-up of the study on transport forecasts on the Iron Rhine, which was based on the Trans-Tools model and completed early summer 2007. After this study, it was concluded that the transport forecast should be fine-tuned on several points in order to make the SCBA more reliable.

The following topics were requested to be added to the previous forecasting exercise:

- The modal-split model.
- Further refinement of regional detail where necessary.
- The generalised cost approach for assignment of the common potential of the Iron Rhine and the Montzen route.
- Additional calculations with the container port choice model of the Dutch Central Planning Bureau (CPB).

II.2. Methodology

II.2.1. Approach of the transport forecast in broad lines

Figure 8 below presents the approach schematically.

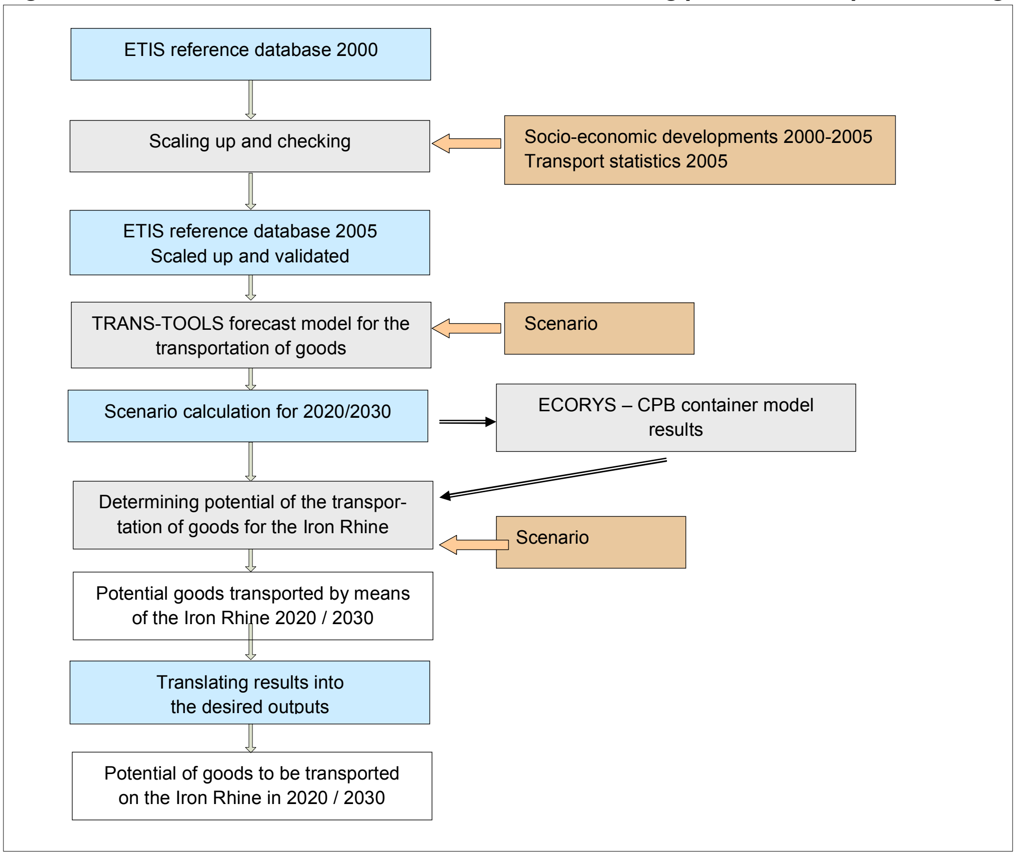
The ETIS[7] reference database of 2000 is used as starting point. In this database, the European transport flows of origin-destination (on a regional level) are given by transport mode and type of good for 2000. The transport flows have been brought up to date based on socio-economic developments in this period and checked against statistics of Belgian trade and transport up to 2005. This is necessary to take into consideration recent developments. The result from this step is an ETIS reference database with transport flows validated with data for 2005.

These data are used as input for the TRANS-TOOLS forecast model which is used to calculate the transport scenarios of future years. For each scenario, there are 2 horizon years: 2020 and 2030. The results of the TRANS-TOOLS model have been combined with the ECORYS-CPB container model results to have more precise results on port and modal choices for containers. The end results give a clear picture of the mode and route choices in the future years in the scenarios considered.

Finally, the results are translated into the desired outputs. The transport flows in tonnes are translated into a number of trains for the different routes. In this step also the amounts and types of transports of dangerous goods are determined.

[7] European Transport policy Information System

Figure 8: Schematic overview of the method of determining potential transportation of goods



In the following sections, these steps are described in more detail.

II.2.2. Current transport flows

The ETIS[8] reference database 2000 is used as a basis for the current transport flows. The construction of this database was ordered by DG TREN and has the advantage that all European transport studies use the same database. The ETIS reference database contains amongst others the European inter-regional flows of goods by transport means, type of good and other characteristics. Because the regional detail of European transport flows together with other transport characteristics, the ETIS reference database is very useful for a transport forecast for the Iron Rhine.

A disadvantage from this source is that the original data are from 2000. However, recent developments in the transport of goods since 2000 are taken into account by making an update of the ETIS reference database to the year 2005 based on available statistics.

Firstly, the ETIS reference database for the year 2000 is updated with the help of the TRANS-TOOLS trade model to the year 2005 on the basis of the socio-economic developments between 2000 and 2005. Following this, the updated ETIS database is compared with recent available statistics for the year 2005 from NMBS (Belgian National Railway Company) and the ETIS database is brought in line with the data from this data source. The result of this is a validated ETIS database for the year 2005 with data and in-

[8] European Transport policy Information System

formation on the European transport of goods. Herein, the actual development of the transport of goods is taken into consideration. This database is used as input for the forecast model.

II.2.3. TRANS-TOOLS forecast model

The transport flow of goods for the current situation and the scenarios form the input for the forecast model. The TRANS-TOOLS[9] forecast model is used in order to make the forecast of freight transport. In the TRANS-TOOLS model, sub-models have been developed for not only the transport of goods but also for passenger transport in Europe. In TRANS-TOOLS, the ETIS reference database is used as a starting point, which is also used in this study. In this study, three sub-models of the TRANS-TOOLS forecast model will be used: the trade model, the modal split model and the assignment model. These models are exhaustively described in the TRANS-TOOLS reports[10] and amendments. In the following section, a summary is given as to the functioning of the model.

II.2.3.1. The freight trade model

In the freight trade model, the freight flows of the base year (2005) are extended to a future year (2020, 2030) by using a two step procedure. First the economic activity by sector in each region is increased from the base year (2005) to the level of the future year (2020 or 2030). Next the trade flows in the future year are simulated by taking into account the initial trade matrix (2005) and the increase in economic activity in the origin and destination regions. Moreover, the trade flows are adjusted, using an econometric production-attraction model. For each origin-destination pair a growth factor is determined based on the economical development of the respective relevant sectors for the two individual regions. This growth factor is then applied on the base year flow between these regions. For each type of goods (NSTR[11] designations) there is a separate model. Since the model has different elasticities for different commodity types it allows to take on board a more than proportional increase in trade for some commodities compared to growth in economic activity due to increasing specialisation, decreasing importance of national borders etc. The resulting freight flows are presented in tonnes.

II.2.3.2. The modal split model

The modal split module of TRANS-TOOLS starts with the observed modal split for the base year for every category of good and every pair of regions. Next the influence of level of service (prices, speed) is estimated using statistical relations that have been estimated on observed data. Changes in the level of service are the result of autonomous developments in the transport market, infrastructural developments (new infrastructure or improvement in the infrastructure) and policy decisions (e.g. the introduction of tolls).The modal split equations are different for every category of goods and for every segment of freight transport. The segmentation is in function of the total distance, the value of the goods and the required speed.

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[9] TOOLS for transport forecasting and scenario testing

[10] D6 TRANS-TOOLS final report, D3 TRANS-TOOLS Report on model specification and calibration results

[11] The goods classification for transport statistics NST came into use in 1961 by the European Commission. The NST codes were modified in 1962 and 1967. The classification has since been called NSTR (Nomenclature uniforme des merchandises pour les Statistiques de Transport. Revisée). The hierarchical structure of the NSTR divides the 176 headings of the classification into 10 chapters and 52 main groups. The goods are classified as far as possible on the basis of their nature, processing stage, methods of transportation and total tonnages transported.

The result of this first step includes data about the annual transport between regions by transport mode, commodity type and load characteristics expressed in weight of the goods (tonnes) and this for each scenario of transport policy and for each infrastructure scenario.

II.2.3.3. The general assignment model

In the TRANS-TOOLS model, assignment models are available for each mode. The freight flows that have been made in the previous steps at the NUTS 2 level are split up and assigned to the NUTS3 level by respect of the GDP in the respective regions. Furthermore, one additional region (Heinsberg in Germany) is also split up into a northern part and a southern part given that not only the Iron Rhine but also the Montzen crosses these regions in a West-East direction. This split up is done on a 50-50 basis for the tonnes related to this NUTS 3 region. For each region, an access point is selected. The access points are determined on basis of a combination of centrality within the region and, where relevant, the connection to port flows.

Rail transport is assigned in an all-or-nothing manner. A more advanced method is not possible with this model given that the available information on the networks is limited and there is no information available on the services of the network.

In the different scenarios, we make a separation between a situation with the Iron Rhine and a situation without an Iron Rhine. In order to do this, separate networks are made for the forecast year. Each of these networks is used as input for the rail assignment mode. In the future networks, other planned infrastructure projects are also taken into account. The different situation are detailed with maps in "Annex B: Rail routes" on page 187 for both the Iron Rhine and the Montzen route. The assignments are done without taking into account restrictions of the available capacity.

Within the assignment model, border resistances are used in order to assign a realistic flow and to let it to connect with the measured situation as accurately as possible in 2005. When rail flows in the forecast year are assigned in the scenario with a reactivation of the Iron Rhine, there is a situation created in which the Iron Rhine crosses two borders while the Montzen route only crosses one. Without further changes this situation makes the Montzen route relatively attractive. It is not realistic to assume that in reality the border resistance for the Iron Rhine is twice as big as for the Montzen route. The organizational aspect that forms a part of the border resistance is not a problem given that in this scenario, the Iron Rhine is reactivated and therefore the organisational aspect is already taken care of. However it can not be expected that in the future there will be one single European time schedule for all train movements. This implies that there will remain different time schedules per country each of which will have its delays and priorities. As a result it has been concluded that in principle the Iron Rhine and the Montzen have similar border resistances but the Iron Rhine will still cross one more country which could still lead to additional time consumption due to the fact that the additional time-schedule could lead to additional waiting times and delays. For this reason an additional 20 minutes border resistance has been left to the Iron Rhine.

II.2.4. The generalized cost method for determining the potential on the Iron Rhine

After having performed the calculations with the TRANS-TOOLS model the potential of the Iron Rhine and the Montzenroute as determined by the assignment model are combined to one common potential for both routes. This was necessary since it was shown that the sensitivity of the assignment to minor changes was very large. This meant that a small change to the costs and border resistances as mentioned before resulted in large shifts between the two routes. It was decided that a generalised cost method was needed to split-up the common potential into a potential for the Iron Rhine and a potential for the Montzen route.

A sample calculation of the method described below can be found in "B.3. Calculation of the generalised costs for different routes" on page 193.

II.2.4.1. Assumption applied

The following assumptions have been used to compute the generalized costs on the two different routes:

- The Iron Rhine will not be electrified in the project alternatives "historical Iron Rhine" and "Iron Rhine via A52", and it will be electrified in the electrification scenarios. The Montzen route is electrified in all scenarios.
- The average speed of rail transport on both routes is equal to 70 kilometres per hour.
- Trains passing the Iron Rhine with a diesel loc can change to an electric loc in Duisburg if this is cheaper according to the generalized costs calculation (see Annex B: Rail routes). Changing a train from a diesel loc to an electric loc takes 30 minutes.
- Trains via the Iron Rhine in southern direction turn at Neuss. Trains via the Montzen in southern direction turn at Aachen. Turning takes 30 minutes and while turning also a change from diesel loc to electric loc can take place at the same time.
- For heavy trains on the Montzen route additional traction is needed to get the trains up-hill. For this purpose the following rules have been applied:
  - Under 1230 tonnes no additional traction is needed.
  - 1230 - 1600 tonnes in the direction Belgium- Germany, no additional traction needed.
  - Above 1600 tonnes in the direction Belgium – Germany, an additional pushing loc over 45 km (from Visé) needed, so double costs for 45 km.
  - Above 1230 tonnes in the direction Germany – Belgium, an extra pushing loc is needed between Aachen and the border (it will not couple with the train while pushing it upwards), so double costs on 5 km.
  - Empty trains are under 1230 tonnes.
- The costs for the first and last km will be assumed to be 30 minutes for electric locs, because the first and last km of a railway-route is almost never electrified, so change to a diesel loc is necessary.

II.2.4.2. The cost for the infrastructure manager and the train operator

In Table 10 the costs of rail transport used are listed for the different policy options and forecasting horizon. In "Annex C: Composition of costs of rail operators" (page 197) and "Annex D: Cost model for energy costs of diesel and electricity" (page 200), a detailed description is given of the different components included. In the process followed the cost components are reviewed by major market players and their comments are incorporated.

The fee that the infrastructure-manager receives contains the wear and tear costs of the network (not the infrastructure investment costs) and has - by assumption - been harmonised at 3.30 €$_{2005}$ per train kilometre for all trains in all countries (see also "Annex A: Background scenario", page 181).

The cost of the train operator depends on the type of traction and on the type of goods transported. The table below gives the main elements.

Table 10: Costs of rail transport

	container		general cargo		wet bulk		dry bulk	
	diesel	**electric**	**diesel**	**electric**	**diesel**	**electric**	**diesel**	**electric**
Average fixed costs (€$_{2005}$/h)	178.56	179.82	144.26	145.52	146.06	147.32	151.76	153.02
Average variable costs (€$_{2005}$/train-km)								
For 2020 and 2030 in scenario A	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
For 2020 in scenario B	8.40	8.40	7.71	7.71	9.71	9.71	10.21	10.21
For 2030 in scenario B	13.09	13.09	11.71	11.71	15.71	15.71	16.71	16.71
Average variable costs (€$_{2005}$/train-km)								
For 2020 in scenario A and B	3.85	2.31	2.60	1.63	2.91	1.93	4.69	3.75
For 2030 in scenario A and B	4.53	2.53	3.07	1.78	3.43	2.10	5.52	4.10

The details for the computation of the average fixed costs and the average variable costs can be found in "Annex C: Composition of costs of rail operators. The computation of the average energy costs can be found in "Annex D: Cost model for energy costs of diesel and electricity".

II.2.4.3. Value of time by commodity group

In the table below, the value of time by commodity group as used in the generalized cost method is listed. The source of this information is the study "*Directe Transporteffecten Kanaal Gent-Terneuzen*"[12].

Table 11: Value of time by NSTR commodity group

NSTR	Value of time (€$_{2005}$/tonne/hour)
0 – agricultural products	0.0119
1 – foodstuffs	0.0124
2 – solid mineral fuels	0.0011
3 – crude oil	0.0065
4 – ores / metal waste	0.0062
5 – metal products	0.0086
6 – building materials	0.0009
7 – fertilisers	0.0047
8 – chemical products	0.0281
9 – other products	0.1350
10 – petroleum products	0.0071

[12] Directe transporteffecten Kanaal Gent-Terneuzen, TNO, 2008.

II.2.4.4. Speed

With respect to the speed on the Montzen line and the Iron Rhine, different numbers, from different sources, are in use. This is shown in the table below.

Table 12: Overview of the speed (km/h) on Iron Rhine and Montzen line

Source	Montzen line	Iron Rhine
Infrabel (17/10/2007)	70.99	68.88
Speeds used in this SCBA	**70**	**70**
Speed in first traffic forecasts	50	52
B-Cargo	60	44 (stops included)
Port of Antwerp	NA	Time gain of 1 hour on the Iron Rhine compared to the Montzen line

For the calculations, we have used the same speed of 70 km/h for the trains on both routes. The value of 70 km/h originates from the average speed on the Montzen line, which is assumed to be 70 km/h (agreed by the steering group) after its electrification (foreseen before the end of 2008) and assuming no non-commercial stops. We assume that this speed is the same in the scenario with and without the reactivation of the Iron Rhine.

To validate these assumed speeds, Infrabel calculated the theoretical speeds for Belgium with the Infrabel program "TP". This program takes into account real infrastructure characteristics (speed limits, location of signals, etc.) and the characteristics of the trains (acceleration, breaking performance, etc.). For the Montzen line a 1200 tonne train with a maximum speed of 90 km/h, using electric traction is assumed. For the Iron Rhine a 1200 tonne train with a maximum speed of 90 km/h, diesel loc Class 66 is assumed. This gave a theoretical speed of 70.99 km/h on the Montzen line and 68.88 km/h on the Iron Rhine, which we rounded both to 70 km/h.

Given that the train characteristics do not change when crossing the borders, we assumed the same average speed of 70 km/h in The Netherlands and Germany.

II.2.4.5. Method

The generalized costs are calculated for the following possible alternatives for each of the different origin-destination pairs:

1. Via Iron Rhine (historical and A52 alternatives), the whole route diesel traction.
2. Via Iron Rhine, the whole route electric traction (only for the electrification scenarios).
3. Via Iron Rhine, diesel traction on the Belgium side and electric traction after the border in Germany (Neuss or Duisburg depending on required direction).
4. Via Montzen route, the whole route diesel traction.
5. Via Montzen route, the whole route electric traction.
6. Via Montzen route, diesel traction on the Belgium side and electric traction after the border in Germany (Aachen).

In these calculations all assumptions listed above are taken into account.

From the 5 or 6 (depending on electrification scenario Iron Rhine) alternatives, the one with the lowest generalized costs is selected.

II.2.5. Container model

In the TRANS-TOOLS modal-split model the transport flows are segmented by commodity group, for container transport no specific segment is distinguished. Furthermore in the TRANS-TOOLS model no sub-model is included for the port choice.

In order to be able to take into account the specific characteristics and the port choice of container flows, a market share model for container transport has been applied. The model used has been developed by ECORYS and CPB[13] for the study "*Verruiming van de vaarweg van de Schelde*"[14]. The main reasons for applying this model is to take into account the competition between ports and to quantify the resulting additional potential for the Iron Rhine. The additional rail transport that can be attracted has consequently also an impact on the modal-split in the hinterland of the Port of Antwerp.

The TRANS-TOOLS model determines the growth of container flows in a consistent way as for the other commodities where the ECORYS/CPB model determines the shift between ports and inland connecting modes simultaneously, but only for container transport. The results from this container model are used to determine how many tonnes and trains should be added to the combined transport flows in relation with especially the port of Antwerp.

When developing the CPB model a lot of work and time was used to determine the cost matrix and the data about the container flows between all hinterland regions and ports. Within this study it was not considered necessary to repeat this exercise. Therefore TNO has delivered to ECORYS the changes in generalised costs due to the reactivation of the Iron Rhine. This has been used by ECORYS as input to make changes to the already existing cost matrices. With this input ECORYS has run the model for the years 2020 and 2033 using data about the transport flows from the study "*Verruiming van de vaarweg van de Schelde*". The 2033 growth rates have been adjusted to the 2030 level.

The data about container flows in the container model is based on the years 1997 and 2002. This data has been based on data sources such as:

- Freight transport statistics.
- Transport Economic Model (TEM).
- Transhipment data for the ports of Rotterdam, Antwerp, Le Havre, Hamburg and Bremen.
- Modal-split data for the ports of Rotterdam, Antwerp, Le Havre, Hamburg and Bremen.
- Shares of containerised transport in the ports.
- For German regions volume in tonnes for the year 1997 per hinterland region, per port and per direction.
- For Antwerp data about hinterland flows from the Port of Antwerp (*Gemeentelijk Havenbedrijf Antwerp).*

[13] For more detailed information about this mode, see report "Ontwikkeling marktaandeelmodel containersector", Ecorys, 15 January 2004.
[14] For more information about this study, see report "Verruiming van de vaarweg van de Schelde", CPB, September 2004

All these sources have been used to construct per port the volumes of containerised transport by hinterland region and by hinterland mode. The volumes in tonnes have been translated into the volumes in TEU by applying tonne/TEU ratios (dependent on the port, these ratios vary between 9.5 – 11.5 tonnes per TEU).

Based on this data a logit model has been calibrated that predicts the market shares of the ports and the market shares of the modes in the hinterland transport. A detailed description of the model can be found in the report "*Ontwikkeling marktaandeelmodel containersector*", ECORYS, 15 January 2004.

Based on these results of the runs with the ECORYS/CPB container model, TNO has determined the relative changes in transport volumes of the container flows between ports and hinterland regions. These relative changes have been applied on the results of the TRANS-TOOLS model in order to combine the results of the TRANS-TOOLS model and the ECORYS/CPB container model. To avoid the inclusion of a double mode shift effect in the results – based on the mode shift in the TRANS-TOOLS model and based on the mode shift in the container model – a correction has been carried out. The final results include both the impact of the mode shift of the container model and the shift between ports of the container model.

More detail can be found in "Annex E: Container model" (page 203), including a description of the approach and the results of the ECORYS/CPB container model.

II.2.6. Translation of tonnes to trains

In order to translate the transported tonnes per year into the number of trains per year, the following guidelines given by Infrabel have been used.

Table 13: Average load per type of train (excl empty trains)

Type of load	Gross tonnage of loaded trains (tonnes/train)	Net tonnage of loaded trains (tonnes/train)	Days / year[15]	Net tonnage of loaden trains (tonnes/train/year)
ore	2 200	1 467.00	300	440 000
coal/bulk	1 800	1 200.00	300	360 000
automotive	800	533.33	250	133 333
chemical	1 800	1 200.00	250	300 000
metal	1 800	1 200.00	250	300 000
agro/food	1 800	1 200.00	250	300 000
combined	1 250	937.50	275	257 813

Note: Table 29 applies the same weights per train but for other commodity groupings (see Table 14 for conversions)

The net tonnage of laden trains shown above only includes the weight of the goods without the weight of train, pallets, containers, etc.

The following assumptions have been made:

1. Gross = 2/3 net + 1/3 extra
2. The exception to the first assumption is container transport. Here, the gross is ¾ net + ¼ extra
3. The number of empty trains is determined by looking at every load type that generates the full

[15] Based on agreement between ProRail and operators.

trains leaving and empty trains returning. This is done for every load type except for the combined transports. For this, it is assumed that the number of empty trains is the same as the difference between leaving and return. This difference is added to the direction with the lowest number of trains.

The type of goods in this table must be translated from the NSTR[16] categories. The table below shows how this is done.

Table 14: Types of loads by NSTR commodity group category

NSTR	Type of good
0 – agricultural products	50% agro/food – 50% combined
1 – foodstuffs	50% agro/food – 50% combined
2 – solid mineral fuels	coal/bulk
3 – crude oil	coal/bulk
4 – ores / metal waste	ore
5 – metal products	50% metal – 50% combined
6 – building materials	coal/bulk
7 – fertilisers	coal/bulk
8 – chemical products	50% chemical – 50% combined
9 – other products	partly automotive – partly combined
10 – petroleum products	coal/bulk

Spreading the NSTR categories into multiple types of loads is based on the detailed demarcation of goods in ETIS[17].

Empty containers are assumed not to generate additional trains; they will use the otherwise empty container trains or otherwise spare capacity on other modes.

[16] NSTR: Nomenclature uniforme des merchandises pour les Statistiques de Transport. Revisée. European system for classification of transported goods.
[17] European Transport policy Information System

II.3. Results on the Iron Rhine and Montzen routes

II.3.1. Introduction

In this section the results for the potential of the Iron Rhine and Montzen route are presented. These results have been obtained after applying the methodology describe before.
This is done by a presentation of the resulting tonnes transported and number of freight trains on the Montzen and the Iron Rhine. After this the different split ups of the potential are shown amongst which the expected transport flows of dangerous goods and number of trains per segment of the route.

The results of the intermediate steps in the methodology can be found in "Annex K: Results of individual modelling steps".

II.3.2. Results for the potential of the Iron Rhine and the Montzen route

II.3.2.1. Total freight flows

In the table below, the total freight flows via the Iron Rhine and the Montzen route are shown as calculated by the methodology. Details on the routes of the alternatives can be found in "Annex B: Rail routes". All results in these tables for the Iron Rhine are measured on the section between Budel and Weert since here the flows are pure Iron Rhine and are not mixed with other flows. For the Montzen route the results are measured between Montzen and the German border.

Table 15: Total freight flows via Iron Rhine and Montzenroute by scenario (in million tonnes), 2020
B-D: direction Belgium - Germany, D-B: direction Germany - Belgium
Measured on the section Budel-Weert (Iron Rhine) and Montzen-Aachen (Montzen). B=Belgium, D=Germany.

	2005	**2020 2A**					**2020 2B**	
		No IR	**Hist. IR**	**Electr. hist. IR**	**IR via A52**	**Electr. IR via A52**	**No IR**	**Hist. IR**
B-D Iron Rhine			5.3	5.4	6.0	6.3		2.6
D-B Iron Rhine			3.8	4.2	4.9	5.3		1.4
Total Iron Rhine			9.1	9.6	10.9	11.6		4.0
B-D Montzenroute	4.4	6.7	2.0	1.8	1.9	1.6	7.0	4.8
D-B Montzenroute	3.8	5.9	2.6	2.2	2.2	1.9	6.1	5.2
Total Montzenroute	8.2	12.5	4.5	4.0	4.1	3.5	13.1	9.9
Total both routes	8.2	12.5	13.6	13.6	15.0	15.0	13.1	14.0
Index both routes	100	153	166	166	183	183	160	171
Total B-D	4.4	6.7	7.2	7.2	7.9	7.9	7.0	7.4
Index B-D	100	152	164	164	179	179	159	168
Total D-B	3.8	5.9	6.4	6.4	7.1	7.1	6.1	6.6
Index D-B	100	155	167	168	188	188	161	174
Additional rail traffic compared to situation without Iron Rhine	-	-	0.98	0.91	2.39	2.33	-	0.90
* Other rail links	-	-	0.79	0.68	2.17	2.03	-	0.89
* Road transport	-	-	0.12	0.11	0.14	0.15	-	0.00
* Inland shipping	-	-	0.05	0.05	0.07	0.09	-	0.00

Table 16: Total freight flows via Iron Rhine and Montzenroute by scenario (in million tonnes), 2030
B-D: direction Belgium - Germany, D-B: direction Germany - Belgium
Measured on the section Budel-Weert (Iron Rhine) and Montzen-Aachen (Montzen). B=Belgium, D=Germany.

	2005	**2030 2A**					**2030 2B**	
		No IR	**Hist. IR**	**Electr. hist. IR**	**IR via A52**	**Electr. IR via A52**	**No IR**	**Hist. IR**
B-D Iron Rhine			5.3	6.1	6.2	6.9		1.9
D-B Iron Rhine			4.0	4.9	5.2	5.8		0.5
Total Iron Rhine			9.3	11.0	11.4	12.7		2.5
B-D Montzenroute	4.4	7.6	2.8	2.1	2.7	2.0	8.3	6.9
D-B Montzenroute	3.8	6.8	3.4	2.4	3.1	2.5	7.5	7.4
Total Montzenroute	8.2	14.3	6.2	4.5	5.8	4.5	15.7	14.3
Total both routes	8.2	14.3	15.5	15.5	17.2	17.2	15.7	16.7
Index both routes	100	175	189	190	209	210	191	204
Total B-D	4.4	7.6	8.1	8.2	8.9	8.9	8.3	8.8
Index B-D	100	172	185	186	202	203	189	200
Total D-B	3.8	6.8	7.3	7.4	8.3	8.3	7.5	8.0
Index D-B	100	179	193	194	218	219	197	211
Additional rail traffic compared to situation without Iron Rhine	-	-	1.2	1.2	2.9	2.9	-	1.0
* Other rail links	-	-	0.97	0.90	2.63	2.53	-	1.00
* Road transport	-	-	0.15	0.20	0.18	0.25	-	0.00
* Inland shipping	-	-	0.08	0.10	0.09	0.12	-	0.00

Historical Iron Rhine

In the table above, when the Iron Rhine is not activated (column "No IR" for 2A), the flow of goods on the Montzen route (line "total Montzen route") grows from 8.2 million tonnes in 2005 to 14.3 million in 2030 (sum of both directions). In the scenario "Historical Iron Rhine - 2A" (column "Hist. IR" for 2A), we see that in 2030 the total of the Montzen route (line "total Montzen route") decreases from 14.3 million tonnes to 6.2 million tonnes. This means that 8.1 million tonnes are shifted from the Montzen route to the Iron Rhine route and only 6.2 million tonnes are left on the Montzen route. Furthermore we see an additional 1.2 million tonne assigned to the Iron Rhine.

The share of rail transport does not significantly increase due to the addition of the Iron Rhine infrastructure (see "Annex K: Results of individual modelling steps" on page 253). So this additional 1.2 million tonnes can be attributed nearly completely to a shift of rail routes (introduced by assignment model and container model) to the Iron Rhine coming from other rail routes than the Montzen route. In 2030 there will be 9.3 million tonnes passing the Iron Rhine of which 8.2 million tonnes are coming from the Montzen route and 1.0 million tonnes from other rail routes, and a very small amount, circa 0.2 tonnes, from other modes.

An interesting result is that **the potential for the Iron Rhine (with diesel traction) is considerably lower under the 2B scenario than for the 2A scenario**. Typical for the 2B scenario compared to the 2A scenario is the further liberalisation of the railway market and the internalisation of external costs. Where the further liberalisation has a positive effect on the tonnes transported on the combined Iron Rhine, Montzen corridor (is positive for both routes) the internalisation of external costs makes that the Iron Rhine scores less well than the Montzen route in the non-electrification variants. In these variants the transport on the Iron Rhine goes entirely by diesel traction. Diesel has a significantly higher external cost[18] than electric traction which can be used on the Montzen route but not on the Iron Rhine in the base variant (so not-electrified variants). The costs for the internalisation of external impacts are therefore significantly higher for the (non-electrified) Iron Rhine than for the Montzen route. Furthermore the internalisation of external costs is implemented gradually so is less important in 2020 than in 2030, which results in an even lower potential for the Iron Rhine in 2030 than in 2020. This effect is especially so large because the generalised costs for the Iron Rhine or the Montzen route are in many cases very close to each other. Any relative difference in costs between the two routes therefore has a large impact.

In the study "*Vervoersprognoses IJzeren Rijn*" (TML/TNO May 2007), beside the scenarios 2A and 2B, also lower economical growth scenarios 1A and 1B and higher economical growth scenarios 3A and 3B have been calculated. To get an impression on the sensitivity of the results on these scenarios we refer to this study.

We see that **the electrification of the Iron Rhine** has a slightly higher potential as result than in the scenario without electrification. It should be noted in this context that the difference between the costs for diesel and electricity is getting larger the higher the oil prices are. At the moment of the calculation in this study we have use a crude oil price of 48$ per barrel in 2030, which was the most recent (2005) forecast of the European Commission (see "A.3. Crude oil price" on page 179). The forecasts of the American EIA (Energy Information Administration) were at the time 60$ in 2020 and 70$ in 2030. In the week of deliv-

[18] See "Annex C: Composition of costs of rail operators" section 0 on page 198.

ery of this report however the IEA (International Energy Agency) has changed their price assumptions to 100$ in 2015 and 120$ in 2030. Under these new oil price assumptions the effect of the electrification will be larger. Also, the reference scenario will be different, closer to the 2B tan to the 2A figures.

Iron Rhine via A52

Through the analysis of the tables per segment Budel – Weert, Weert – Roermond and Roermond – Germany and through further analysis, it was concluded that the A52 variant (as we have defined it with the curve to the south at the Mönchengladbach junction) is competing with the Brabant route. The distance is nearly the same, with a small advantage for the A52 variant. Furthermore the origin-destinations in the direction of South-East Germany, which is the target market for the Brabant route, can be reached just as easily with the A52 variant given the curve to the south.

The Brabant route is complementary to the Betuwe route that is designed for the more Northern part of Germany and more Eastern destinations. The Brabant route is expected to gradually "loose" some of the traditional flows to the Betuwe route.

It can be expected that these flows from The Netherlands and Rotterdam in particular, that would otherwise go along the Brabant route will now also be at least partly directed to the A52 variant. The exact share is hard to determine since the quality and distance is nearly identical. A generalized costs method as has been applied for the split between the Montzen route and the Iron Rhine will therefore not add much to the analysis.

We therefore made the assumption (in agreement with the steering group) that these flows will fully stay on the Brabantroute (via Venlo).

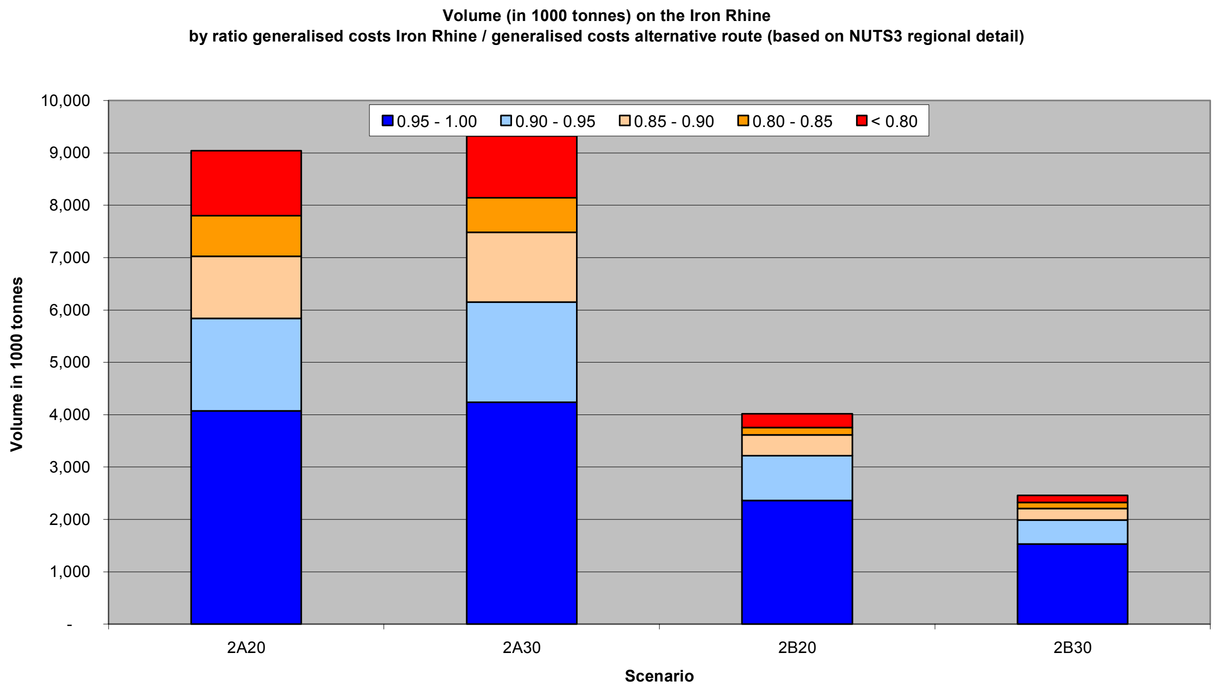
II.3.2.2. Reduction of generalised costs

In this paragraph an overview is presented of the reduction of the generalised costs that is due to the Iron Rhine. This is the driver in the allocation of rail traffic over the two parallel routes and will be an important component for the SCBA. The results are presented in the figure below.

For each origin/destination relation (on NUTS3 level) the following ratio is determined: generalised costs of the Iron Rhine route divided by the generalised costs on the alternative route that is used in the situation that the Iron Rhine is not reactivated. Then for these ratios five different classes have been determined. For clarification, a ratio of for instance 0.90 means that the generalised cost of the Iron Rhine route is 90% of the generalised cost of the alternative route that is taken in the situation that the Iron Rhine is not reactivated.

For the "Historical Iron Rhine - 2A" scenario in 2020, from the total volume of 9.4 million tonnes on the Iron Rhine, 4.1 million tonnes has a generalised cost ratio between 0.95-1.00 (maximum 5% lower generalised costs on the Iron Rhine), 1.8 million tonnes has a generalised cost ratio between 0.90-0.95 (5 to 10% lower generalised costs on the Iron Rhine), 1.2 million tonnes has a generalised cost ratio between 0.85-0.90 (10 to 15% lower generalised costs on the Iron Rhine), 0.8 million tonnes has a generalised cost ratio between 0.80-0.85 (15 to 20% lower generalised costs on the Iron Rhine) and 1.2 million tonnes has a generalised cost ratio between 0.75-0.80 (20 to 25% lower generalised costs on the Iron Rhine).

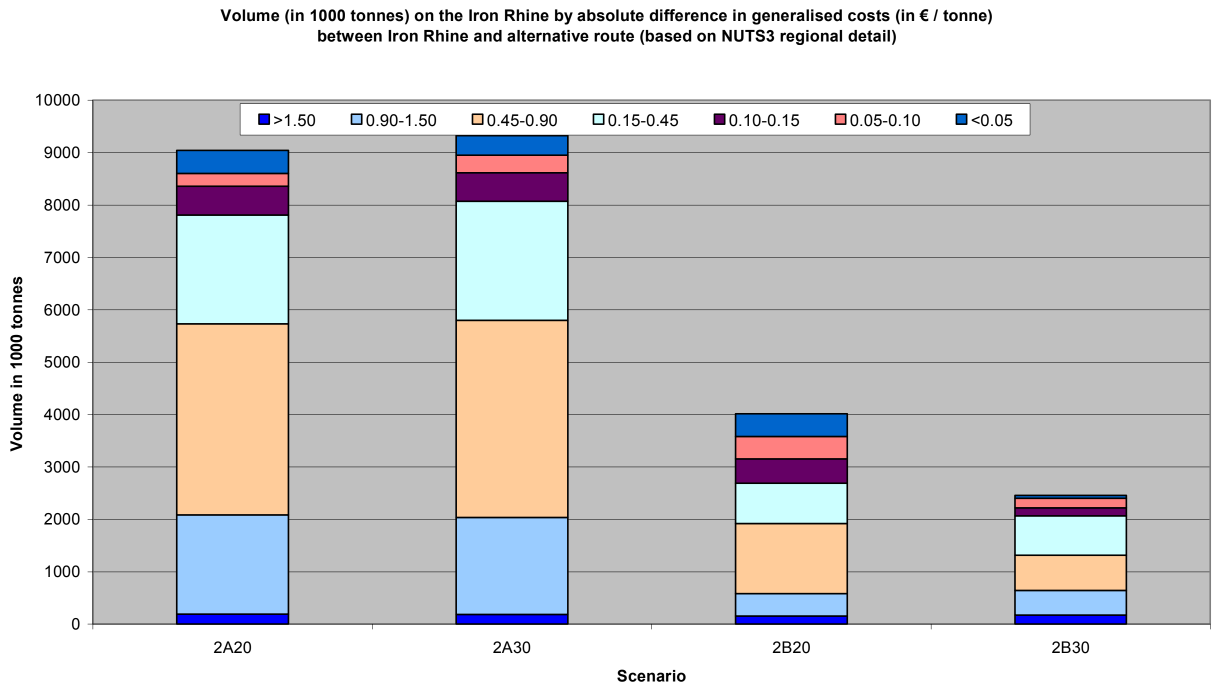
Figure 9: Volumes on the Iron Rhine by ratio generalised costs Iron Rhine / generalised costs alternative route



In the following the results are shown in absolute figures. In this figure the difference in generalised costs between the Iron Rhine and its alternative route in terms of € per tonne are shown. As can be seen again for the "Historical Iron Rhine - 2A" scenario in 2020 0.44 million tonnes are 0.05 €/tonne cheaper than the alternative, 0.25 million tonnes have a generalised cost difference of 0.05-0.10 €/tonne, 0.55 million tonnes have a generalised cost difference of 0.10-0.15 €/tonne, 2.07 million tonnes have a generalised cost difference of 0.15-0.45 €/tonne, 3.65 million tonnes have a generalised cost difference of 0.45-0.90 €/tonne, 1.89 million tonnes have a generalised cost difference of 0.90-1.50 €/tonne and 0.19 million tonnes have a generalised cost difference of more than 1.50 €/tonne.

So, mostly, there is a cost difference between the Iron Rhine and the Montzen route of 0.15-0.90 € per transport tonne. This is quite low, which means that the choice between Iron Rhine and Montzen route is a close call.

Figure 10: Volumes on the Iron Rhine by absolute difference in generalised costs (in € /tonne) between Iron Rhine and alternative route



II.3.2.3. Freight flows by type of goods

In the tables below, the total expected transport on respectively the Iron Rhine and the Montzen route is disaggregated by type of goods and by direction. In the two tables following the number of trains are shown in the same level of detail. Again all results in these tables for the Iron Rhine are measured on the section between Budel and Weert and for the Montzen route the results are measured between Montzen and the German border.

When looking at the "Historical Iron Rhine - 2A" results in 2020, we see that for the Iron Rhine transport of containers (4.3 million tonnes) has the largest share of total volume transported, followed by coal/bulk (1.3 million tonnes), metals (1.4 million tonnes) and chemicals (1.1 million tonnes). In total, there is more going from Belgium to Germany than in the other direction.

For the Montzen route in "Historical Iron Rhine - 2A", containers have also the largest share (1.6 million tonnes), followed by ores (1.0 million tonnes). In total there is more transport from Germany to Belgium than to the other side.

When looking at the other variants, we see that the relative share of the commodities remains the same but merely all commodities show an increase compared to the plain historical 2A scenario. The major difference for the A52 scenarios is the growth of container and chemical flows.

Between "Historical Iron Rhine - 2A" and "Historical Iron Rhine – 2B", we see that the major part of the difference comes from the container flows that are less present under the 2B scenario. The second largest difference can be found under the metal products. As can be expected for the Montzen we find the opposite effects.

Table 17: Transported weight Iron Rhine (million tonnes), by type of load and by direction, 2020
Measured on the section Budel-Weert. B=Belgium, D=Germany.

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
Ores	0	0	0	0	0.173	0.169	0.160	0.074	0.173	0.185	0.174	0.200	0.175	0.427
Coal/bulk	0	0	0	0	0.881	0.228	0.723	0.052	0.882	0.230	0.923	0.290	0.937	0.294
Cars	0	0	0	0	0.417	0.269	0.061	0.151	0.436	0.293	0.533	0.376	0.587	0.400
Chemicals	0	0	0	0	0.866	0.208	0.513	0.044	0.896	0.223	1.010	0.247	1.043	0.254
Metal	0	0	0	0	0.659	0.667	0.221	0.257	0.693	0.737	0.719	0.922	0.779	0.943
Agric/foodstuffs	0	0	0	0	0.090	0.161	0.050	0.057	0.092	0.163	0.099	0.175	0.102	0.180
Container	0	0	0	0	2.178	2.073	905	0.751	2.258	2.340	2.501	2.723	2.656	2.784
Total by direction	0	0	0	0	5.265	3.774	2.632	1.386	5.429	4.170	5.959	4.933	6.279	5.281
Both directions	**0**		**0**		**9.040**		**4.019**		**9.599**		**10.892**		**11.560**	

Table 18: Transported weight Iron Rhine (million tonnes), by type of load and by direction, 2030
Measured on the section Budel-Weert. B=Belgium, D=Germany.

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
Ores	0	0	0	0	0.176	0.151	0.125	0.067	0.177	0.181	0.184	0.161	0.185	0.189
Coal/bulk	0	0	0	0	0.896	0.210	0.402	0.042	0.897	0.228	0.974	0.265	0.979	0.286
Cars	0	0	0	0	0.379	0.271	0.041	0.047	0.507	0.351	0.528	0.340	0.667	0.444
Chemicals	0	0	0	0	0.913	0.214	0.450	0.017	1.085	0.255	1.116	0.247	1.202	0.273
Metal	0	0	0	0	0.653	0.806	0.144	0.108	0.741	0.894	0.711	1.094	0.824	1.150
Agric/foodstuffs	0	0	0	0	0.093	0.172	0.043	0.014	0.103	0.181	0.102	0.180	0.112	0.190
Container	0	0	0	0	2.233	2.153	0.705	0.255	2.577	2.839	2.592	2.915	2.934	3.316
Total by direction	0	0	0	0	5.343	3.978	1.909	0.549	6.087	4.930	6.208	5.202	6.902	5.848
Both directions	**0**		**0**		**9.321**		**2.459**		**11.017**		**11.410**		**12.750**	

Table 19: Transported weight Montzen route (million tonnes), by type of load and by direction, 2020
Measured on the section Montzen-Aachen. B=Belgium, D=Germany.

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
Ores	0.145	1.204	0.146	1.202	0.002	1.045	0.016	1.138	0.002	1.029	0.001	1.016	0	0.789
Coal/bulk	1.249	0.128	1.277	0.132	0.490	0.041	0.679	0.234	0.490	0.039	0.468	0.032	0.455	0.028
Cars	0.502	0.426	0.560	0.461	0.154	0.198	0.552	0.340	0.137	0.175	0.200	0.181	0.148	0.159
Chemicals	0.872	0.212	0.917	0.220	0.083	0.075	0.455	0.239	0.055	0.061	0.070	0.058	0.042	0.052
Metal	1.087	0.994	1.113	1.026	0.448	0.352	0.907	0.783	0.415	0.284	0.407	0.286	0.348	0.267
Agric/foodstuffs	0.091	0.150	0.094	0.155	0.010	0.009	0.051	0.106	0.008	0.008	0.010	0.012	0.008	0.009
Container	2.722	2.762	2.850	2.944	0.769	0.868	2.104	2.330	0.695	0.604	0.760	0.614	0.616	0.561
Total by direction	6.668	5.875	6.958	6.139	1.954	2.587	4.764	5.170	1.802	2.200	1.916	2.198	1.617	1.865
Both directions	**12.543**		**13.097**		**4.542**		**9.934**		**4.002**		**4.114**		**3.482**	

Table 20: Transported weight Montzen route (million tonnes), by type of load and by direction, 2030
Measured on the section Montzen-Aachen. B=Belgium, D=Germany.

	No IR 2A		**No IR 2B**		**Historical IR 2A**		**Historical IR 2B**		**Electrified historical IR 2A**		**IR via A52 2A**		**Electrified IR via A52 2A**	
	B-D	**D-B**	**B-D**	**D-B**	**B-D**	**D-B**	**B-D**	**D-B**	**B-D**	**D-B**	**B-D**	**D-B**	**B-D**	**D-B**
Ores	0.156	1.206	0.157	1.197	0.010	1.065	0.063	1.140	0.009	1.035	0.002	1.056	0.001	1.029
Coal/bulk	1.382	0.144	1.451	0.156	0.620	0.086	1.189	0.291	0.619	0.067	0.564	0.092	0.560	0.070
Cars	0.584	0.509	0.742	0.603	0.281	0.284	0.764	0.592	0.157	0.208	0.314	0.321	0.181	0.222
Chemicals	1.063	0.255	1.167	0.274	0.232	0.121	0.779	0.331	0.071	0.082	0.180	0.111	0.104	0.089
Metal	1.172	1.172	1.231	1.246	0.539	0.397	1.103	1.153	0.453	0.313	0.500	0.363	0.389	0.313
Agric/foodstuffs	0.102	0.168	0.110	0.180	0.018	0.016	0.074	0.174	0.010	0.010	0.019	0.023	0.010	0.016
Container	3.099	3.332	3.406	3.823	1.104	1.384	2.882	3.730	0.781	0.711	1.090	1.125	0.773	0.741
Total by direction	7.558	6.785	8.264	7.479	2.803	3.353	6.854	7.411	2.099	2.425	2.670	3.091	2.018	2.480
Both directions	**14.343**		**15.744**		**6.156**		**14.265**		**4.525**		**5.761**		**4.498**	

II.3.2.4. Number of trains per day

In the tables in this section the number of trains is shown for the Iron Rhine and Montzen route. This is shown by commodity, direction and scenario/variant. Since the number of trains results from the translation from the tonnes as shown in the previous section also the relative differences as described are comparable. Again all results in these tables for the Iron Rhine are measured on the section between Budel and Weert and for the Montzen route the results are measured between Montzen and the German border. In the 4 tables below, the results for the Iron Rhine and the Montzen route are shown for respectively 2020 and 2030 by variant.

All figures in this paragraph are numbers of trains per day and in both directions together.

For the 2A variants we find on the low end in 2020 the non-electrified historical Iron Rhine with 52.6 trains per day in 2020 and on the high end the electrified A52 variant with 69 trains in 2030 (sum of both directions). The 2B scenario has 23.2 trains in 2020.

It should be noted that in 2030 the number of trains for the electrified A52 variant is 69 trains due to the limitation to 72[19] of the Iron Rhine which is reached at another section than where the numbers of tables below are measured. Some empty trains were redirected to the Montzen route in order to stay under the limit of 72. The check for this has been performed on 2 point: the Belgian-Dutch border and the Dutch-German border. In this case, the Dutch-German border values exceeded the number of 72 trains. The original values are indicated in italic in the table.

[19] The renewed Iron Rhine will have a capacity of 72 trains/days both directions (ProRail and Infrabel, 2007). See Annex T: Advice 2007 "Commissie Onafhankelijke Deskundigen IJzeren Rijn" op page 298 for more details.

Table 21: Number of trains per day on the Iron Rhine, by type of load and by direction, 2020
Measured on the section Budel-Weert. B=Belgium, D=Germany.

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
Ores	0	0	0	0	0.4	0.4	0.4	0.2	0.4	0.4	0.4	0.5	0.4	1.0
Coal/bulk	0	0	0	0	2.4	0.6	2.0	0.1	2.4	0.6	2.6	0.8	2.6	0.8
Cars	0	0	0	0	3.1	2.0	0.5	1.1	3.3	2.2	4.0	2.8	4.4	3.0
Chemicals	0	0	0	0	2.9	0.7	1.7	0.1	3.0	0.7	3.4	0.8	3.5	0.8
Metal	0	0	0	0	2.2	2.2	0.7	0.9	2.3	2.5	2.4	3.1	2.6	3.1
Agric/foodstuffs	0	0	0	0	0.3	0.5	0.2	0.2	0.3	0.5	0.3	0.6	0.3	0.6
Container	0	0	0	0	8.4	8.0	3.5	2.9	8.8	9.1	9.7	10.6	10.3	10.8
Empty trains	0	0	0	0	6.5	11.8	2.66	6.06	7.3	11.7	9.4	13.1	9.87	13.82
Total by direction	0	0	0	0	26.3	26.3	11.6	11.6	27.8	27.8	32.2	32.2	34.0	34.0
Both directions	**0**		**0**		**52.6**		**23.2**		**55.6**		**64.3**		**68.0**	

Table 22: Number of trains per day on the Iron Rhine, by type of load and by direction, 2030
Measured on the section Budel-Weert. B=Belgium, D=Germany. In italic: the values without the capacity restriction of 72 trains.

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
Ores	0	0	0	0	0.4	0.3	0.3	0.2	0.4	0.4	0.4	0.4	0.4	0.4
Coal/bulk	0	0	0	0	2.5	0.6	1.1	0.1	2.5	0.6	2.7	0.7	2.7	0.8
Cars	0	0	0	0	2.8	2.0	0.3	0.4	3.8	2.6	4.0	2.6	5.0	3.3
Chemicals	0	0	0	0	3.0	0.7	1.5	0.1	3.6	0.9	3.7	0.8	4.0	0.9
Metal	0	0	0	0	2.2	2.7	0.5	0.4	2.5	3.0	2.4	3.6	2.7	3.8
Agric/foodstuffs	0	0	0	0	0.3	0.6	0.1	0.0	0.3	0.6	0.3	0.6	0.4	0.6
Container	0	0	0	0	8.7	8.3	2.7	1.0	10.0	11.0	10.1	11.3	11.4 *(11.4)*	12.9 *(15.27)*
Empty trains	0	0	0	0	7.0	11.6	1.13	5.62	9.1	13.1	10.0	13.5	7.86	11.71
Total by direction	0	0	0	0	26.9	26.9	7.7	7.7	32.3	32.3	33.5	33.5	34.5 *(38.1)*	34.5 *(38.1)*
Both directions	**0**		**0**		**53.8**		**15.4**		**64.5**		**67.1**		**69.0** ***(76.1)***	

Table 23: Number of trains per day on the Montzen route, by type of load and by direction, 2020
Measured on the section Montzen-Aachen. B=Belgium, D=Germany.

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
Ores	0.3	2.7	0.3	2.7	0.0	2.4	0.0	2.6	0.0	2.3	0.0	2.3	0.0	1.8
Coal/bulk	3.5	0.4	3.5	0.4	1.4	0.1	1.9	0.7	1.4	0.1	1.3	0.1	1.3	0.1
Cars	3.8	3.2	4.2	3.5	1.2	1.5	4.1	2.6	1.0	1.3	1.5	1.4	1.1	1.2
Chemicals	2.9	0.7	3.1	0.7	0.3	0.2	1.5	0.8	0.2	0.2	0.2	0.2	0.1	0.2
Metal	3.6	3.3	3.7	3.4	1.5	1.2	3.0	2.6	1.4	0.9	1.4	1.0	1.2	0.9
Agric/foodstuffs	0.3	0.5	0.3	0.5	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Container	10.6	10.7	11.0	11.4	3.0	3.4	8.2	9.0	2.7	2.3	2.9	2.4	2.4	2.2
Empty trains	11.0	14.4	11.6	15.2	5.8	4.3	10.4	10.8	4.9	4.3	4.9	5.0	4.2	3.9
Total by direction	35.9	35.9	37.8	37.8	13.1	13.1	29.4	29.4	11.6	11.6	12.3	12.3	10.2	10.2
Both directions	**71.8**		**75.6**		**26.2**		**58.7**		**23.2**		**24.6**		**20.5**	

Table 24: Number of trains per day on the Montzen route, by type of load and by direction, 2030
Measured on the section Montzen-Aachen. B=Belgium, D=Germany. In italic: the values without the capacity restriction of 72 trains.

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
Ores	0.4	2.7	0.4	2.7	0.0	2.4	0.1	2.6	0.0	2.4	0.0	2.4	0.0	2.3
Coal/bulk	3.8	0.4	4.0	0.4	1.7	0.2	3.3	0.8	1.7	0.2	1.6	0.3	1.6	0.2
Cars	4.4	3.8	5.6	4.5	2.1	2.1	5.7	4.4	1.2	1.6	2.4	2.4	1.4	1.7
Chemicals	3.5	0.8	3.9	0.9	0.8	0.4	2.6	1.1	0.2	0.3	0.6	0.4	0.3	0.3
Metal	3.9	3.9	4.1	4.2	1.8	1.3	3.7	3.8	1.5	1.0	1.7	1.2	1.3	1.0
Agric/foodstuffs	0.3	0.6	0.4	0.6	0.1	0.1	0.2	0.6	0.0	0.0	0.1	0.1	0.0	0.1
Container	12.0	12.9	13.2	14.8	4.3	5.4	11.2	14.5	3.0	2.8	4.2	4.4	3.0	2.9
Empty trains	13.2	16.4	15.0	18.3	7.7	6.5	16.7	15.7	5.4	5.0	6.9	6.3	9.1 *(5.6)*	8.3 *(4.7)*
Total by direction	41.6	41.6	46.5	46.5	18.4	18.4	43.5	43.5	13.2	13.2	17.3	17.3	16.7 *(13.2)*	16.7 *(13.2)*
Both directions	**83.1**		**93.0**		**36.8**		**87.0**		**26.3**		**34.7**		**33.5 *(26.4)***	

II.3.2.5. Aggregate results for freight and passenger trains on the Iron Rhine link

In this section, the number of trains for both freight and passenger transport on various links of the Iron Rhine and connecting links are presented schematically.

The numbers of freight trains in the schemes are based on the forecasts of this study. The results are completed with data from ProRail ("*Autonome ontwikkelingen baanvakken IJzeren Rijn*", 3 April 2007):

- **Number of passenger trains.**
  Maximum values are applied (ProRail provides a minimum as well as a maximum value). ProRail

applied the following assumptions:

- The number of trains per working day in 2005 (for both directions) is based on the time table of 2005. The number of trains is based on the number of trains per hour multiplied with the assumed operational duration of 18 hours per day[20]. Additionally, peak trains are added (2 x fast Maastricht – Eindhoven – Utrecht in the morning peak and 2 x fast Utrecht – Eindhoven – Maastricht in the evening peak).
- The number of trains per working day in 2020 (for both directions) is based on the number of trains per hour multiplied with the assumed operational duration of 18 hours per day. Therefore, the rail network and services as described in "*Netwerkanalyse Spoor*"[21], is used. It is assumed that peak trains between Maastricht – Eindhoven are operational throughout the day.
- The number of trains per working day in 2030 (for both directions) is based on the year 2020, since there is no forecast or planning data available for 2030.

- **Number of trains for freight transport on links Eindhoven – Maastricht and Venlo – Maastricht for the year 2005.** For the years 2020 and 2030, the number of trains are adapted proportionally: *((number ProRail 2005 / number TRANS-TOOLS 2005) * number TRANS-TOOLS forecast year).*
- **Number of trains for freight transport on the section Belgian/Dutch border – Budel (zinc factory).** This is 2 trains in 2020, 3 trains in 2030.

The additional data from ProRail shown above focuses on passenger trains and on freight trains for some connecting links. The number of freight trains over the Iron Rhine is determined in this study. Together with the additional ProRail data it provides a complete picture of the passenger and freight flows.

In the following schemes, the number of trains on the different links is visualized for the situation including the Iron Rhine. In the schemes the number of trains are shown for the years 2005, 2020 and 2030 on 8 different links. The thick black line represents the Iron Rhine, which consist of four sections :

- Belgian/Dutch border – Budel (branch to zinc factory);
- Budel – Weert;
- Weert – Roermond;
- Roermond – Dutch/German border.

As an example, scenario 2A for the Iron Rhine is explained. From this scheme one can for instance find that the total number of trains per day between Budel and Weert has 0 commodity flows in 2005, 55 trains in 2020 and 56 trains in 2030. On this section for all years the number of passenger trains is equal to 0. In the figures "F" indicates the number of freight trains per day (sum of both directions together) and "P" indicates the number of passenger trains.

[20] For passengers traffic it is assumed that during the morning the operation starts in Limburg while in the evening this is reversed (train service from Limburg will stop earlier than the service to Limburg). It is assumed that the first service in Limburg starts around 5:30, and the first service to Limburg around 6:30. The last train from Limburg departs around 23:30 and the last train to Limburg around 0:30.
[21] Referentie Middellange Termijn, Basisvariant Netwerkanalyse

Figure 11: Number of trains/day in both directions together in the reference scenario 2A (without Iron Rhine), in 2005, 2020 and 2030

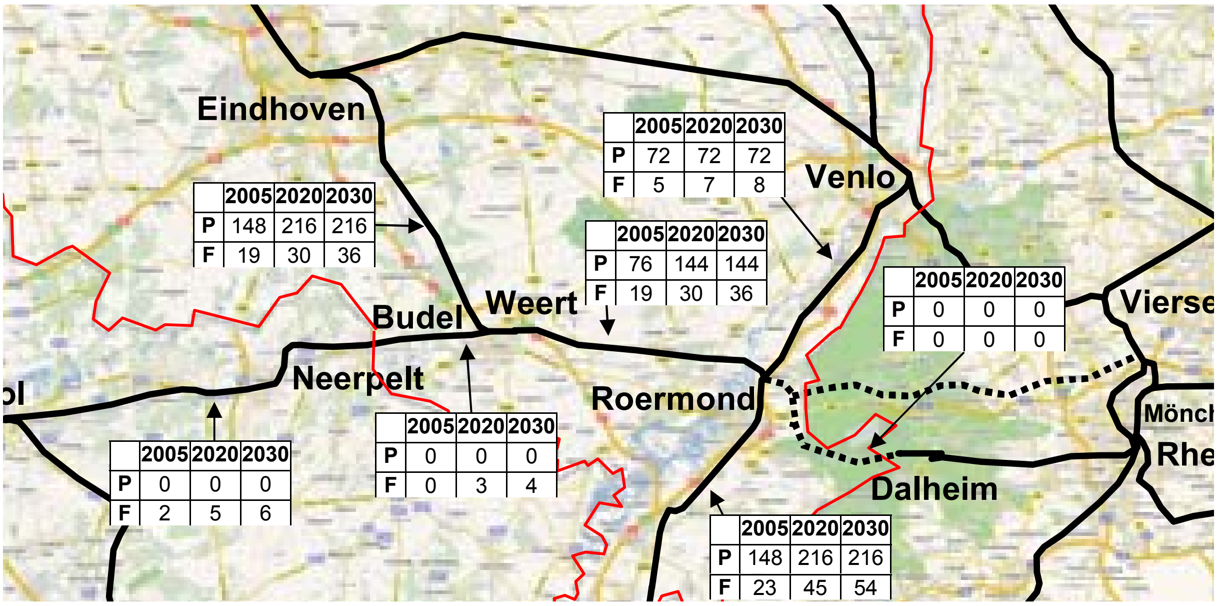


Figure 12: Number of trains/day in both directions together with reactivation of Iron Rhine in scenario "Historical Iron Rhine - 2A", in 2005, 2020 and 2030

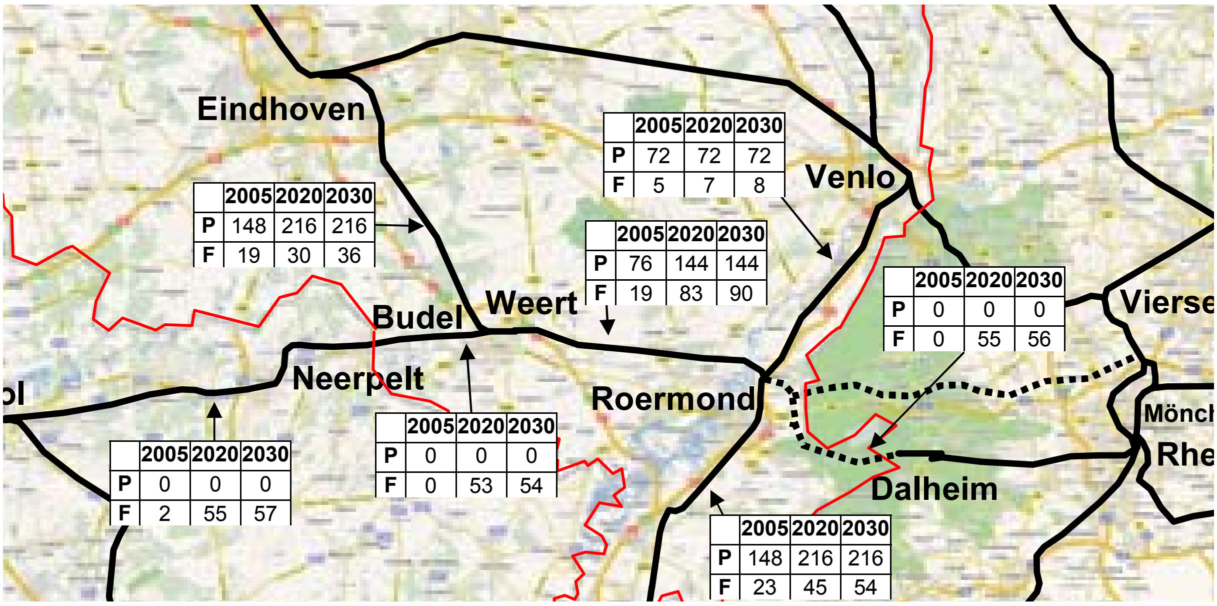


Figure 13: Number of trains/day in both directions together with reactivation of Iron Rhine in scenario "Historical Iron Rhine – 2B", in 2005, 2020 and 2030

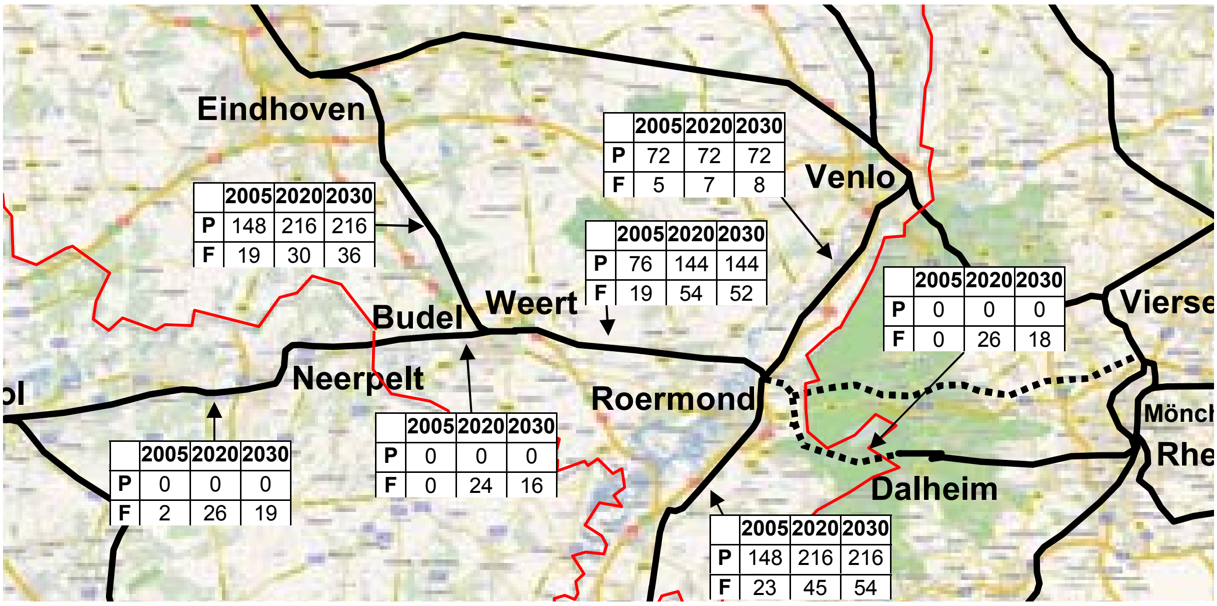


Figure 14: Number of trains/day in both directions together with reactivation of Iron Rhine in scenario "Electrified historical Iron Rhine – 2A", in 2005, 2020 and 2030

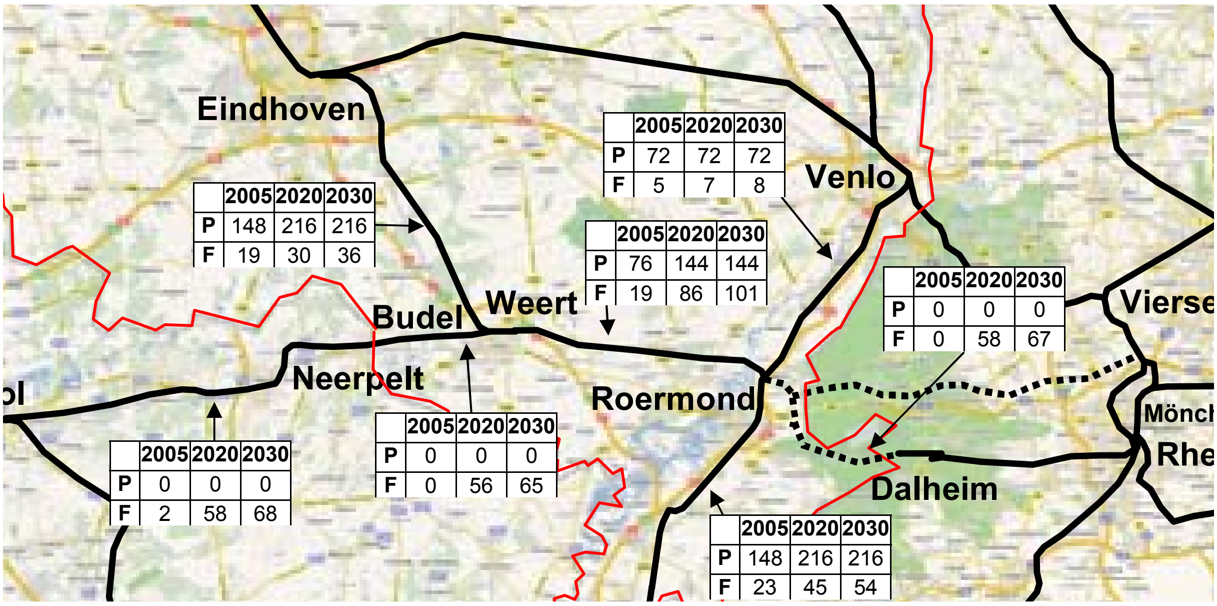


Figure 15: Number of trains/day in both directions together with reactivation of Iron Rhine in scenario "Iron Rhine via A52 – 2A", in 2005, 2020 and 2030

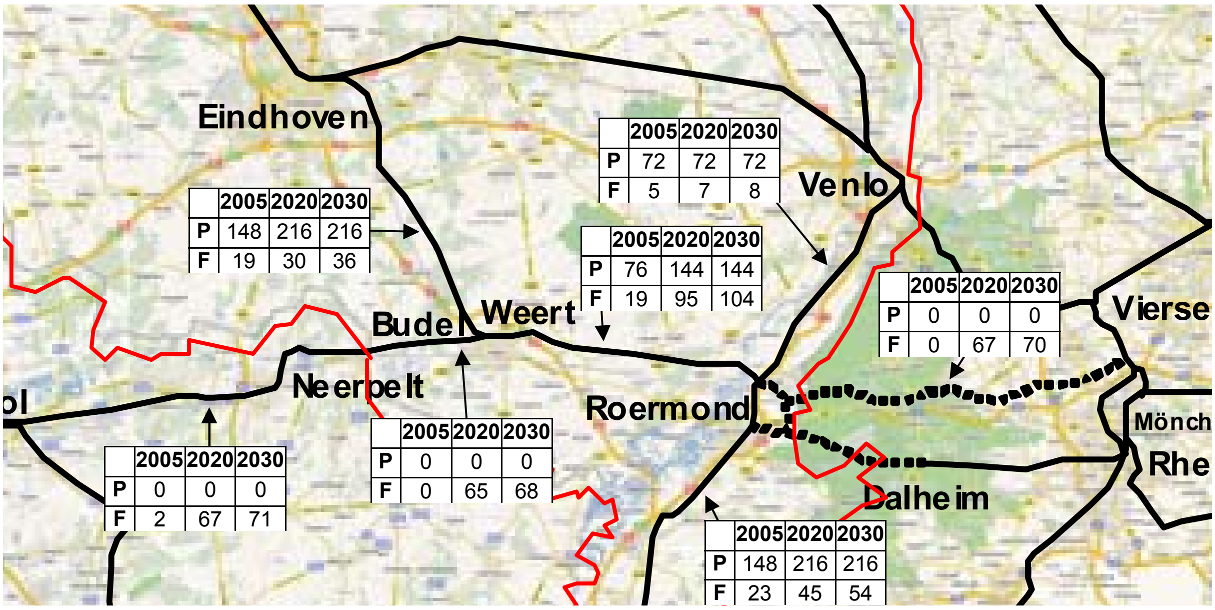
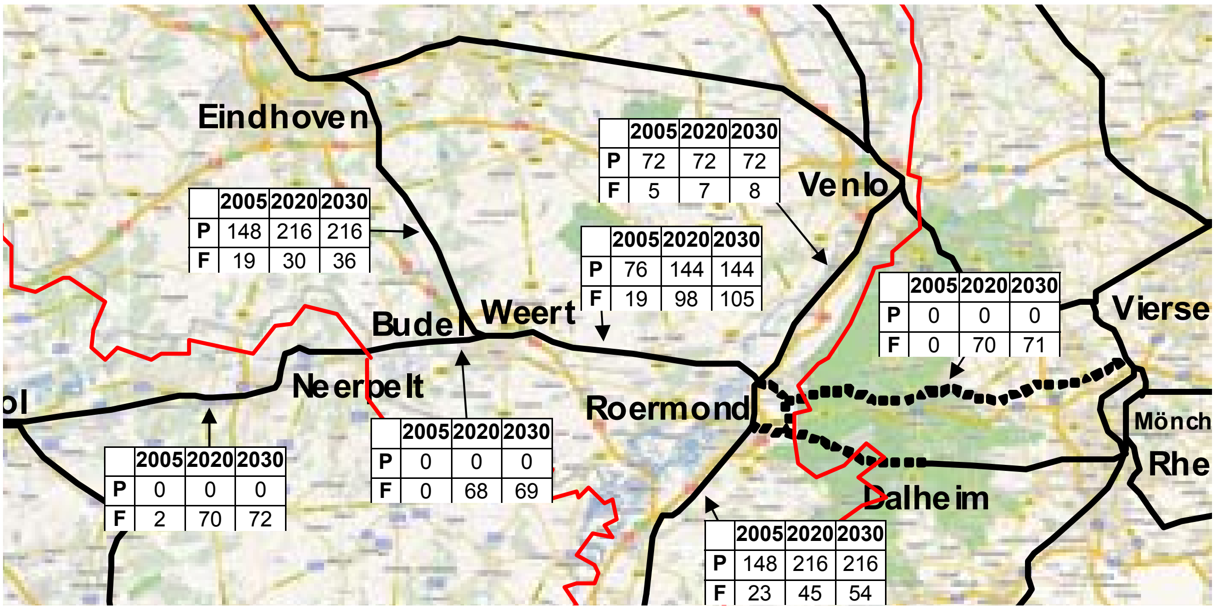


Figure 16: Number of trains/day in both directions together with reactivation of Iron Rhine in scenario "Electrified Iron Rhine via A52 – 2A", in 2005, 2020 and 2030



II.3.3. Results for other modes

II.3.3.1. Freight transport: effect on road and inland shipping

The reactivation of the Iron Rhine has an impact on the modal split on the corridor. In Table 25 the reduction of truck-km and tonne-km for respectively road transport and inland navigation transport are shown for Belgium, Germany and The Netherlands. By country the different calculated network options are listed. The numbers show the difference between the situation with the variant and the situation without Iron Rhine. The numbers are generated by using the results of TRANS-TOOLS assignment results for the different modes and the modal shift effect of the container model. In the table only the absolute figures are shown since comparisons with for instance country totals or regional totals are not relevant in this study; the absolute reductions as shown here serve as input for the SCBA.

As can also be observed in the results, besides the number of tonnes reduced also the distance travelled in a country is of influence on the truck-km and tonne-km reduction. For this reason for instance looking at the scenario "Historical Iron Rhine – 2A" in 2020, road transport the reduction in Germany (-1.596 million truck-km) is larger than the reduction in The Netherlands (-0.162 million truck-km) and Belgium (-0.364 million truck-km).

It is interesting in this respect to note that for road transport the effect is larger for Belgium (-0.364 million truck-km) than for The Netherlands (-0.162 million truck-km) and for inland waterways the effect is larger for The Netherlands (-0.887 million tonne-km) than it is for Belgium (-0.229 million tonne-km). This is because of the relative distance in the countries of the route chosen which is for road transport mainly a shorter piece transiting Limburg.

Comparing the different variants we see that the base variant has the smallest effect followed by the base variant electrified, the A52 variant and the electrified A52 variant. Furthermore the effects are higher for 2030 than for 2020 which could be expected under this scenario.

Table 25: Road and inland navigation reduction by variant, by country, 2020 and 2030 (million truck-km and tonne-km)

	road		**inland navigation**	
Belgium	2020	2030	2020	2030
	Truck-km	Truck-km	Tonne-km	Tonne-km
Historical Iron Rhine	-0.364	-0.444	-0.229	-0.271
Electrified historical Iron Rhine	-0.457	-0.785	-0.288	-0.480
Iron Rhine via A52	-0.662	-0.832	-0.417	-0.508
Electrified Iron Rhine via A52	-0.781	-1.089	-0.492	-0.665
Netherlands	2020	2030	2020	2030
	Truck-km	Truck-km	Tonne-km	Tonne-km
Historical Iron Rhine	-0.162	-0.200	-0.887	-1.076
Electrified historical Iron Rhine	-0.172	-0.236	-0.942	-1.272
Iron Rhine via A52	-0.195	-0.246	-1.071	-1.326
Electrified Iron Rhine via A52	-0.207	-0.275	-1.138	-1.483
Germany	2020	2030	2020	2030
	Truck-km	Truck-km	Tonne-km	Tonne-km
Historical Iron Rhine	-1.596	-2.010	-2.398	-2.927
Electrified historical Iron Rhine	-2.064	-3.601	-3.101	-5.245
Iron Rhine via A52	-3.416	-4.297	-5.132	-6.258
Electrified Iron Rhine via A52	-3.984	-5.592	-5.985	-8.145

II.3.3.2. Effects on road passenger transport

TRANS-TOOLS only calculated the effect on freight transport. However, a (rather small) effect can be expected for passenger transport: as there will be fewer trucks on the road, the cars will encounter less congestion. This effect is fully taken into account, in chapter III.4.2 on page 137.

We did not take into account any volume effects on cars. Due to less congestion, some cars may be attracted from off-peak hours towards peak hours and dampen the positive effect of congestion. This effect is very small.

II.3.3.3. Effects on rail passenger transport

As for road passenger transport, we did not calculate any effect on the rail passenger transport volumes. However, an effect on the travel times can be expected. Where freight and passenger transport share lines, the risk on delays increases. There can be no discussion about the fact that extra trains will have a negative effect on reliability (al else equal), and Iron Rhine trains are no exception to this rule. The reason is simple: the more crowded the network becomes, the more chance that (small) deviations from the timetable will cause small delays to other trains.

For the Netherlands, a calculation has been made by ProRail. They compared a situation with and without 72 extra freight trains[22] on the Iron Rhine. The calculation is based on a queuing theory model[23]. This model estimates the waiting time of trains, which is defined as time above the minimum travel time needed based on infrastructure characteristics (speed limits etc.). Other input which is used by the model is origin and destination of trains, and the number of trains. The model uses statistical techniques to calculate hindrances and the according extension of train travel times.

By comparing the difference in estimated waiting time in a situation with and without a reactivated Iron Rhine, the model found a difference of 40 seconds. These 40 second can be intuitively explained.

With 4 passenger trains (2 IC trains more than nowadays) per hour and per direction, and with the expected Iron Rhine freight trains between Weert and Roermond, ProRail has set up a train schedule for 2020. The week point in the schedule appears to be when a passenger train follows a freight train by only a few minutes. The passenger trains have no stop between Weert and Roermond, and travel the 20 km at 140 km/h in 7 minutes. The freight trains drive the same distance in 15 minutes at 80 km/h. A freight train that has slowed down can cause the passenger train behind him to slow down as well.

The punctuality of freight trains is a bit less than 70% at a 3 minute level (75% at a 5 minute level)[24]. If a freight Iron Rhine freight train is not punctual, and a passenger train would follow him, this would cause an average delay for the passenger trains of 4.5 minutes (8 minutes delay of the freight train minus 3.5 minutes time between the freight and passenger train).

[22] The renewed Iron Rhine will have a capacity of 72 trains/days both directions (ProRail and Infrabel, 2007). See Annex T: Advice 2007 "Commissie Onafhankelijke Deskundigen IJzeren Rijn" op page 298 for more details.
[23] Huisman T., Boucherie R.J., van Dijk N.M., "A solvable queueing network model for railway networks and its validation an applications for The Netherlands", European Journal of Operations Research 142 (2002) 30-51.
[24] ProRail, figures for 2004/2005 on the Dutch railway net.

Of the 72 freight trains, 30% have the risk of delay. Of the 8 passenger trains per hour (both directions), 50% (4 trains) have the risk of experiencing a delay caused by a freight train.

In total: 30% * 50% * 4.5 minutes = 40 seconds, the average delay for each passenger train.

It is possible to reschedule the passenger trains towards a slower speed, better matching the freight train speeds and avoiding the delays, but then the passengers will loose time as well compared to the schedule at 140 km/h now.

Assume the number of passengers on the Weert-Roermond line is 21000 per average day (ProRail, figure for 2020). The value of time for 1 passenger is 5.26 $€_{2005}$/hour (in line with Table 73 on page 138: 7.369 for a car with an occupancy rate of 1.4).

The delay costs are 40 seconds * 5.26 €/hour * 21000 passengers per day * 365 days = 447 977 € per year, for 72 extra trains in 2020.

In reality, every scenario has different freight train numbers per year (see e.g. the tables in "Annex J: Maintenance and renewal costs"), and the number of hindered passengers also varies (from 16000 now until 21000 in 2020, and growing 1% per year beyond). The table below gives the calculation for 3 years and for all scenarios.

Table 26: Effect on passenger rail transport, in $€_{2005}$ per year, The Netherlands

	2020	2025	2030
Historical Iron Rhine – 2A	327 272	365 635	408 444
Historical Iron Rhine – 2B	144 348	132 646	116 915
Electrified historical Iron Rhine – 2A	345 938	412 714	489 677
Iron Rhine via A52 – 2A	400 068	451 546	509 416
Electrified Iron Rhine via A52 – 2A	423 089	470 790	523 841

For Belgium, Infrabel states that the Iron Rhine cannot influence passenger transport, as the latter should be scheduled and optimised in a way that both passenger and freight transport do not obstruct each other. If any effect would occur, it could not be calculated.

In Germany, the effect is assumed 0, as there are only 6 passenger trains per day on the route.

II.3.4. Dangerous goods

An extra analysis for dangerous goods on rail has been performed. Details can be found in "Annex P: Dangerous goods" on page 283.

II.4. Conclusions

In the table below, a summary is given of the number of trains by variant and scenario.

Table 27: Number of trains per day, both directions together, on the Iron Rhine by variant and scenario

variant	2020	2030
Historical Iron Rhine – 2A	52.6	53.8
Historical Iron Rhine – 2B	23.2	15.4
Electrified historical Iron Rhine– 2A	55.6	64.5
Iron Rhine via A52– 2A	64.3	67.1
Electrified Iron Rhine via A52– 2A	68.0	69.0

Note: measurement point between Budel and Weert

The historical Iron Rhine – 2A variant will have 52.2 trains per day in 2020 and this will increase to 53.8 trains per day in 2030. In historical Iron Rhine – 2B variant, this looks completely different: the Iron Rhine will have 23.2 trains per day in 2020 and this will decrease to 15.4 trains per day in 2030. The main reason for the difference between scenario 2A and 2B causing these different results is the internalization of external costs which is differentiated for electric and diesel locs. Since the external impact of diesel locs is significantly higher also the additional tax is higher than for the electric locs. Since the Iron Rhine is not electrified in this variant, this implies an advantage for the Montzen route. And since the differences in generalized costs between the two routes are in many cases small this results to a major shift from the Iron Rhine to the Montzen route compared to the situation under the 2A scenario. Since in 2020 the external costs are only implemented for 50% and in 2030 for the full 100% the effect is even larger in 2030.

The basic variant electrified shows under the 2A scenario 55.6 trains per day in 2020 increasing to 64.5 trains per day in 2030. Compared to the basic variant 2A scenario the electrification leads to an increase of 2.0 trains per day in 2020 and 10.7 trains per day in 2030.

Besides the basic variant also the A52 variant has been calculated under the 2A scenario. The A52 variant will have 64.3 trains per day in 2020 increasing to 67.1 trains per day in 2030. This is 11.7 trains per day more in 2020 than the basic variant and 13.3 trains per day more in 2030. If the A52 variant is electrified this will lead to 3.7 additional trains per day (68.0) in 2020 and 1.9 trains per day more (69.0) in 2030.

This last number of 69.0 trains per day for the A52 electrified in 2030 would be higher if there would be no limitation to 72 trains[25] on the Iron Rhine (the number of 72 is measured at both border crossings, thus on another section than the 69). To reduce the number of trains to the 72 level, 7 empty trains are rerouted to the Montzen route.

When looking by section on the Iron Rhine there will be in 2020[26] between Neerpelt and Budel 55-70 trains per day, between Budel and Weert 53 – 68 trains per day, between Weert and Roermond 83-98 trains per day and between Roermond and Germany 55 – 70 trains per day

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[25] The renewed Iron Rhine will have a capacity of 72 trains/days both directions (ProRail and Infrabel, 2007). See Annex T: Advice 2007 "Commissie Onafhankelijke Deskundigen IJzeren Rijn" op page 298 for more details.

[26] Scenario 2A with basic variant as low value and A52 electrified as high value.

The commodities transported are in most variants more or less present in the same composition. For instance for the basic variant under the scenario 2A 2020 scenario there will be per day 16.4 container trains, 5.1 car trains, 4.4 metal trains, 3.6 chemical trains, 3.0 coal/bulk trains and in smaller amounts also some trains carrying ores and agro/foodstuffs. In total there will be 18.3 empty trains of different types per day.

III SCBA

In a SCBA we compare the aggregate benefits for society with the aggregate costs for society. We first discuss the structure, next we analyse each of the components.

The SCBA is performed for 5 project alternatives:

- SCBA historical Iron Rhine - 2A
- SCBA historical Iron Rhine - 2B
- SCBA electrified historical Iron Rhine - 2A
- SCBA Iron Rhine via A52 - 2A
- SCBA electrified Iron Rhine via A52 - 2A

III.1. Structure of the SCBA

III.1.1. Main effects considered

For the SCBA, the OEI[27] methodology distinguishes the direct effects from the investments, the indirect effects and the external effects. We analyze these effects according to the structure presented in Table 28

In a well functioning market economy it can be shown that the net benefit of an infrastructure investment can be computed as follows: (we follow the structure of Table 28).

- **The direct effects on the rail market**: this is the benefit for consumers and producers where the infrastructure has its immediate impact, here the rail market between Antwerp and the hinterland – consumers may benefit because they have a better service at a lower price and rail operators or infrastructure manager may have a larger producer surplus (profit margin)
- **External effects of the rail infrastructure**: as the external effects associated to the use of the infrastructure are already included in the category above, there remain the external effects, such as the loss of recreation opportunities, vibration, living environment, landscape, ecology, soil and water, agriculture, that are not directly proportional to the use of the infrastructure.
- **The external effects associated to the use of the rail infrastructure:** these are the unpriced (usually) negative effects of a more intensive use of rail services (air pollution, accidents etc.)
- **The indirect effects on the road market:** whenever road use is priced below its marginal social cost, any decrease in the volume of road transport is a benefit equal to the reduction in volume times the unpaid marginal social cost.
- **External effect of the road market:** this represents the change in the marginal social costs (congestion and time losses at crossings, emissions, accidents, road wear & tear, safety, noise) associated to the reduction in the use of the roads.
- **The indirect effect on inland waterways:** equals the change in net tax revenues.
- **External effect of inland waterways:** equals the change in costs of emissions.

[27] Eijgenraam, C.J.J. e.a., Evaluatie van infrastructuurprojecten : leidraad voor kosten-baten analyse – Deel II: capita selecta.

- **Government:** here it is assumed that the investment costs of the rail project are paid by the government – the direct effect is equal to the investment costs. There can be an indirect effect on other markets (labour market) if the cost of public funds equals 1. If it is larger than 1, this category becomes more important.
- **Indirect effects on other sectors:** if other markets than transport markets are affected, and if on these markets the prices are different from the marginal costs, one needs to take into account the change in volume times the difference between price and marginal cost (net margin or tax).

The effects that occur during the building period on the Iron Rhine were not taken into account.

Through the whole report, positive numbers indicate a benefit, negative numbers indicate a cost.

Table 28: Structure of the SCBA in this analysis

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus					
Direct effect on infrastructure manager	Infrastructure fee					
	Costs renewal					
	Costs maintenance					
External effects related to the building and use of the rail						
Effect on society	Emissions					
	Noise					
	Accidents					
	External safety					
	Recreation					
	Vibrations					
	Loss of living environment					
	Landscape					
	Ecology					
	Soil and water					
	Agriculture					
Effects on passenger rail						
	Delay time					
Effects on the road market						
Indirect effect on road users	Congestion time					
	Time at crossings					
	Taxes paid					
Effect on society	Emissions					
	Noise					
	Accidents					
	Marginal wear & tear costs					
Effects on the iww market						
Indirect effect on iww users	Taxes paid					
Effect on society	Emissions					
Effects on the government						
Indirect effect	MCPF correction					
Effects on other sectors						
Indirect effect						
SUBTOTAL						
Effects on the government						
Direct effect	Investment costs					
TOTAL						

III.1.2. General assumptions used for computations

III.1.2.1. Price levels

All prices and costs that are named in this report are computed at **2007 price levels** unless otherwise stated.

III.1.2.2. Base year and horizon

We use an **infinite horizon**. The effects are calculated for each year between 2015 and 2030. Note that there are only traffic scenarios for the year 2020 and 2030. The traffic quantities for the other years are derived using linear extrapolation. From 2030 onwards we assume an infinite repetition of the 2030 situation, using constant parameters and a constant level of demand and infrastructure.

The **year 2007 is the base year** as investments costs started in 2007. Up to 2007 already some € 20 million where spend on studies, but those are in this SCBA regarded as "sunk costs", so they will not be taken into account.

The Net Present Value (NPV) of all costs and benefits is therefore also calculated for the year 2007 (with price levels of 2005).

III.1.2.3. Discount rate

For the discount rate, the practices in Belgium and in The Netherlands differ. Therefore, the two approaches have been used, in parallel.

In Belgium, the standard discount rate is 4%.

In the Netherlands, the Dutch Ministry of Economic Affairs recommends as central value for the real discount rate a risk free value of 2.5%[28] plus a risk premium that is project specific. The project specific risk premium depends on the covariance of the project with the general macro-economic fluctuations. For this freight transport project it is reasonable to assume that the benefits fluctuate with the overall economic growth and in that case there is a recommendation to use a risk premium of 3%[29]. So this gives a real discount rate of 5.5%. For the investment costs, we did not include the risk premium as the investment costs are independent of economic growth. The discount rate for the investment costs is thus 2.5%. For the maintenance and renewal costs, we assume that half of it is related to the actual number of trains, and thus to economic growth. This gives a resulting discount rate of 4% for maintenance and renewal costs.

Therefore, in the SCBA, all Net present Values (NPV) have been calculated twice: once with a discount rate of 4% (Belgian approach), once with 2.5-4-5.5% (Dutch approach).

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[28] "Discontovoet verlaagd van 4% naar 2 1/2%" Ministerie van Financiën, Kamerstukken Overig | 08-03-2007 | nr IRF07-90

[29] MV&W, Ministerie van Financiën, Centraal Planbureau, Groep Rebel, "Risicowaardering – aanvulling op de leidraad OEI", http://www.verkeerenwaterstaat.nl/Images/Risicowaardering_tcm195-161185.pdf

III.2. Direct effects on rail

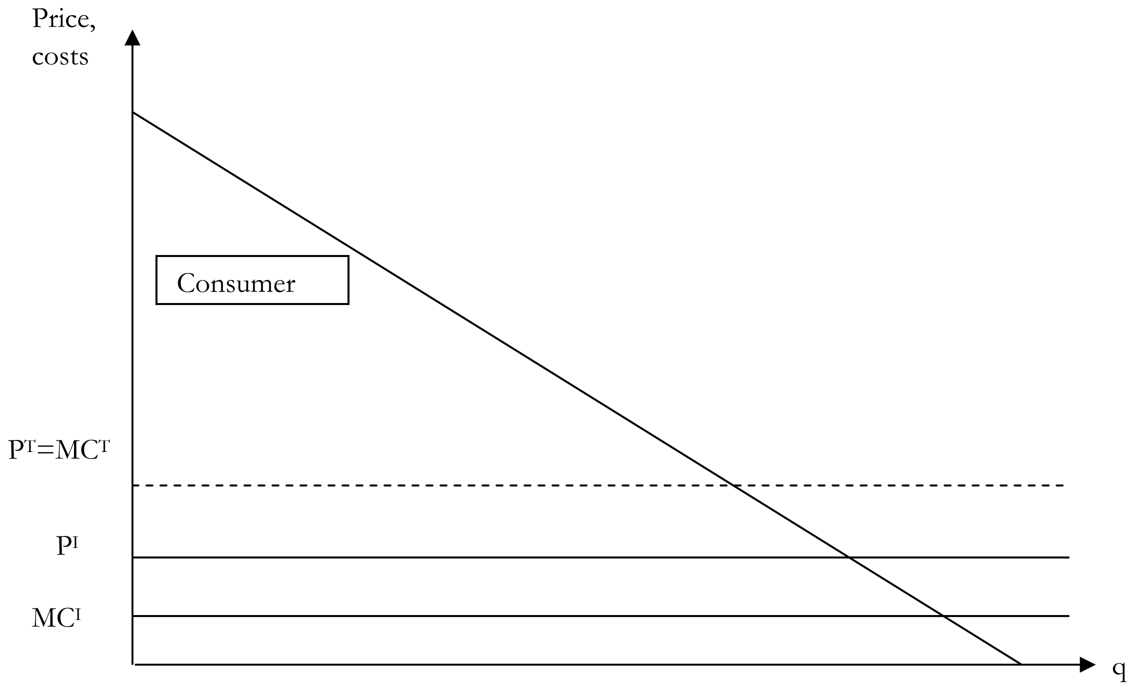
In the next paragraphs we distinguish the effect on the consumers (the users of the transport services) and the effects on the infrastructure managers and the effects on society (external effects).

We do not explicitly consider the producers of transport services, here the transport firms. The reason for this is that we assume perfect competition and constant marginal costs, and hence that in the long run, prices equal marginal costs and no profits (in addition to the normal market return on capital) are possible. The main reason for using this assumption is to avoid assumptions on profit margins of the transport firms as this information is not available. Moreover, this assumption merely implies a transfer of possible benefits, rather then influencing the total benefits.

Figure 17 shows a simplified graphical representation of the role of the first two groups on the rail market. The demand of consumers for rail transport in function of the price they have to pay, p^T and the elements which make up this price are shown. The infrastructure manager sets a levy, p^I for the use of the network. This price can be larger or equal than the marginal cost of offering the network services, MC^I. The difference between price and marginal cost is the gross margin of the infrastructure manager, W^I. The transport company charges a price p^T to the consumer which is equal to the price he has to pay for using the network and his operational costs OVC^T.

q	Quantity of transport
MC^I	Marginal cost of the infrastructure manager
W^I	Gross profit margin of the infrastructure manager
$P^I=MC^I+W^I$	Price paid by the transporters to the infrastructure manager
OVC^T	Other variable costs
$MC^T=P^I+OVC^T$	Marginal cost of rail traffic for the transport firm
$P^T=MC^T$	Price paid by the users for the railway traffic, equal to the marginal cost of the transport firm

Figure 17: The rail market



III.2.1. Direct effect for the consumer: consumer surplus

The main effects of the Iron Rhine for the consumer is the effect on the price and the quality (time, reliability,…) of rail transport. The way to measure this effect, is to calculate the consumer surplus. "Consumer surplus" is a measure of the excess of willingness to pay for the trip. E.g. is the consumer is willing to pay 8 € for a trip, and it costs 5 €, then his consumer surplus is 3 €. In the case of freight transport, the consumer surplus benefit is – usually – mutually shared by the producer of the goods and the end user. Only in rare case, the transport company can have some consumer surplus.

In this paragraph we first briefly describe the methodology to compute the benefits (based on OEI[30]), next we look into the calculation of the effect of the new infrastructure on the generalized price and we conclude with a discussion of the results.

III.2.1.1. Methodology

If a project leads to changes in the generalized prices of a transport mean, the change in consumer surplus is a good approximation of the benefits for the user. Two types of users have benefits from a decrease in the generalized price: *the existing users and the new users.*

The approach we suggest is to calculate the benefit of the Iron Rhine using the decrease of the generalized price of rail transport for each origin-destination pair (OD-pair)[31]. Figure 18 shows the rail market be-

[30] Eijgenraam, C.J.J. e.a., Evaluatie van infrastructuurprojecten : leidraad voor kosten-baten analyse – Deel II: capita selecta.
[31] This approach is justified here because Iron Rhine and Montzen route are close substitutes as regards the nature of the good.

tween an OD-pair for a representative future year and for one type of transported good. Initially there is only the Montzen line and a generalized price gp_0 with a volume of rail transport q_0. The reactivation of the Iron Rhine causes a decrease in the generalized price of rail transport for this OD-pair from gp_0 to gp_1 and a corresponding increase in volume from q_0 to q_1.

The direct benefit for the user equals the grey area: the benefit for the existing users (q_0) + the benefit for the new users (q_1-q_0) who start using the rail link.

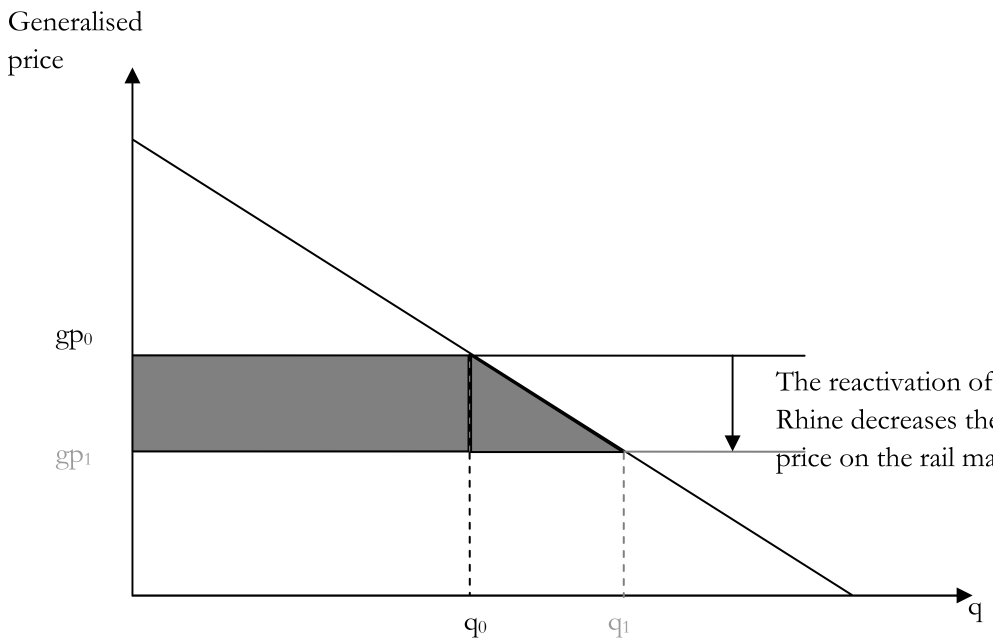
$$CS = (gp_0 - gp_1)q_0 + \frac{1}{2}(gp_0 - gp_1)(q_1 - q_0)$$

This change in consumer surplus can also be written as the product of the (generalized) price difference and the average demand with and without the reactivation of the project.

$$CS = 0.5 * (q_0 + q_1) * (gp_0 - gp_1)$$

This rule – which assumes a linear demand curve – is also called 'the rule of half'. This is well known and is also prescribed by the OEI and RAILPAG[32]. The calculation of the change in the generalized price is described in the next paragraph.

Figure 18 : Effect on Rail market when Iron Rhine alternative is added



For some other OD's and other goods the generalized price may not decrease by the reactivation of the Iron Rhine and this transport will remain on the Montzen line. Hence consumer surplus does not change for transport of goods which remain on the Montzen line.

[32] RAILPAG (2003), Orientations pour l'évaluation d'effets ferroviaires, Commission Européenne et Banque européenne d'investissement

III.2.1.2. Generalised price

The generalized price[33] is defined as the sum of the monetary cost and the monetary valuation of the quality. With respect to the quality, this analysis only takes the time costs into account. Other quality characteristics such as reliability, easier logistic planning, etc. are not taken into account as they are hard to quantify.

a. Time cost

The time cost is calculated using the time which is needed for the trip and the value of the time. The time needed for the trip is calculated using the average speed. We know from the section II.II.2.4.4 on page 75 that the speed on both routes is almost the same.

For the valuation of the time we use the values shown in Table 29, which were also used in the traffic forecasts. These values differ in function of the good transported. Goods with a high value of time (such as electronics) are much more sensitive to cost and travel time differences than goods with a low value of time (such as sand). Given the value of time per tonne-hour and the average weight of a train we can then calculate the value per hour per train. Using the average speed, we can then also express this in €/train-km.

Table 29: Value of time for freight transport

	commodity group	€$_{2005}$/tonne/hour	train weight (tonne)	€$_{2005}$/train-hour
0	Agriculture Products and Live Animals	0.0119	1525	18.16
1	Foodstuffs and Animal Fodder	0.0124	1525	18.86
2	Solid Mineral Fuels	0.0011	1800	1.91
3	Crude Oil	0.0065	1800	11.62
4	Ores and Metal Waste	0.0062	2200	13.65
5	Metal Products	0.0086	1525	13.15
6	Crude and Manufactured Minerals, Building Materials	0.0009	1800	1.65
7	Fertilizers	0.0047	1800	8.43
8	Chemicals	0.0281	1525	42.88
9	Machinery, Transport Equipment, Manufactured Articles And Miscellaneous Articles	0.1350	1115	150.51
10	Agriculture Products and Live Animals	0.0071	1800	12.78

Note: Table 13 applies the same weights per train but for other commodity groupings (see Table 14 for conversions)

b. Monetary cost

To determine the costs of the operators we use the cost model used for the forecasts (Annex C: Composition of costs of rail operators). We distinguish electric from diesel trains and 11 types of goods, as the price depends on the type of load. The costs are subdivided into average costs per hour, average variable costs per train-km and average energy cost per train-km. The average costs per hour capture the costs of the locomotive, the wagon costs (and if applicable the container costs) and the personnel costs. The aver-

[33] The same generalized price was used in the calculation of the transport quantities on the Montzen line and the Iron Rhine.

age variable costs capture the slot and shunting costs and the average energy costs capture the fuel or electricity cost per train-km.

Table 30: Costs electric traction

		Average costs (€$_{2005}$/train/h)	Average variable costs (€$_{2005}$/train-km)	Average energy costs (€$_{2005}$/train-km)
0	Agriculture Products and Live Animals	160.63	3.71	2.10
1	Foodstuffs and Animal Fodder	161.20	3.71	2.23
2	Solid Mineral Fuels	153.02	3.71	2.76
3	Crude Oil	147.32	3.71	1.42
4	Ores and Metal Waste	153.02	3.71	2.76
5	Metal Products	161.20	3.71	2.23
6	Crude and Manufactured Minerals, Building Materials	153.02	3.71	2.76
7	Fertilizers	147.32	3.71	1.42
8	Chemicals	158.35	3.71	1.56
9	Machinery, Transport Equipment, Manufactured Articles And Miscellaneous Articles	157.45	3.71	1.45
10	Petroleum Products	147.32	3.71	1.42

Table 31: Costs diesel traction

		Average costs (€$_{2005}$/train/h)	Average variable costs (€$_{2005}$/train-km)	Average energy costs (€$_{2005}$/train-km)
0	Agriculture Products and Live Animals	159.37	3.71	2.41
1	Foodstuffs and Animal Fodder	159.94	3.71	2.52
2	Solid Mineral Fuels	151.76	3.71	2.77
3	Crude Oil	146.06	3.71	1.72
4	Ores and Metal Waste	151.76	3.71	2.77
5	Metal Products	159.94	3.71	2.52
6	Crude and Manufactured Minerals, Building Materials	151.76	3.71	2.77
7	Fertilizers	146.06	3.71	1.72
8	Chemicals	157.09	3.71	1.99
9	Machinery, Transport Equipment, Manufactured Articles And Miscellaneous Articles	156.19	3.71	1.90
10	Petroleum Products	146.06	3.71	1.72

Furthermore, the same assumptions with respect to changing locs, electrification, double traction etc. as in the traffic forecasts have been made.

The generalized price in the situation without reactivation of the Iron Rhine equals the generalized price on the Montzen line. Note that – because of the assumption that there are no capacity problems on the Montzen line in either of the alternatives – the generalized cost on the Montzen line is equal in both alternatives.

The generalized price on the railway market in the alternative with the Iron Rhine equals the generalized price on the Montzen line $\left(gp_M\right)$ if traffic does not change routes and equals the generalized price on the

Iron Rhine $\left(gp_{IR}\right)$ if traffic changes towards the Iron Rhine. Hence the generalized price for each rail market if the Iron Rhine is reactivated equals $min\left(gp_{IR}, gp_{M}\right)$.

III.2.1.3. Consumer surplus

The benefits of an infrastructure project depend strongly on the effects of the project on transport flows. The effects are determined by the individual behaviour of the users. The TRANS-TOOLS model and the ECORYS container model were used to determine the effects on modal split and port choice. The route choice between the Montzen line and the Iron Rhine was determined by minimizing generalized costs.

For full details on the traffic forecasts we refer to the previous chapter. The traffic scenarios shows, for example in the scenario "historical Iron Rhine - 2A" results, that when the Iron Rhine is not activated the flow of goods on the Montzen route grows from 8.2 million in 2005 to 12.5 in 2020 and 14.3 million in 2030. In the scenario where the Iron Rhine is activated we see that in 2020 8.0 million tonnes are shifted from the Montzen route to the Iron Rhine and 4.5 million tonnes are left on the Montzen route. Furthermore we see an additional 1.4 million tonne assigned to the Iron Rhine.

Hence reactivating the Iron Rhine does not lead to a strong generation effect for new traffic volumes. The main consumer surplus effect is from existing users that now have a lower generalised cost: mainly some 8 million tonnes that were transported via the Montzen route and now travel via the Iron Rhine, thus having a calculated benefit of 0.5-1 € per tonne, depending on the destination and good type. The share of the new users in the consumer surplus is very low.

Given the quantities and the generalized prices we calculate the consumer surplus (CS) for each category of goods by computing the generalised prices and rail volumes for each of the 150 000 markets.

Computation of the full consumer surplus

Table 32 gives the consumer surplus per good type (NSTR) for the year 2020. Total consumer surplus equals 5 290 337 €$_{2005}$ for the year 2020 or 0.62 €$_{2005}$/tonne. Note that, because of the low generation effect, about 98 % of consumer surplus comes from existing users.

Table 32: Consumer surplus for the year 2020, scenario "Historical Iron Rhine – 2A", in €$_{2005}$
Source: own calculations.

NSTR	CS existing users	CS new users	Total CS
0 – agricultural products	66 728	761	67 489
1 – foodstuffs	210 002	10 044	220 047
2 – solid mineral fuels	116 627	62	116 689
3 – crude oil	0	0	0
4 – ores / metal waste	270 689	439	271 129
5 – metal products	1 566 689	19 274	1 585 963
6 – building materials	181 926	114	182 040
7 – fertilisers	9 348	23	9 371
8 – chemical products	1 284 588	34 499	1 319 087
9 – other products	1 060 217	40 444	1 100 661
10 – petroleum products	417 379	484	417 862
Total	**5 184 192**	**106 145**	**5 290 337**

We have calculated the consumer surplus for each year between 2015 and 2030. From 2030 onwards, we assume consumer surplus to be fixed. We then calculated the net present value using an interest rate of 4%[34] and a perpetuity from 2030 onwards, with 2007 as the base year.

Table 33 shows the result; for the yearly results per country we refer to "Annex G: Consumer surplus".

Note that the allocation per country has been based on the OD-pair on NUTS2 level (provinces), taking into account the generalised costs per OD-pair, and allocating half of the benefits to the origin of the goods, and half to the destination. E.g. a trip from China to Poland via the port of Antwerp and via Iron Rhine would have the benefits allocated to the China producer and Polish consumer of the goods.

Table 33: Net present value of consumer surplus (2007), discount rate 4%, scenario "Historical Iron Rhine – 2A", in €$_{2005}$
Source: own calculations

NSTR	CS existing users	CS new users	Total CS
0 – agricultural products	762 991	8 221	775 023
1 – foodstuffs	2 388 911	110 579	2 499 490
2 – solid mineral fuels	1 386 728	759	1 387 487
3 – crude oil	0	0	0
4 – ores / metal waste	3 233 979	5 401	3 239 380
5 – metal products	18 017 903	232 154	18 250 057
6 – building materials	2 054 840	1 439	2 056 279
7 – fertilisers	100 693	276	100 969
8 – chemical products	15 140 517	398 637	15 539 153
9 – other products	11 788 369	458 309	12 246 678
10 – petroleum products	4 959 107	6 154	4 965 261
Total	**59 834 039**	**1 221 928**	**61 059 779**

III.2.2. Direct effects for the infrastructure manager

For the infrastructure managers there are two effects compared with the scenario without reactivation:

- On the one hand the revenues and the costs decrease on the Montzen line. The costs of the infrastructure manager consist of the investments for extensions, costs for renewals and costs of maintenance. The cost decrease depends on their sensitivity with respect to the number of tonne-km.
- On the other hand there are the new revenues and costs from the Iron Rhine. In this part we do not take into account the investment costs as they are discussed in section III.7.1 on page 149.

III.2.2.1. Change in revenue (infrastructure fee)

For the calculation of the difference in revenue with and without the Iron Rhine we multiply on both lines the infrastructure fee with the difference in transported volume. The difference in transported volume on the Iron Rhine and the Montzen line is given in the table below.

[34] The interest rate of 5.5% is also calculated, the results can be found in the overview tables in chapter 0.

Table 34: Change in volume (million tonne-km), scenario "Historical Iron Rhine – 2A"
Source: own calculations

		Historical Iron Rhine – 2A		Historical Iron Rhine – 2B		Iron Rhine via A52 – 2A		Electrified historical Iron Rhine – 2A		Electrified Iron Rhine via A52 – 2A	
		2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
Belgium	Iron Rhine	643.40	653.57	260.22	137.41	754.55	791.85	678.05	775.17	799.29	883.49
	Montzen	-1051.44	-1087.45	-457.05	-229.00	-1079.43	-1124.46	-1108.71	-1294.53	-1116.50	-1271.12
Netherlands	Iron Rhine	431.08	443.63	191.22	115.53	466.57	489.65	458.07	525.36	495.74	548.22
Germany	Iron Rhine	568.90	586.85	248.36	149.98	621.10	653.72	605.62	699.77	659.88	734.04
	Montzen	-717.44	-755.65	-317.26	-192.62	-752.65	-782.40	-762.17	-881.01	-811.25	-885.64
TOTAL	Iron Rhine	1643.38	1684.04	699.80	402.93	1842.22	1935.22	1741.74	2000.30	1954.92	2165.75
	Montzen	-1768.88	-1843.10	-774.31	-421.62	-1832.08	-1906.87	-1870.88	-2175.55	-1927.75	-2156.77

Note that "Iron Rhine" and "Montzen" routes are defined here quite broad. It includes the additional (to the reference scenario) volume that is transported on the blue lines indicated in Figure 19 on page 153.

For the infrastructure fee, we assume, as before, a price of 3.30 $€_{2005}$/train-km. See also "Annex A: Background scenario" on page 181. This cost per train-km can be divided into a fixed cost per train-km and a cost depending on the transported tonnes (weight). Based on the analysis of current tariffs (calculation ProRail), this division is set at 50%. This makes that the fixed tariff per train-km equals 1.65 $€_{2005}$. On average, the gross weight of a train is 1140 tonnes, including the weight of the train, implying a transported weight of 570 tonnes. The variable part of the tariff is then equal to 1.65/1140 $€_{2005}$/tonne = 0.0014474 $€_{2005}$/tonne. Using the average weights per type of good, we have calculated the average tariff per tonne-km, which amounts to 0.0024598 $€_{2005}$/tonne-km. We then multiplied this number with the change in tonne-km.

Table 35 reports the total discounted revenues for the 3 involved infrastructure managers. As the Iron Rhine is shorter and not much extra traffic is generated, total revenues decrease. As the Iron Rhine uses the Dutch network, the Dutch infrastructure revenues increase, the revenues for the German and Belgian infrastructure managers decrease. The prices in the above are in $€_{2005}$. To convert to $€_{2007}$ for the table below, a factor of 0.9885 will be used.

Table 35: Net present value (rate 4%) change in revenue for the infrastructure manager, in million $€_{2007}$
Source: own calculations

Country		Historical Iron Rhine 2A	Historical Iron Rhine 2B	Electrified historical Iron Rhine 2A	Iron Rhine via A52 2A	Electrified Iron Rhine via A52 2A
Belgium	Iron Rhine	29.71	8.60	33.70	35.54	38.88
	Montzen	-49.08	-14.61	-55.83	-50.61	-55.33
	Total Belgium	-19.37	-6.01	-22.13	-15.07	-16.44
Netherlands	Iron Rhine	20.06	6.70	22.81	21.98	24.12
Germany	Iron Rhine	26.51	8.70	30.30	29.31	32.23
	Montzen	-33.87	-11.07	-38.14	-35.24	-39.15
	Total Germany	-7.35	-2.37	-7.83	-5.94	-6.92
Total	Iron Rhine	76.28	23.99	86.82	86.82	95.24
	Montzen	-82.95	-25.68	-93.97	-85.85	-94.48
	Total	-6.66	-1.69	-7.15	0.97	0.76

Note that the (assumed) infrastructure fee is lower (50 to 80%) than the maintenance and renewal costs. We assume an infrastructure fee of 3.30 € in 2020. Apparently, his will not cover the full maintenance and renewal costs (see section III.2.2.2 on page 110). However, the infrastructure fee could be sufficient to cover the variable maintenance and renewal costs, though is it unknown how much they amount.

III.2.2.2. Change in maintenance and renewal costs

For the costs of the infrastructure manager, we distinguish between investments for extensions, costs of conservation and costs of maintenance. We consider these costs on both lines.

a. Costs of renewal

The change in the costs of renewals[35] depends on the physical depreciation of the infrastructure that is due to ageing and to the use in volumes. The depreciation of track and switches is a function of the replacement value and the technical lifetime. In general, a change in volume will only change the technical lifetime and not the value. However, note that apart from the volumes, it should also be taken into account that if the reactivation of the Iron Rhine causes earlier replacement, the investment in this new infrastructure delays some renewal costs. This could even lead to a saving in costs.

The renewal costs are calculated in detail for each country. The full methodology is included in "Annex J: Maintenance and renewal costs" on page 240.

Table 36: Yearly extra renewal costs on the Iron Rhine, in €$_{2007}$/year for the year 2020
Source: Own calculations

	Historical Iron Rhine – 2A		Historical Iron Rhine – 2B		Electrified historical Iron Rhine – 2A		Iron Rhine via A52 – 2A		Electrified Iron Rhine via A52 – 2A	
Country	Number of trains	Renewal costs	Number of trains	Renewal costs	Number of trains	Renewal costs	Number of trains	Renewal costs	Number of trains	Renewal costs
NL – Iron Rhine	52.6	95958	23.2	41778	55.6	104455	64.3	133597	68	148335
BE – Iron Rhine	52.6	0	23.2	0	55.6	0	64,3	0	68	0
BE – Montzen	-45,6	0	-16.9	0	-48.6	0	-47.2	0	-51.3	0
DE – Iron Rhine	52.6	PM	23.2	PM	55.6	PM	64.3	PM	68	PM
DE – Montzen	-45.6	PM	-16.9	PM	-48.6	PM	-47.2	PM	-51.3	PM

Table 37: Other extra renewal costs on the Iron Rhine, in €$_{2007}$/year for the year 2020
Source: Own calculations

Country		Historical Iron Rhine	Electrified historical Iron Rhine	Iron Rhine via A52	Electrified Iron Rhine via A52
NL – Iron Rhine	Every 35 years	7 047 145	7 047 145	4 795 000	4 795 000
	Every 50 years	177 000 000	213 000 000	16 000 000	45 500 000
	Every 100 years	72 000 000	72 000 000	20 000 000	20 000 000
BE – Iron Rhine	Every 50 years	0	54 000 000	0	54 000 000
BE – Montzen		0	0	0	0
DE – Iron Rhine		PM	PM	PM	PM
DE – Montzen		PM	PM	PM	PM

[35] Based partly on memo ProRail (27/05/2008)

b. Costs of maintenance

The costs of maintenance[36] depend on the type of track, the traction and the transported tones. The maintenance costs are calculated in detail for each country. The full methodology is included in "Annex J: Maintenance and renewal costs" on page 240. The table below gives an overview. The cost calculation takes into account the actual number of trains that is predicted on the Iron Rhine and Montzen routes.

Table 38: Extra maintenance costs on the Iron Rhine, in €$_{2005}$/year for the year 2020
Source: Own calculations

	Historical Iron Rhine – 2A		Historical Iron Rhine – 2B		Electrified historical Iron Rhine – 2A		Iron Rhine via A52 – 2A		Electrified Iron Rhine via A52 – 2A	
Country	Number of trains	Mainten. costs	Number of trains	Mainten. costs	Number of trains	Mainten. costs	Number of trains	Mainten. costs	Number of trains	Mainten. costs
NL – Iron Rhine	52.6	3 137 058	23.2	2 341 897	55.6	3 794 279	64.3	1 670 468	68	2 273 056
BE – Iron Rhine	52.6	1 755 709	23.2	1 310 683	55.6	2 652 223	64,3	1 972 311	68	3 000 237
BE – Montzen (existing track)	-45.6	-4 429 614	-16.9	-3 329 921	-48.6	-4 563 736	-47,2	-4 500 648	-51,3	-4 687 914
BE – Montzen (Aarschot)	-45.6	-2 500 000	-16.9	-2 500 000	-48.6	-2 500 000	-47,2	-2 500 000	-51,3	-2 500 000
DE – Iron Rhine	52.6	PM	23.2	PM	55.6	PM	64,3	PM	68	PM
DE – Montzen	-45.6	PM	-16.9	PM	-48.6	PM	-47,2	PM	-51,3	PM

The dominant factor of the maintenance costs in The Netherlands is the maintenance of the Meinweg tunnel in the first 3 scenarios. Belgium has a positive effect on maintenance, because the Iron Rhine is shorter than the Montzen route, and because the maintenance of an investment in Aarschot can be avoided.

III.2.3. Effect on passenger rail

This effect is as follows:

Table 39: Effect on passenger rail transport, in million €$_{2007}$ (NPV with discount rate 4%)

	BE	NL	DE	Other countries
Historical Iron Rhine – 2A	PM	-7.12	0.00	0.00
Historical Iron Rhine – 2B	PM	-2.36	0.00	0.00
Electrified historical Iron Rhine – 2A	PM	-8.25	0.00	0.00
Iron Rhine via A52 – 2A	PM	-8.83	0.00	0.00
Electrified Iron Rhine via A52 – 2A	PM	-9.15	0.00	0.00

See also II.3.3.3 on page 94.

[36] Based on note ProRail (02/06/2008)

III.3. External effects on the rail market

In the first 3 sections we discuss the external effects of the reactivation of the Iron Rhine which are directly related to the volumes transported. These are the effects on emissions, noise and accidents.

In the sections after that, we discuss those external effects which are largely independent of the volumes transported. They are caused merely by the reactivation of the Iron Rhine. We first discuss the yearly effects (recreation) and after that, the one shot effects (vibrations, living environment, landscape, archaeology, ecology, soil & water, agriculture) are studied. For each category we discuss the methodology used, the input values and the result.

III.3.1. Emissions

Emissions of air pollutants cause negative health and environmental impacts. The emissions considered for this study are: CH_4, CO, N_2O, NMVOC, NO_x, PM and SO_2. These pollutants are subject of valuation studies (see further) and cover most external costs. A detailed description of the merely health effects of the pollutants can be found in "Annex H: Description of the effect of emissions".

The general approach to estimate cost of emissions for all transport modes is to multiply transport activity, in vehicle km, or tonne-km, with an emission factor. This gives total emissions which give, after multiplication with a valuation factor, total cost. This is then allocated to the countries, using a "blame" matrix.

III.3.1.1. Calculation of emissions

First, for the change in transport activity for all modes we used the recent traffic forecasts. Secondly, the emission factors for rail are calculated in the following way.

Rail fleet projections are based on EMMOSS[37]. In EMMOSS fleet data for rail activity was investigated for Belgian rail operators. These data include figures on actual fleet but also on rolling stock investment schemes, to allow for projections until 2015. In EMMOSS, it was shown that major investments on rolling stock were done in the recent past; also average lifespan of a loc was estimated at about 20 years. This information leads to the expectations of a new rapid replacement of rolling stock after 2015. Therefore, after 2015, for this study, linear phase-out of existing fleet is assumed until 2025, causing gradual replacement of the fleet with new locs, complying to Stage IIIb emission standards.

Given the current diesel locomotive fleet of the rail operators, (Class 66, T77) and the legislation for future fleet (Emission standards Stage IIIb), the average fleet using the Iron Rhine has been simulated for every year between 2015 and 2030. From 2030 on we assume a constant composition of the fleet. Related to the fleet per year, an emission factor was calculated for every year.

[37] Kris Vanherle et. al., (2007), TML: "*EMissieMOdel voor Spoorverkeer en Scheepvaart in Vlaanderen, EMMOSS*" (emission model for maritime, inland waterway and rail for Flanders)

Table 40: Rail fleet evolution

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025 – 2030 and beyond
T77	0.2	0.18	0.16	0.14	0.12	0.1	0.08	0.06	0.04	0.02	0
Class66	0.5	0.45	0.4	0.35	0.3	0.25	0.2	0.15	0.1	0.05	0
Stage IIIb	0.3	0.37	0.44	0.51	0.58	0.65	0.72	0.79	0.86	0.93	1

For fair comparison between diesel and electric trains, the emission calculation is done for both direct and life-cycle emissions. Life-cycle emissions are the emissions that occur due to the production of electricity and diesel. The external costs of electricity takes into account the emissions at the level of generation. The life-cycle emission factors used, take into account the evolution of the nation specific power plant mix (coal/natural gas/nuclear).

The tables below contain the resulting emission factors for diesel and electric trains, per country.

Table 41: Emission factors for diesel trains, well-to-tank, in g/tonne-km

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CH_4	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
CO	0.288	0.293	0.298	0.304	0.309	0.314	0.319	0.325	0.330	0.335	0.340	0.340	0.340	0.340	0.340	0.340
CO_2	64.824	64.820	64.817	64.813	64.810	64.803	64.799	64.794	64.791	64.787	64.784	64.781	64.778	64.774	64.771	64.771
N_2O	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NMVOC	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
NOx	0.703	0.671	0.639	0.607	0.575	0.543	0.511	0.479	0.447	0.415	0.383	0.383	0.383	0.383	0.383	0.383
PM	0.018	0.017	0.015	0.014	0.013	0.012	0.011	0.010	0.008	0.007	0.006	0.006	0.006	0.006	0.006	0.006
SO_2	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238
VOC	0.027	0.026	0.025	0.024	0.024	0.023	0.022	0.021	0.020	0.020	0.019	0.019	0.019	0.019	0.019	0.019

Table 42: Emission factors for electric trains, well-to-tank, in g/tonne-km

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BE																
CH_4	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
CO	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
CO_2	11.760	12.381	13.000	13.619	14.235	14.861	15.863	16.936	17.962	18.994	20.077	21.368	22.658	23.946	25.232	26.507
N_2O	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NMVOC	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NOx	0.010	0.010	0.010	0.010	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
PM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SO_2	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
NL																
CH_4	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
CO	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
CO_2	22.794	22.538	22.283	22.027	21.771	21.513	21.737	21.952	22.222	22.436	22.649	23.255	23.860	24.465	25.069	25.616
N_2O	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NMVOC	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NOx	0.018	0.018	0.017	0.017	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
PM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SO_2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
DE																
CH_4	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
CO	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
CO_2	28.764	29.374	29.985	30.597	31.209	31.816	31.697	31.586	31.480	31.373	31.326	31.100	30.933	30.707	30.540	30.373

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
N_2O	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NMVOC	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NOx	0.015	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
PM	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SO_2	0.014	0.013	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011

For the Iron Rhine, all trains are assumed to be diesel in the non-electrified variants. For the Montzen route, and for the electrified Iron Rhine variants, the figures are a result of the calculation, as described in the generalised cost method (II.2.4 on page 73).

Table 43: Percentage of tonnes in diesel / electric trains on the Montzen route and Iron Rhine route

Variant	Iron Rhine route				Montzen route			
	2020		2030		2020		2030	
	Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric
Historical Iron Rhine – 2A	100.0 %	0.00 %	100.0 %	0.00 %	5.7 %	94.3 %	5.7 %	94.3 %
Historical Iron Rhine – 2B	100.0 %	0.00 %	100.0 %	0.00 %	0.0 %	100.0 %	0.0 %	100.0 %
Electrified historical Iron Rhine – 2A	15.6 %	84.4 %	15.6 %	84.4 %	7.7 %	92.3 %	7.7 %	92.3 %
Iron Rhine via A52 – 2A	100.0 %	0.00 %	100.0 %	0.00 %	6.1 %	93.9 %	6.1 %	93.9 %
Electrified Iron Rhine via A52 – 2A	16.9 %	83.1 %	16.9 %	83.1 %	7.5 %	92.5 %	7.5 %	92.5 %

III.3.1.2. Valuation

Results after the above calculations are total emissions in tonnes per year. The next step is to convert emissions to costs. To this end, CAFE-ExternE[38] cost values are used (€/tonne of emitted pollutant). Within the ExternE projects funded under the JOULE Programme, a detailed bottom-up 'impact pathway' (or damage function) approach was developed to quantify external costs from energy conversion resulting from impacts on human health, crop losses, material damage, and global warming. The ExternE external costs accounting framework is widely accepted and has been successfully used to support decision making in the field of energy and environmental policy. The monetary valuation of mortality impacts is the dominant parameter in the assessment of external costs from energy conversion. Monetary valuation of ecological and CO_2 impacts based on preferences revealed in political negotiations (standard-price approach).

The values are shown in the table below. They are used in all scenarios.

Table 44: Overview of valuation of air pollutant emissions (in €$_{2005}$/tonne of pollutant)

Pollutant	Belgium	Germany	Netherlands
CH_4	2 500	1 700	1 900
CO	0	0	0
NMVOC	2 500	1 700	1 900
NOx	5 200	9 600	6 600
PM	61 000	48 000	63 000
SO_2	11 000	11 000	13 000

[38] Rainer Friedrich, Peter Bickel, Environmental External costs of Transport, 2001.

Table 45: Overview of valuation of greenhouse gas emissions (in €2005/tonne of pollutant)

Pollutant	Belgium	Germany	Netherlands
CH_4	920	920	920
N_2O	11 840	11 840	11 840
CO_2	40	40	40

These external costs (€2005) per tonne of pollutant (Table 44) are the result of damage estimates that take into account dose-response relationships. The values differ between countries because the population density and the value of life differ between countries.

III.3.1.3. Treatment of CO_2

For the climate change damage, an estimate of 40 €/tonne CO_2-equivalent is used for the whole period of analysis. The 40 €/tonne is an estimate of the marginal cost of reaching the EU target in the period up to 2030[39]. The EU target, if it is determined efficiently, means that the marginal cost of reaching the target equals the marginal damage for Europe. But the marginal damage of climate change is often not explicitly computed. Here the EU's ambition is to limit global climate change to 2 degrees Celsius, at least if there is sufficient international participation what we assume here. When this type of absolute physical damage target is used, the choice of the discount rate for the very long term damages (beyond one generation) is not really an issue anymore because there is no need to monetise the damage: one chooses for a maximum cumulative emission in 2020. The goal is to reach that physical damage target at lowest cost in 2020-2030 and this implies trading off pollution abatement efforts in different sectors. The EU wants to reach this target via a quota system that is tradable within EU and later probably also tradable within a larger set of countries. An alternative instrument would be a carbon tax. As long as both instruments lead to the same desired emission reduction they are equivalent in terms of marginal cost of emission reduction and they lead to the same socially optimal investment decisions when alternative means of transport have to be selected.

For rail, the climate damage has been integrated into the operation costs of traction by adding the cost of the necessary tradeable permits (at 40 €/tonne) in the energy prices. To see how this affects the choices in the SCBA, take a diesel train that emits more CO_2 (and other greenhouse gasses as CH_4 and N_2O) than an electric train. The diesel train will have to buy more emission permits and is therefore rightly penalized compared to an electric train. Even if an electric train is used, this train needs to buy permits to run and this extra cost will affect overall volume of rail traffic and modal choice. What happens if a train operator buys X extra carbon permits? This means that some other emitters have made extra efforts to reduce their emissions by a total of X tonnes of CO_2. In equilibrium the marginal cost of emission reduction will be equalized over all sources of emissions and whenever the transport sector manages to save one tonne of CO_2, this is a genuine cost saving for the economy as a whole.

For inland waterways and road the damage (or avoided abatement cost) has been added ex post as one of the external costs again at the cost of 40 €/tonne. So all modes have received an extra cost per tonne of CO_2 of 40 €/tonne but this was operationalised in a slightly different way for the different modes[40].

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[39] See Com (2007)2 final "Limiting global climate change to 2 degrees Celsius - the way ahead for 2020 and beyond"
[40] The main reason for working this way is that for rail, the CO2 input comes via the price of Electricity, a sector that already participates in the tradeable permit scheme. For road, there is already an important fuel tax that also acts as a CO2 tax.

III.3.1.4. "Blame" matrix

The emission "blame" matrix allocates emissions of a given country to other countries where damage due to emissions occur. E.g. emissions of NOx in Belgium cause ozone levels to increase in Belgium, but also in other countries as NOx is transported by wind over long distances and can be deposited in other countries. Dispersion by wind and atmospheric reaction are typical for every pollutant and country.

Countries cannot claim air pollution damage costs to other countries, even if it is clear that this pollution originates there, as long as these countries are in line with EU regulations on emissions.

In this matter, 2 European Directives are of importance:

- **Emissions**: National Emission Ceilings (NEC) for certain atmospheric pollutants[41] are regulated by Directive 2001/81/EC (NECD)[42]. As part of the preparatory work associated with the revision of the NECD, the European Commission is assisted by the NECPI working group (National Emission Ceilings – Policy Instruments). Member States can negotiate the emission ceiling for their country.
- **Air quality**: Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (the new Air Quality Directive) has entered into force 11 June 2008. Important is that individual citizens can force their local councils to tackle air pollution, following an important ruling in July 2008 from the European Court of Justice (ECJ).

The directive on air quality is more stringent than the directive on emissions. It is expected that Belgium and The Netherlands will not be able to tackle all air quality problems by 2010, while the NEC directive should cause less problems. Therefore, the allocation of the effect based on air quality (health impact of the damage) is of higher importance than the allocation of the effect based on emissions (polluter). Also note that PM, the most important pollutant of diesel, is included in the air quality directive, but not in the NEC.

The table below contains the "blame" matrix. What is indicated is the percentage of emissions emitted in one country that affects other countries. E.g. 15.02% of the Belgian SO_2 emissions will in fact be blown towards Germany. The "blame" matrix is used to better allocate the external costs of pollutants to the countries.

For greenhouse gasses (which cause climate change: CO_2, N_2O and CH_4), the "blame" matrix was not applied, as here the emission regulations are more dominant (e.g. Kyoto).

[41] Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), Volatile Organic Compounds (VOC), Ammonia (NH_3)

[42] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.

Table 46: "Blame" matrix
Source: EMEP

SO_2	Into BE	Into DE	Into NL	Into other countries	Into the sea	Total
From Belgium (BE)	33.90%	15.02%	5.62%	34.02%	11.44%	100.00%
From Germany (DE)	4.30%	40.68%	1.94%	42.93%	10.15%	100.00%
From The Netherlands (NL)	12.11%	20.55%	11.35%	35.36%	20.62%	100.00%

NOx	Into BE	Into DE	Into NL	Into other countries	Into the sea	Total
From Belgium (BE)	12.22%	14.15%	4.68%	55.64%	13.31%	100.00%
From Germany (DE)	4.93%	33.76%	5.45%	45.16%	10.71%	100.00%
From The Netherlands (NL)	7.18%	15.42%	8.60%	50.59%	18.22%	100.00%
VOC	Into BE	Into DE	Into NL	Into other countries	Into the sea	Total
From Belgium (BE)	10.79%	21.27%	8.87%	58.39%	0.68%	100.00%
From Germany (DE)	2.60%	30.06%	4.29%	62.51%	0.54%	100.00%
From The Netherlands (NL)	5.76%	25.39%	11.99%	56.10%	0.76%	100.00%

PM	Into BE	Into DE	Into NL	Into other countries	Into the sea	Total
From Belgium (BE)	19.82%	21.00%	10.41%	41.11%	7.65%	100.00%
From Germany (DE)	2.57%	42.73%	3.63%	44.48%	6.59%	100.00%
From The Netherlands (NL)	6.86%	26.24%	16.99%	37.94%	11.96%	100.00%

Note on the methodology

The use of the "blame" matrix, described above, is not a common method in an SCBA. We have used it though, as the division of the costs and benefits between the countries is of high importance in this particular SCBA.

A calculation without using the "blame" was also subject to a sensitivity analysis, which can be found in section V.2 on page 168. This calculation (without) reflects a reasoning that some also might follow: the costs for the emissions should be allocated to the country where they are emitted, because that country is responsible for abating these emissions. This reasoning is in line with the "polluter pays" principle.

On the other hand, if trains emit pollutants in The Netherlands, and these pollutants end up in Belgium, it is Belgium that suffers from them. This is the principle of an impact pathway assessment, where the costs are allocated to the people (and places) where the health impact occurs. This is also the reasoning followed in the calculations above (including the "blame" matrix).

III.3.1.5. Results

The total resulting damage effects are calculated for both Iron Rhine and Montzen route for the three countries. Results are shown in the table below. As transport activity and emission factors are different for every year, the cost values for 2030 are given as an illustrative example. Costs will be different for other years.

A positive number indicates a benefit, a negative number a cost. CO_2 and N_2O are included in the table, but not in the final SCBA, as indicated above. CH_4 is only partly included (as it is both air pollutant and greenhouse gas).

Table 47: Effect on emissions of rail (million €$_{2005}$ in 2030), scenario "Historical Iron Rhine – 2A", allocated to the country where the impact occurs
Source: own calculations. The impact on the sea is not included.

	BE		NL		DE		Other countries
	Iron Rhine	Montzen	Iron Rhine	Montzen	Iron Rhine	Montzen	
CH_4	-0.005	0.162	-0.003	0.000	-0.003	0.187	0.000
CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	-1.693	1.248	-1.149	0.000	-1.520	0.977	0.000
N_2O	-0.002	0.000	-0.001	0.000	-0.002	0.000	0.000
NMVOC	-0.008	0.001	-0.009	0.001	-0.026	0.002	-0.057
NOx	-0.346	0.034	-0.275	0.022	-1.086	0.110	-2.054
PM	-0.064	0.007	-0.061	0.004	-0.169	0.020	-0.214
SO_2	-0.812	0.075	-0.282	0.015	-1.164	0.110	-1.575

Note that "Iron Rhine" and "Montzen" routes are defined here quite broad. It includes the additional (to the reference scenario) volume that is transported on the blue lines indicated in Figure 19 on page 153.

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used.

We see that cost of emissions increases on the Iron Rhine while costs decline on the Montzen route. In total the increase in emissions on the Iron Rhine dominates the effect on rail. This can be explained by the substitution of the relatively clean transport activity (electric trains) on the Montzen route by polluting transport activity on the Iron Rhine (diesel trains). The dominant pollutants with respect to external costs are CO_2 and NOx.

The scenarios "Historical Iron Rhine – 2B" and "Iron Rhine via A52" have very similar results. The variants with electrification on the Iron Rhine differ obviously. The effect of the extra trains on the Iron Rhine is less negative than in the non-electrified variants.

Table 48: Effect on emissions of rail (million €$_{2005}$ in 2030), scenario "Electrified historical Iron Rhine – 2A", allocated to the country where the impact occurs
Source: own calculations. The impact on the sea is not included.

	BE		NL		DE		Other countries
	Iron Rhine	Montzen	Iron Rhine	Montzen	Iron Rhine	Montzen	
CH_4	-0.125	0.186	-0.109	0.000	-0.173	0.216	0.000
CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	-1.081	1.494	-0.654	0.000	-1.000	1.167	0.000
N_2O	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NMVOC	-0.001	0.001	-0.002	0.001	-0.005	0.004	-0.002
NOx	-0.061	0.048	-0.048	0.031	-0.189	0.154	-0.098
PM	-0.011	0.010	-0.010	0.006	-0.033	0.027	-0.008
SO_2	-0.128	0.110	-0.042	0.022	-0.196	0.154	-0.067

III.3.2. Noise

The external costs of noise hindrance are directly related to the number of train-km or tonne-km. We first determine the marginal noise cost per tonne-km for The Netherlands, because data is available for detailed calculations, both with mitigation measures and without mitigation measures. Next we use the marginal noise cost computed for The Netherlands also for Belgium and Germany on both the Iron Rhine and Montzen route. Note that these routes are defined here quite broad. It includes the additional (to the reference scenario) volume that is transported on the blue lines indicated in Figure 19 on page 153.

For the calculation of the effect on noise in The Netherlands we base ourselves on SO I[43]. We use detailed noise exposure data: the number of households exposed to noise interval as shown in the table below.

Table 49: Number of dwellings exposed to different noise levels in NL in the reference case, in the Iron Rhine without mitigation measures case and in the Iron Rhine with mitigation measures case
Source: SO I

dB(A)	2030 Reference – 2A	2030 Historical Iron Rhine – 2A (no measures)	2030 Historical Iron Rhine – 2A (with measures)
<56	1724	3675	5921
56-58	485	1081	198
59-63	475	967	156
64-68	231	500	41
69-71	29	85	16
>71	12	36	12

After mitigation measures, 12 dwellings remain exposed to noise-levels > 71 dB(A). According to legislation, this is too high for housing; therefore these houses will be expropriated. This is taken into account in the investment cost. The 12 dwellings with exposure rate higher then 71 dB(A) are excluded form the marginal external cost calculation, because the removal of these houses is included in the investment costs.

We observe that the Iron Rhine, without measures, increases the number of households that experience noise damage, and this holds for all classes of noise. When the Iron Rhine is introduced with noise reduction measures, the number of dwellings that experience medium to severe noise damage (>56 dB(A)) actually decreases below the number of dwellings that experience damage in the baseline.

The valuation methodology is based on HEATCO[44] estimates and includes health & annoyance effects. The values are reported in Table 50. To get a match with the disturbance classes in SO I, the upper value of the interval is taken (e.g. for SO I interval 56-58 dB, HEATCO 58 dB(A) value is taken in the calculations).

[43] SO I stands for "Studie Opdracht I" and discusses the effects of the reactivation of the Iron Rhine following the trajectory for the Dutch part of the line. B.C.J. Weijers et. al. (2008): "IJzeren Rijn: Actualisering 2007 Eindrapportage studieopdracht I Actualisatie ontwerp tracévariant A3 BIJLAGE H: Trillingsonderzoek" (reference: TCE5-27-I-L11-043r).
[44] Bickel et. al. (2006), IER : HEATCO "Developing Harmonised European Approaches for Transport Costing and Project Assessment", ANNEX 5 to Deliverable 5: "Derivation of fall-back values for impacts due to noise"

Table 50: Overview valuation of noise, in €$_{2002}$/dB(A)-level
Source: HEATCO

dB(A)	BE	DE	NL
>=51	0	0	0
>=52	0	0	0
>=53	0	0	0
>=54	0	0	0
>=55	0	0	0
>=56	10	10	10
>=57	19	19	21
>=58	29	29	31
>=59	39	39	42
>=60	48	49	52
>=61	58	58	63
>=62	67	68	73
>=63	77	78	84
>=64	87	88	94
>=65	96	97	105
>=66	106	107	115
>=67	116	117	126
>=68	125	127	136
>=69	135	136	147
>=70	144	146	157
>=71	208	210	226
>=72	224	226	243
>=73	240	242	261
>=74	256	259	278
>=75	272	275	296
>=76	288	291	313
>=77	304	308	331
>=78	320	324	348
>=79	336	340	366
>=80	352	357	383
>=81	369	373	401

In the scenarios, noise mitigation measures are taken into account in the investment cost for The Netherlands. We observe that with mitigation measures a small benefit occurs (Table 51). This is because the mitigation measures (noise screens) lead to a decrease in total noise exposure.

Based on the Dutch noise cost calculation, marginal noise cost is calculated (€/tonne-km), and is extrapolated to Belgium and Germany.

In Belgium, 3.7 km (x2, both sides of the track) of noise screens are planned. Of these, 1/3 is autonomous development (included in the reference scenario), and 2/3 additional to the project. We then assume that the mitigation has a linear effect to what happens in The Netherlands, using the km screen / km track ratio.

For Germany we used the marginal external cost with mitigation measures, as investment cost in Germany includes mitigation with noise screens. The results are shown in Table 51. Because activity differs between years, 2020, 2025 and 2030 cost values are given as an illustrative example. Costs will be different for other years.

Table 51: The noise damage in million €$_{2005}$/year, scenario "Historical Iron Rhine – 2A"
Source: own calculations. Negative values are a cost, positive values a benefit.

	2020	2025	2030
Belgium	453 423	463 796	474 168
Netherlands	185 759	188 464	191 168
Germany	747 630	764 877	782 125
Total	1 386 812	1 417 137	1 447 462

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used. An overview per section can be found in "Annex Q: Calculation of noise and recreation per section".

This results in a net benefit for The Netherlands and Germany, as the mitigation measures more than compensate the increased cost. For Belgium the net result is a cost on the Iron Rhine track and a benefit on the Montzen line. In total there is a benefit that has of course a counterpart in higher investment costs that include noise mitigation measures.

III.3.3. Accidents

We distinguish between external safety (group risk) and effects on individual risk (split in internal safety and safety at road-rail crossings).

III.3.3.1. External safety (group risk)

Group risk is the probability per year that a group of people gets killed as a consequence of an incident with dangerous goods.

a. The Netherlands

The international study[45] analyzed this qualitatively and concluded that the group risk increase associated to the Iron Rhine project was negligible.

However, the rail infrastructure design around Weert had to be adapted due to possible problems of external safety, as The Netherlands have regulations about this. This caused an extra cost, which is included in the investment costs. Nonetheless, the groups risk still increases from 0.12 to 0.68 due to the Iron Rhine project.

In order to valuate this change in groups risk we multiplied the value of a statistical life for the Netherlands[46] with the change in the expected numbers of people killed. For the valuation, HEATCO[47] values for injuries and fatalities are used. The determination of these values is a research field on its own. In the estimation, aspects like rehabilitation cost, health care cost and production losses are considered. For a

[45] "Comparative cross-border study on the Iron Rhine" - Final Report of 14th of May, 2001, ARCADIS 2001
[46] HEATCO[46]
[47] Bickel et. al. (2006), IER: HEATCO *"Developing Harmonised European Approaches for Transport Costing and Project Assessment"*, Deliverable 5 "*Proposal for Harmonised Guidelines"*

more detailed description of the methodology on how the values are determined, we refer to HEATCO deliverables. The values we used for this project can be found in the table below.

Table 52: HEATCO accident cost values (in €$_{2002}$)
Source: HEATCO

Country	Fatality	Severe injury
Belgium	1 639 000	249 000
Germany	1 661 000	229 400
Netherlands	1 782 000	236 600

The change in the expected number of people killed over the whole trajectory can be calculated using the following formula[48]: S=N*0.00000444.

With S the expected number of people killed per year and N the numbers of trains. In the reference case, 0.0000242 per year are expected to be killed, in the Iron Rhine alternative 0.000309 per year, for 72 trains. This means that there is an annual cost of 563 €$_{2007}$ for external safety in The Netherlands, taking the value of a statistical life of 1 925 447 €$_{2007}$ for The Netherlands.

Table 53: Yearly external safety costs on the Iron Rhine in The Netherlands, for all scenarios, in €$_{2007}$/year
Source: Own calculations

	Historical Iron Rhine – 2A		Historical Iron Rhine – 2B		Iron Rhine via A52 – 2A		Electrified histori-cal Iron Rhine – 2A		Electrified Iron Rhine via A52 – 2A	
Year	**Number of trains**	**External safety costs**	**Number of trains**	**External safety costs**	**Number of trains**	**External safety costs**	**Number of trains**	**External safety costs**	**Number of trains**	**External safety costs**
2015	52.6	399	23.2	150	64.3	498	55.6	424	68	529
2016	52.6	399	23.2	150	64.3	498	55.6	424	68	529
2017	52.6	399	23.2	150	64.3	498	55.6	424	68	529
2018	52.6	399	23.2	150	64.3	498	55.6	424	68	529
2019	52.6	399	23.2	150	64.3	498	55.6	424	68	529
2020	52.6	399	23.2	150	64.3	498	55.6	424	68	529
2021	52.72	400	22.42	143	64.58	501	56.49	432	68.1	530
2022	52.84	401	21.64	137	64.86	503	57.38	440	68.2	531
2023	47.58	357	19.32	117	58.43	448	51.82	392	61.4	474
2024	53.08	403	20.08	124	65.42	508	59.16	455	68.4	533
2025	53.2	404	19.3	117	65.7	510	60.05	462	68.5	534
2026	53.32	405	18.52	110	65.98	512	60.94	470	68.6	535
2027	53.44	406	17.74	104	66.26	515	61.83	477	68.7	535
2028	53.56	407	16.96	97	66.54	517	62.72	485	68.8	536
2029	53.68	408	16.18	90	66.82	520	63.61	492	68.9	537
2030	53.8	409	15.4	84	67.1	522	64.5	500	69	538

b. Belgium and Germany

For Belgium and Germany, possible small costs and/or benefits on external safety also occur, but they could not be calculated due to lack of data.

[48] Source: "Berekening verwachtingswaarden referentiesituatie en projectsituatie", 9 January 2009, AVIV.

III.3.3.2. Internal safety

It is assumed for now that the internal safety does not change due to the project. This is the probability per year that train passengers get killed as a consequence of train accident. The ERTMS system[49] is set up to avoid this, so the risk is very low, and moreover, it will not change because of the project.

III.3.3.3. Safety at road-rail crossings

Changes in road-rail crossing safety are calculated in the following way: First, the probability of accident per car-train passing is determined using data from The Netherlands. This data holds figures of road traffic intensity, rail traffic intensity and number of (equal-level) crossings (SO I[50] "*L18 overwegveiligheid*"[51]). Also, data on accidents over several past years is given; therefore, the probability of an accident per train-car passing is calculated. For Germany and Belgium, the value for The Netherlands is used, but scaled with average number of rail crossings per km track. Note that this assumes equal road traffic intensity for Belgian & German roads compared to Dutch roads, crossing the Iron Rhine.

<u>The Netherlands</u>

For individual risk, safety of rail crossings has been examined. The probability of accidents (with injured and killed) per type of rail crossing in The Netherlands is assumed to be linear in number of trains and vehicles passing the crossing. Similar to external cost due to noise exposure, the difference in probability of accidents is calculated in a case with mitigation measures (by upgrading crossing infrastructure to enhance safety) and a case without mitigation measures. For The Netherlands, mitigation is included in the investment. The mitigation in The Netherlands incorporates in fact the upgrading of the two busiest crossing from an equal-level crossing to a viaduct or underpassing, thus avoiding car-train passings. These measures decrease the overall probability of accident in The Netherlands, despite increase in traffic intensity due to the project and therefore lead to a benefit of road-rail crossings safety.

For the valuation, HEATCO[52] values for injuries and fatalities are used (see III.3.3.1 page 121).

The marginal accident cost per tonne-km is calculated taking into account the values for injuries and fatalities and mitigation measures (if applicable) due to the project and is assumed to be constant in time. The total accident cost is then obtained by taking into account the marginal accident cost and the number of trains passing.

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[49] ERTMS is the European Railway Traffic Management System. It has 2 components: 1) ETCS, the European Train Control System, makes it possible not only to transmit permitted speed information to the train driver, but also to monitor constantly the driver's compliance with these instructions, and 2) GSM-R, based on standard GSM but using various frequencies specific to rail as well as certain advanced functions. It is the radio system used for exchanging voice and data information between the track and the train.

[50] B.C.J. Weijers et. al. (2008): "IJzeren Rijn: Actualisering 2007 Eindrapportage studieopdracht I Actualisatie ontwerp tracévariant A3 HOOFDRAPPORT" (reference: TCE5-27-I-L01-007r). A newer version of this report is in progress.

[51] A.J.M. Snel et. al. (2007): "*IJzeren Rijn, Actualisering 2007 Studieopdracht I - II - III L18: Externe Veiligheid Overwegveiligheid Eindrapport beoordeling overwegen.*"

[52] Bickel et. al. (2006), IER: HEATCO *"Developing Harmonised European Approaches for Transport Costing and Project Assessment"*, Deliverable 5 "*Proposal for Harmonised Guidelines*"

For the A52 variant, we assumed that all new crossings are level-free.

Germany and Belgium

For Belgium and Germany, the Dutch values without mitigation measures have been used, as mitigation is not included in the investment. To have a better estimation of marginal accident cost in Belgium and Germany, the marginal accident cost for The Netherlands was rescaled by the number of rail-road crossing per km track in Belgium and Germany.

For the A52 variant in Germany, we assumed that no new level crossings will be built on the new part of the track (source: DB Netz).

Results

The results are differences in total costs per year based on number of trains passing and are shown in Table 54 (for 2030). As the Iron Rhine is shorter and not much extra traffic is generated, total accident costs decrease.

Table 54: Change in total individual risk costs in million €$_{2005}$ for scenario "Historical Iron Rhine – 2A" for 2030
Negative values equal a cost, positive values a benefit.
Source: own calculations

	Iron Rhine route	Montzen route	Total
Belgium	-0.713	1.401	0.688
The Netherlands	0.223	---	0.223
Germany	-0.282	0.363	0.081

Table 55: Change in total individual risk costs in million €$_{2005}$ for scenario "Iron Rhine via A52 – 2A" for 2030
Negative values equal a cost, positive values a benefit.
Source: own calculations

	Iron Rhine route	Montzen route	Total
Belgium	-0.864	1.449	0.584
The Netherlands	0.246	---	0.246
Germany	0.000	0.376	0.376

Note that "Iron Rhine" and "Montzen" routes are defined here quite broad. It includes the additional (to the reference scenario) volume that is transported on the blue lines indicated in Figure 19 on page 153.

The detailed calculation of the safety impact is very similar to the one time losses at road-rail crossings in "Annex M: Calculation of rail-road crossing time losses" on page 267.

The table below gives an overview of the costs in 2020, 2025 and 2030 and the NPV of all years for 2 variants. The A52 variant has equal costs in the Netherlands, because most accidents will occur on the Budel-Roermond section, the different Roermond-Germany section has no so much influence. In Belgium, this is a bit lower due to a larger number of trains din the A52 variant. In Germany, the benefits are larger for the A52 variant compared to the historical variant, because the A52 variant has no road-rail crossings in Germany (and the Iron Rhine variant does).

The electrified variants have similar values.

Table 56: Change accident costs in €$_{2005}$
Negative values equal a cost, positive values a benefit
Source: own calculations

		NPV 4%	2020	2025	2030
Historical Iron Rhine- 2A	Belgium	11 430 506	652 439	670 085	687 731
	Netherlands	3 727 389	216 539	219 692	222 844
	Germany	1 321 694	71 329	76 196	81 063
	Total	16 479 588	940 307	965 973	991 639
Iron Rhine via A52 - 2A	Belgium	9 772 857	567 187	575 836	584 485
	Netherlands	4 092 722	234 367	240 163	245 959
	Germany	6 267 628	361 432	368 575	375 719
	Total	20 133 207	1 162 986	1 184 574	1 206 163

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used.

III.3.4. Recreation

In this section we discuss the effects of the project alternative which occur every year. Apart from the volume related external costs which were discussed in other sections (effects on emissions, noise, accidents, time losses at crossings), the only remaining yearly external cost is recreation.

The effect of the reactivation on the Iron Rhine is threefold. All three effects cause deterioration of the recreational area and consequently people will visit these areas less often. There is:

- a loss of recreational area,
- an increase in fragmentation,
- an increase in ecological disturbance.

III.3.4.1. Historical Iron Rhine variants

a. Loss of recreational area

For the valuation of *the loss of recreational area* in The Netherlands we used the 'shortage' method as described in Ruijgrok et al (2006)[53]. With this method the current supply and demand of recreational visits in an area is given. When decreasing the recreational area, supply decreases and loss of demand is calculated. Since in this case only small areas of land are lost in different places and this in areas with a high share of recreational area (many & large green areas), change in demand due to loss of area is very low. Costs are calculated by losses of net benefit (consumer surplus) per visit and equals 0.056 million €/year. Belgium and Germany do not suffer loss of recreational area due to the project as the Iron Rhine is an existing track which is already in use.

[53] Ruijgrok (2006), Witteveen & Bos: "*Kentallen Waardering Natuur, Water, Bodem en Landschap Hulpmiddel bij MKBA's*"

The calculation can be found in the table below. The areas mentioned are recreation areas, which is more than only the Natura-2000 areas. The area sizes are derived from SO I[54].

Table 57: Calculation of loss of recreational area, Netherlands, €$_{2005}$/year

		Name	Type
Part A (Budel-Weert)	3.8 ha	Weerter- en Budelbergen	Mixed forest
Part B (Weert-Roermond)	4.3 ha 2,5 ha	Leudal Leudal	Wetlands Dry conifer forest
Part C (Roermond)	12.5 ha	Melickerheide	Deciduous forest
Part D (Meinweg)	1.8 ha	Meinweg	Conifer forest + heathland
Total loss of recreation area	24.9 ha		
Cost (willingness-to-pay)	2 268.6 €/ha/year	Average of: Hanley & Pash (1993): 2 230 €/ha/year Willis (1995): 1 086 €/ha/year Bishop (1992): 3 490 €/ha/year	
Total cost	56 489.3 €/year		

b. Fragmentation of recreational area

The external cost due to *fragmentation of recreational areas* is not considered for two reasons. First, if enough crossings are foreseen, the fragmentation effect of infrastructure is mitigated and cost is zero (this is the case with the Meinweg area). Second, apart from the Meinweg, no big recreational areas are crossed by rail track where traffic is increasing dramatically due to the project.

c. Disturbance

For the valuation of *disturbance* we also used the 'shortage' method. For disturbance, the area affected is larger and situated in the three countries. The valuation is taken from Ruijgrok[55], which uses a stated preference WTP (*willingness to pay*). The number of bikers and hikers per acre is also derived from Ruijgrok. The calculation can be found in the table below. The resulting cost is 0.108 million €$_{2005}$/year.

[54] SO I stands for "Studie Opdracht I" and discusses the effects of the reactivation of the Iron Rhine following the trajectory for the Dutch part of the line.
[55] Ruijgrok (2006), Witteveen & Bos: "*Kentallen Waardering Natuur, Water, Bodem en Landschap Hulpmiddel bij MKBA's". The valuation of the recreational noise could not be verified as Ruijgrok does not gove any sources for his calculations.*

Table 58: Calculation of recreation disturbance, Netherlands, €2005/year

			Hiking (number of trips per ha per year)				Bikers (number of trips per ha per year)			
Community		Area	Agrarian country-side	Wet na-ture	Dry na-ture	Forests, parks	Agrarian country-side	Wet nature	Dry nature, forests	Parks
Bergen	Weert	Boshoven buitengebied	11	93	187	280	23	19	38	58
	Weert	Industrieterrein Boshoverheide	14	113	227	340	23	19	38	57
	Cranendock	Verspreide huizen in het Oosten	9	78	157	235	24	19	38	58
	Cranendock	Industrieterrein Dorplein	13	103	206	308	22	18	35	53
Melickerheide	Roermond		19	131	263	394	38	28	56	84
	Roermond	Kitkensberg en omgeving	18	123	247	370	41	31	62	92
Meinweg + Roerdal	Roerdalen	Verspreide huizen Herkenbosch	21	138	276	414	43	31	63	94
	Roerdalen	Vlodrop	18	120	240	361	46	34	68	102

		Hiking	Bikers
Total number of trips per ha per year	Bergen	2375	544
	Melickerheide + Meinweg + Roerdal	3154	914

		Hiking + Bikers	Hiking + Bikers
	Total area	Disturbed area (> 55dB)	Disturbed area * # dB above 55dB
Bergen	1150 ha	117.81 ha	911.64 ha*dB
Melickerheide + Meinweg + Roerdal	850 ha	95.37 ha	737.99 ha*dB

	Hiking	Bikers
Willingness to pay	0,018 €/dB/trip	0,023 €/dB/trip

		Hiking	Bikers	Total
Number of disturbed trips * dB (above 55) per year	Bergen	2 164 861	495 724	
	Melickerheide + Meinweg + Roerdal	2 327 670	674 568	
	TOTAL	4 492 531	1 170 292	
TOTAL euro per year		80 866	26 917	107 782

For Belgium, the Dutch values are extrapolated to 0.021 million €2005/year and for Germany to 0.109 million €2005/year. For the extrapolation, the area surface has been used as a factor.

Table 59: Recreation area in disturbance interval

	BE	NL	DE
Historical Iron Rhine	173.28 ha	867.7 ha	875.02 ha
Iron Rhine via A52	173.28 ha	855.9 ha	875.02 ha
SOURCE	*Disturbed area (40 dB from LISEC study*	*PEHS area (36dB) from SO I*[56]	*PEHS are from International study*[57]

The result can be found in the table below.

Table 60: Recreation disturbance, €$_{2005}$ /year

BE	NL	DE
21 524	107 782	108 692

An overview per section can be found in "Annex Q: Calculation of noise and recreation per section".

d. Total

The table below gives an overview of the total recreation costs and benefits.

Table 61: The recreation damage in €$_{2005}$/year, "Historical Iron Rhine" scenarios
Source: own calculations. Negative values are a cost, positive values a benefit.

	NPV 4%	Yearly
Belgium	-400 182	-21 524
Netherlands	-3 054 173	-164 272
Germany	-2 020 817	-108 692
Total	-5 475 172	-294 487

III.3.4.2. A52 variants

a. Loss of recreational area

For the valuation of *the loss of recreational area,* we assume no loss of recreation areas in The Netherlands in part D of the table above (Table 57), as the additional track is next to a motorway. Belgium does not suffer loss of recreational area and quality due to the project as the Iron Rhine is an existing track which is already in use. For Germany we did not have data, though most probably there will be some effect, as the motorway A52 passes several FFH- and nature protection areas, as the nature and bird protection area "Nierstal" and the river "Niers".

b. Fragmentation of recreational area

The *fragmentation of recreational areas* is zero as for the historical Iron Rhine.

[56] B.C.J. Weijers et. al. (2008): "IJzeren Rijn: Actualisering 2007 Eindrapportage studieopdracht I Actualisatie ontwerp tracévariant A3 BIJLAGE H: Trillingsonderzoek" (reference: TCE5-27-I-L11-043r).
[57] "Comparative cross-border study on the Iron Rhine" - Final Report of 14th of May, 2001, ARCADIS 2001

c. Disturbance

For the valuation of *the disturbance,* we assume no disturbance in The Netherlands in part D of the table above (Table 57), as the additional track is next to a motorway. For Belgium, the valuation is the same as for the historical Iron Rhine. For Germany we did not have data, though most probably there will be some effect, as the motorway A52 passes several FFH- and nature protection areas.

d. Total

Table 62: The recreation damage in €$_{2005}$/year, "Iron Rhine via A52" scenarios
Source: own calculations. Negative values are a cost, positive values a benefit.

	NPV 4% in 2007	yearly
Belgium	-400 182	-21 524
Netherlands	-1 383 584	-74 417
Germany	NA	NA
Total	-1 783 766	-95 942

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used.

III.3.5. Vibrations

For the effect of vibrations we distinguish damage from disturbance costs. As an input, vibration research of SO I[58] is used. This report delivers number of houses within a given range of critical vibrations levels for both disturbance and property damage. Based on these figures, marginal external vibration cost is calculated for The Netherlands and applied to Belgium and Germany.

Disturbance

We assume that real estate values decrease 5% for houses suffering from increased rail *disturbance* and 10% for houses suffering damage due to rail vibrations. These percentages are an estimate based on Ruijgrok et al (2006). Average real estate values are set at 200 000 € per house[59].

Disturbance due to vibrations is linear with the dose, implying a linear correlation with traffic[60]. Based on Dutch volumes and determined cost levels, we calculated a marginal vibration annoyance cost per tonne-km and applied it for Belgium and Germany.

[58] B.C.J. Weijers et. al. (2008): "IJzeren Rijn: Actualisering 2007 Eindrapportage studieopdracht I Actualisatie ontwerp tracévariant A3 BIJLAGE H: Trillingsonderzoek" (reference: TCE5-27-I-L11-043r).
[59] Source: CBS: http://statline.cbs.nl/StatWeb/table.asp?PA=37610
[60] Expert opinion from Mattias Schevenels (Department of Civil Engineering, K.U.Leuven).

Table 63: Disturbance costs in million €$_{2005}$ for the historical Iron Rhine variant, costs occur in 2015
Negative values equal a cost, positive values a benefit
Source: own calculations

	Iron Rhine	Montzen	Total
Belgium	-1.90	3.05	1.15
Netherlands	-1.26	0.00	-1.26
Germany	-1.64	2.12	0.48
TOTAL	-4.80	5.17	0.37

Note that "Iron Rhine" and "Montzen" routes are defined here quite broad. It includes the additional (to the reference scenario) volume that is transported on the blue lines indicated in Figure 19 on page 153.

<u>Damage</u>

The marginal cost of *damage* is a function of the peak load of vibrations[61]. This means that damage due to vibrations is the same for 15 trains or for 35 trains, given the same peak load vibration emissions of the trains. For determining the increase of external costs, we determined the km of track with a significant[62] increase of freight trains (causing increased peak level) for The Netherlands, and determined the marginal cost in €/km track. We then applied this factor for Belgium and Germany, after determining the length of track with significant increase of freight trains.

For *damage*, it is assumed that the decrease of volume on the Montzen route, is not enough to decrease the vibration peak level, thus assuming no effect.

<u>Result</u>

Both vibration costs are calculated as one shot effect cost because the valuation methodology uses real estate value decreases. The results for external cost of vibrations are summarized in Table 64.

Table 64: Change vibration costs in €$_{2005}$
Negative values equal a cost, positive values a benefit
Source: own calculations

		NPV 4% in 2007	Historical Iron Rhine (in 2015)	NPV 4% In 2007	Iron Rhine via A52 (in 2015)
Belgium	Damage	-58 394	-79 916	-58 394	-79 916
	Disturbance	840 039	1 149 652	545 845	747 027
Netherlands	Damage	-43 841	-60 000	-43 841	-60 000
	Disturbance	-920 670	-1 260 000	-920 670	-1 260 000
Germany	Damage	-34 447	-47 143	-34 447	-47 143
	Disturbance	353 076	483 209	239 150	327 293

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used.

[61] Expert opinion from Mattias Schevenels (Department of Civil Engineering, K.U.Leuven)
[62] We considered "significant" as an increase of traffic with at least a factor 5 as an estimate.

III.3.6. Living environment

Similar to recreational losses, the effect on the living environment is threefold. There is:

- the loss of living area,
- the increase in fragmentation,
- the increase in disturbance.

Loss of living area

The *loss of living area* (residential & industrial land) due to new infrastructure is only relevant in The Netherlands as there are no expropriations in Belgium and Germany on the historical Iron Rhine. The calculation of external cost of expropriations is not straight forward. ProRail applies the following approach when determining the cost for expropriations:

1. The property value assessment by external experts.
2. Compensation for additional damage to the owner: indirect cost for the purchase of a replacing property, moving cost, financing cost, …
3. Legal and unforeseen costs

According to ProRail, this last term is to be set at 17% of property value and additional compensation cost together. So the three cost-elements together represent the actual and total costs of the loss of living area.

As a consequence, the cost for expropriation is higher then the market price of the property, but this "overcompensation" cannot be perceived as a benefit for the owner or The Netherlands as these are forced expropriation and require additional cost for legal handling etc. Therefore, the "overcompensation" is not seen as a benefit for The Netherlands and it is assumed that the budget foreseen in the investment cost for expropriations compensates the costs.

For the A52 variant, we assume that there will be no expropriations for the part of the railway that is next to the motorway.

Effect on fragmentation

The *effect on fragmentation* is hard to valuate and probably very small, and hence is taken as Pro Memori.

Disturbance

Disturbance is assumed zero since this would lead to double counts as disturbance of living area is a combination of aspects, which are already taken into account:

- due to noise,
- due to vibrations,
- perceived risk.

Result

Table 65: Change living environment costs in €2005
Negative values equal a cost, positive values a benefit
Source: own calculations

		NPV 4%	Historical Iron Rhine	NPV 4%	Iron Rhine via A52
Belgium	Loss of living area	0	0	0	0
	Fragmentation	PM	PM	PM	PM
	Disturbance	0	0	0	0
Netherlands	Loss of living area	0	0	0	0
	Fragmentation	PM	PM	PM	PM
	Disturbance	0	0	0	0
Germany	Loss of living area	0	0	0	0
	Fragmentation	PM	PM	PM	PM
	Disturbance	0	0	0	0

III.3.7. Landscape and archaeology

For the valuation of landscape we distinguish the effects on:

- landscape itself,
- GEA-objects[63],
- culture,
- archaeology.

Landscape

For the merely visual effect on landscape, the method as described in Ruijgrok et al (2006)[64] was not applicable, as Ruijgrok leaves both quantification of the effect on landscape (e.g. nr. of houses suffering from deteriorated landscape) and valuation per quantity unit (e.g. real estate value decrease or WTP per household) open to be determined project-specific. A study of this kind was not the topic in MER or other SO studies, so other, existing yet simplified input data was used for external cost estimation. Therefore we used a valuation study by Bowker and Didychuk[65], focusing on agricultural landscape loss, with low value for the landscape. Bowker and Didychuk came up with 142.6 €$_{2005}$/ha and included landscape conservation exclusively. The calculated valuation is based on WTP (stated preference) in €/ha, allowing easy compatibility with SO I & MER[66]. As only a very limited amount of landscape is lost due to the newly built track around Roermond (25 ha, according to the international study[67]), this results in a very low value of approximately 3565 €$_{2005}$.

[63] A GEA object is an object with geological or geomorphological value. (e.g. Dunes, "holle wegen", natural terraces,…).
[64] Ruijgrok (2006), Witteveen & Bos: "*Kentallen Waardering Natuur, Water, Bodem en Landschap Hulpmiddel bij MKBA's*"
[65] J.M. Bowker and D.D. Didychuk (1994): "*Estimation of the Nonmarket Benefits of Agricultural Land Retention in Eastern Canada.*"
[66] TCE, Transport Consultants and Engineers (Witteveen+Bos/DE-Consult) (2001): *"Trajectnota/MER IJzeren Rijn Hoofdrapport deel B: Achtergronden"*
[67] "Comparative cross-border study on the Iron Rhine" - Final Report of 14th of May, 2001, ARCADIS 2001

For the A52 variant we assumed equal effects as for the historical Iron Rhine, as the effect only occurs around Roermond thus in each scenario in the same way.

Effect on landscape is only valid for The Netherlands as the track in Belgium already existst and the new track in Germany is next to a highway, therefore not increasing the visual intrusion.

GEA-objects

"*Trajectnota/MER & SO I*"[68] state no effects on GEA-objects are observed, hence the effect is zero.

Culture

No effects are mentioned in "*Trajectnota/MER, SO I*" and the international study on culture.

Archaeology

The cost of archaeological research (of the order of 3.7 million € for the historical iron Rhine and 3.2 million € for the A52 variant) is included in the investment cost. This is only relevant for new track. They are considered as preventive measures to avoid damage. Hence no archaeological benefits need to be included. [69]

Result

Table 66: Change landscape and archaeology costs in €$_{2005}$
Negative values equal a cost, positive values a benefit
Source: own calculations

		NPV 4%	Historical Iron Rhine	NPV 4%	Iron Rhine via A52
Belgium	Landscape	0	0	0	0
	GEA-objects	PM	PM	PM	PM
	Culture	0	0	0	0
	Archaeology	0	0	0	0
Netherlands	Landscape	-2 605	-3 565	-2 605	-3 565
	GEA-objects	PM	PM	PM	PM
	Culture	0	0	0	0
	Archaeology	0	0	0	0
Germany	Landscape	0	0	0	0
	GEA-objects	PM	PM	PM	PM
	Culture	0	0	0	0
	Archaeology	0	0	0	0

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used.

[68] SO I stands for "Studie Opdracht I" and discusses the effects of the reactivation of the Iron Rhine following the trajectory for the Dutch part of the line. B.C.J. Weijers et. al. (2008): "IJzeren Rijn: Actualisering 2007 Eindrapportage studieopdracht I Actualisatie ontwerp tracévariant A3 BIJLAGE H: Trillingsonderzoek" (reference: TCE5-27-I-L11-043r).

[69] Decision of COD of October 2 2008

III.3.8. Ecology

The external costs on ecology can be calculated using different approaches. Here we use only one approach – the compensation approach.

The compensation plan approach consists in compensating the loss of ecological valuable area by turning an equivalent area of agricultural land into ecological valuable area. The investment cost of acquiring and preparing the agricultural land for this purpose mitigates all ecological effects. So it is sufficient to add this cost to the investment cost.

The investment foreseen in The Netherlands is approximately 28 million € for compensation to reach full mitigation and this sum is already included in the investment cost. The investment costs in Germany also contain a compensation plan and hence no external cost of ecology is taken up. Only the Belgian investment costs do not yet contain a compensation plan and for that reason we foresee an ecological cost of 4.765 million € (computed via the compensation plan approach).

Table 67: Change ecology costs in €$_{2005}$
Negative values equal a cost, positive values a benefit
Source: own calculations

		Historical Iron Rhine	Iron Rhine via A52
Belgium	Loss of ecological area	4.765	4.765
	Fragmentation	0	0
Netherlands	Loss of ecological area	0	0
	Fragmentation	0	0
	Disturbance	0	0
Germany	Loss of ecological area	0	0
	Fragmentation	0	0
	Disturbance	0	0

III.3.9. Soil & water

There are benefits of clean soil that will emerge from soil sanitation at several sites due to the construction/upgrading of the Iron Rhine track. As the soil and water sanitation is anticipated by the infrastructure project, the benefits are probably lower than the costs. Benefits are estimated at one half of the costs[70]. Costs of sanitation are estimated at app. 8 million € and are included in the investment costs. The benefits are then equal to 4 million €.

Negative effects due to changes in groundwater level due to the project are mitigated in the design phase. This could be e.g. mitigation in Germany, close to the bird protection area "Nierstal" and the river "Niers". It is not sure that this mitigation is included in the investment costs, therefore there might be a water problem left. We could not estimate the value of this, therefore it is treated as PM.

No additional water pollution is expected by the (increased) use of the Iron Rhine tracks.

[70] Decision of COD of October 2 2008

For the A52 variant, there is soil sanitation needed, as additional soil sanitation is needed for the area where the new track is to be built. In The Netherlands there will be build approx. 7 km new track, in Germany 28 km new track.

Table 68: Change soil and water costs in €$_{2005}$
Negative values equal a cost, positive values a benefit
Source: own calculations

		NPV 4% In 2007	Historical Iron Rhine (in 2015)	NPV 4% in 2007	Iron Rhine via A52 (in 2015)
Belgium	soil	0	0	0	0
	soil pollution	PM	PM	PM	PM
	water	0	0	0	0
	ground water	0	0	0	0
Netherlands	soil	0	0	0	0
	soil pollution	2 920 939	3 997 507	322 256	441 029
	water	0	0	0	0
	ground water	0	0	0	0
Germany	soil	0	0	0	0
	soil pollution	PM	PM	PM	PM
	water	0	0	PM	PM
	ground water	0	0	PM	PM

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used.

III.3.10. Agriculture

The valuation of loss of agricultural area is based on the market values of agricultural ground. As this is already included in the investment costs, including this valuation here would lead to double counting.

Moreover note that if we take into account the fact that agriculture is subsidized, the direct opportunity cost of agriculture land due to infrastructure could lead to a benefit (for example in Moons et al (2007), the loss of agriculture land is valued at -1938 €/ha/year so a benefit).

III.4. Effects on road transport

For roads we calculate the indirect effect on the road market, which is equal to the difference between the taxes and the marginal external cost times the change in volumes for each country. The marginal external costs exist of the marginal external congestion, infrastructure, emissions and noise costs and the change in time costs at crossings.

III.4.1. Effect on taxes paid

The difference in taxed paid by road modes is calculated by multiplying the tax per vehicle-km with the difference in volumes.

Table 69: Effect on volumes for road transport, 2020, 2025 and 2030, in vehicle-km

		2020	2025	2030
Belgium	Vehicle-km Reference	9 353 926 248	10 061 301 469	10 822 170 773
	Vehicle-km Historical Iron Rhine – 2A	9 353 562 315	10 060 899 269	10 821 726 599
	Difference	-363 932	-402 200	-444 174
Netherlands	Vehicle-km Reference	6 928 870 702	7 449 452 548	8 009 146 896
	Vehicle-km Historical Iron Rhine – 2A	6 928 708 894	7 449 272 717	8 008 947 246
	Difference	-161 808	-179 831	-199 650
Germany	Vehicle-km Reference	58 759 362 141	62 771 370 296	67 057 312 832
	Vehicle-km Historical Iron Rhine – 2A	58 757 766 064	62 769 577 037	67 055 302 905
	Difference	-1 596 077	-1 793 259	-2 009 927

The tax[71] per vehicle-km is based on the TREMOVE model as this model predicts taxes up to the year 2030 and includes the registration tax, the ownership tax, possible network taxes (for example the German Maut), the insurance tax and the fuel tax.

Note that these tax levels are higher than the external emission costs for trucks. The main reason is that truck emissions will drop down drastically now and in the near future, due to the introduction of Euro standards for emissions. However, the tax levels are lower than the total external costs (emissions, plus accidents, road wear & tear, noise, congestion).

Table 70: Tax levels for truck transport (€/vehicle-km)

	2020			2030		
	Belgium	**Germany**	**The Netherlands**	**Belgium**	**Germany**	**The Netherlands**
Registration taxes	0.000 €	0.000 €	0.000 €	0.000 €	0.000 €	0.000 €
Ownership taxes	0.008 €	0.016 €	0.026 €	0.008 €	0.016 €	0.027 €
Network taxes	0.031 €	0.078 €	0.031 €	0.031 €	0.078 €	0.031 €
Insurance taxes	0.004 €	0.009 €	0.016 €	0.005 €	0.010 €	0.017 €
Fuel taxes	0.079 €	0.099 €	0.090 €	0.081 €	0.100 €	0.092 €
TOTAL	**0.12 €**	**0.20 €**	**0.17 €**	**0.12 €**	**0.20 €**	**0.17 €**

[71] The TREMOVE model includes 1 type of light duty vehicle and 4 types of heavy duty vehicles. Given that substitution with rail will not take place with the light duty type, we used the average tax for heavy duty vehicles.

The result of the calculation can be found in the table below.

Table 71: Difference in tax revenue road mode for the year 2020, 2025 and 2030, NPV for all years, historical Iron Rhine – 2A, in €$_{2005}$
Source: Transport forecast, own calculations with TREMOVE
Negative values are costs, positive values are benefits.

	NPV 4%	2020	2025	2030
Belgium	950 539	44 651	49 723	55 331
Netherlands	567 615	26 524	29 660	33 131
Germany	6 951 037	322 174	362 752	407 452
Total	8 469 191	393 350	442 134	495 913

The prices in the above are in €$_{2005}$. To convert to €$_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used. For the other scenarios, similar calculations have been made.

Note that these tax benefits also occur as a cost at the government level (see chapter III.5.1 on page 146), and in the MCPF calculation (see chapter III.7.2on page 150).

III.4.2. Effect on congestion

The effects on congestion are calculated by estimating the effect of a reduction of the truck volumes on the average speeds on the motorways in the study area.

For this, speed-flow functions have been used for each of the relevant motorways:

$$T = T_{\mathrm{ff}}\left(1+\alpha\left(\frac{q}{q_{\max}}\right)^{\beta}\right)$$

In this relation, T_{ff} corresponds to the travel time under free-flow conditions, $q_{\max}$ to the maximum observed daily volume, and α and β are parameters that influence the shape of the function.

The parameters of these speed-flow functions have been estimated based on data of the Belgian motorways in the study area. More detail on this can be found in "Annex N: Estimating road travel times with speed flow functions" on page 271.

Effects on travel times

In the next sections, we give the estimation results for 19 motorways. A sample calculation for the year 2020 of the scenario "historical Iron Rhine – 2A" can be found in the table below.

Table 72: Calculation of travel time gains, scenario "historical Iron Rhine – 2A", year 2020

	Truck-km/year Without Iron Rhine	Truck-km/year With Iron Rhine	Time gains (min/km)	Benefit cars (hours/year)	Benefit trucks (hours/year)
Belgium					
R1 ringway Antwerp	183 784 386	183 775 376	-0.0000464	241	142
E313 between ringway Antwerp and interchange in Ranst	146 279 128	146 258 116	-0.0001093	357	266
E313 between interchange Ranst and interchange Lummen	323 225 401	323 166 343	-0.0002162	3 690	1 164
E34 between interchange Ranst and Ducth border	488 685 869	488 590 773	-0.0001874	2 258	1 526
E314 between interchange Lum-men and Dutch border	267 240 569	267 184 381	-0.0002002	1 848	891
Netherlands					
E34 complete Dutch part	429 248 459	429 133 349	-0.0002060	3 184	1 473
E314 complete Dutch part	186 575 282	186 545 734	-0.0001768	939	550
E35 complete Dutch part	369 088 342	369 087 890	-0.0000002	13	1
E31 complete Dutch part	258 398 307	258 397 959	-0.0000002	11	1
E25 complete Dutch part	867 606 920	867 596 781	-0.0000029	271	41
E30 complete Dutch part	703 635 438	703 635 096	-0.0000001	9	2
E231 complete Dutch part	140 165 448	140 165 436	0.0000000	0	0
Germany					
E34 complete German part	1 531 580 364	1 531 338 969	-0.0000863	5 422	2 203
E314/E40 complete German part	3 692 157 597	3 692 024 680	-0.0000207	3 173	1 277
E35 complete German part	3 861 999 608	3 861 883 478	-0.0000151	2 756	973
E31 complete German part	1 551 880 078	1 551 789 392	-0.0000201	2 104	521
E30 complete German part	3 040 502 598	3 040 133 777	-0.0000660	8 712	3 345
E52 complete German part	3 352 219 123	3 352 151 331	-0.0000098	1 487	550
E41 complete German part	2 662 198 551	2 662 132 052	-0.0000098	1 463	437

Calculation monetary time gain

Given the relationships estimated above and the results of the traffic forecasts, we calculated the monetary effect of the change in congestion by multiplying the gain in time with the value of time, taking into account the distribution of cars and trucks on those particular links and multiplying everything by the volume. This is equivalent to the computation of the product of the marginal external congestion cost and the change in road traffic volume.

$$MECCdx = \left[\frac{\delta TTC}{\delta x} - ATC\right]dx = x\frac{\delta ATC}{\delta x}dx$$

where TTC= Total travel cost, ATC= Average travel cost paid by user
MECC= marginal external congestion cost; x= volume of traffic

Table 73: VOT

value of time car (€/hour)	7.369
value of time truck (€/hour)	26.689

The overall results per scenario can be found in the table below. These are results for the year 2020. The other years have similar results (increasing up to 2030 due to background congestion caused by the increased road traffic).

Table 74: Overall results for congestion, for the year 2020, €/year

	Historical Iron Rhine 2A	Historical Iron Rhine 2B
R1 ringway Antwerp	5 567	2 630
E313 between ringway Antwerp and interchange in Ranst	9 742	6 937
E313 between interchange Ranst and interchange Lummen	58 270	16 074
E34 between interchange Ranst and Dutch border	57 364	34 913
E314 between interchange Lummen and Dutch border	37 411	17 142
Belgium total	**168 355**	**77 696**
E34 complete Dutch part	62 780	37 683
E314 complete Dutch part	21 590	8 890
E35 complete Dutch part	136	80
E31 complete Dutch part	105	59
E25 complete Dutch part	3 107	2 030
E30 complete Dutch part	103	66
E231 complete Dutch part	3	2
Netherlands total	**87 825**	**48 810**
E34 complete German part	98 748	59 348
E314/E40 complete German part	57 449	33 134
E35 complete German part	46 274	24 563
E31 complete German part	29 400	15 627
E30 complete German part	153 470	96 482
E52 complete German part	25 632	14 656
E41 complete German part	22 437	13 737
Germany total	**433 410**	**257 547**

Sample calculation for E313 between ringway Antwerp and interchange in Ranst in 2020:

1. The volume in truck-km decreases from 146 279 128 to 146 258 116, or 21 012 truck-km/year less in 2020.
2. The volume of car-km is assumed to be constant: 196 201 959 car-km/year
3. The total car-equivalent decreases from 577 976 367 to 577 922 698 car-eq./year (assuming 1 truck = 2.5 cars)
4. The travel time needed per km decreases from 1.29223 to 1.29212 minutes. The speed-flow function used is: (1+0.2*((x/511074881)^4)) with x=577.976.367 or.577.922.698, and the result in minutes.
5. The time gains are -0.0001093 min/km.
6. Multiplied by the total number of truck-km gives a gain of 266 hours/year. For cars, this is 357 hours/year.
7. Multiplied by the value of time (7.369 for cars, 26.689 for trucks) gives the saved travel time costs.

The prices in the above are in $€_{2005}$. To convert to $€_{2007}$ for the overview SCBA table, a factor of 0.9885 will be used.

Calculated as an external cost per vkm, the values are in the range of 0.13 to 0.98 €/vkm in 2020, depending on the motorway. These are high numbers, due to the fact that the speed-flow functions were chosen rather steep.

III.4.3. Time losses at crossings

When rail traffic increases, road-rail crossing will be closed more often leading to increased waiting times for road vehicles at rail crossings.

The Netherlands

The number of train and road vehicles per crossing is known in a reference case, a project case with mitigation measures and a project case without mitigation measures for The Netherlands. The data used here is the same as for road-rail crossing safety: SO I[72] "*L18 overwegveiligheid*"[73]). From this data, the increased waiting time is calculated.

For all Iron Rhine road-rail crossings in the Netherlands, SO I delivers road traffic intensity, waiting time per train passing and number of trains passing in reference and project case. From these data, for every crossing the total time loss is calculated. The activity figures (road and rail passings) are allocated to different periods of day: daytime (12h), evening (4h) and night (8h). This further desaggregation is needed to take into account the relatively high rail activity at night compared to a low road activity, thus avoiding most car-train passings and consequent time loss (and accidents). Below a calculation example for e.g. "Fabriekstraat" (on tracé A), "daytime" is given:

1. *Road traffic intensity: 98 passings per hour (= 1.63 passings/minute)*
2. *Waiting time per train passing: 1 min/passing*
3. *Trains passings: reference scenario: average of 1.6, historical Iron Rhine – 2A: 42.2 trains per daytime period.*
4. *The additional closing time due to increased rail activity is consequently: (42.2-1.6) * 1 = 40.5 min/daytime*
5. *This additional closing time affects more road users, namely: 1.63 * 40.5 = 66.15 minutes additional time loss per 12h daytime period due to increased rail activity due to the project.*

In the Netherlands, a total of 15 road-rail crossings exist over the 44.78 km track (smaller rail-road crossings are not taken into account). Due to the project, some frequently used crossings will be replaced by viaducts or underpassings. Off course, the passings being upgraded are exactly those that suffer the highest number of train-car passings, so by upgrading 3 of the busiest road-rail crossings, the overall results is actually a decrease in total time loss at crossings.

An overview of calculations of all crossings can be found in "Annex M: Calculation of rail-road crossing time losses" on page 267.

[72] B.C.J. Weijers et. al. (2008): "IJzeren Rijn: Actualisering 2007 Eindrapportage studieopdracht I Actualisatie ontwerp tracévariant A3 HOOFDRAPPORT" (reference: TCE5-27-I-L01-007r). A newer version of this report is in progress.

[73] A.J.M. Snel et. al. (2007): "*IJzeren Rijn, Actualisering 2007 Studieopdracht I - II – III L18: Externe Veiligheid Overwegveiligheid Eindrapport beoordeling overwegen.*"

Marginal cost due to waiting time at crossings is determined by multiplying this increased waiting time witch a value of time (VOT). VOT's are taken from the TREMOVE model; average values for all road vehicles types were calculated. Increased waiting time is determined for 3 periods of day: a day-period (VOT: 4.2€/h), an evening-period (VOT: 6.4€/h) and a night-period (VOT: 2.1€/h).

Belgium and Germany

The table below contains the rail-road level crossings on the Iron Rhine in Belgium.

Table 75: Safety categories on rail-road crossing, line 15 (Belgium Iron Rhine), status 2008

Line	Cat 1: Fully equipped	Cat 2: Medium equipped	Cat 3: Only light and sound	Cat 4: No light and sound	Total
Iron Rhine + Montzen (Antwerp – Lier)		5			5
Iron Rhine route (Lier – border)	3	64	2	3	72
Montzen route (Lier – border)	1	71	4	1	77

Belgium plans to remove 1 crossing in Neerpelt in the near future. This is included in the reference scenario. The Iron Rhine project itself does not have mitigation measures foreseen for road-rail crossings.

Germany has a lot of level crossings in the historical track of the Iron Rhine; the new A52-track will be build without level crossings. Germany has no rail-road level crossings on the Montzen line, between the Belgian border and Aachen-West, but there are level crossing further on the line.

For Belgium and Germany, the marginal cost due to time losses at level crossings in a case without mitigation measures from The Netherlands is used. Again this implicitly assumes that the type of crossings are the same in all countries. The marginal cost due to time loss is scaled with a factor representing the number of rail-road level crossing per km track.

Results

Results are differences in time cost per year, based on number of trains passing. In Table 76 results for 2020 are shown. As the Iron Rhine is shorter and not much extra traffic is generated, total rail-road time loss costs decrease for all countries.

Table 76: Change in cost due to time losses at crossings in million €$_{2005}$ for scenario "Historical Iron Rhine – 2A", 2020

Source: own calculations. Negative values equal a cost, positive values a benefit

	Iron Rhine	Montzen line	Total
Belgium	-0.453	0.889	0.436
The Netherlands	0.256	---	0.256
Germany	-0.179	0.230	0.051

Table 77: Change in cost due to time losses at crossings in €2005 for scenario "Historical Iron Rhine – 2A"
Negative values equal a cost, positive values a benefit
Source: own calculations

		NPV 4%	2020	2025	2030
Historical Iron Rhine- 2A	Belgium	7 253 260	414 007	425 204	436 402
	Netherlands	4 276 649	248 448	252 065	255 682
	Germany	838 684	45 262	48 351	51 439
	Total	12 368 593	707 717	725 620	743 523

III.4.4. Effect on road safety

The road safety costs are calculated by multiplying the reduction in truck-km with the marginal external accident cost of trucks. The latter has been derived from the GRACE project[74], where an extended calculation has been made based on accident risks and the values of a statistical life (VOSL). See tables below.

Table 78: Risk in 2004 for heavy duty vehicle (per million vehicle-km) and VOSL (€)
Sources: IRTAD, CARE: Annual Statistical Report (different years), HEATCO € 2002 Factor cost

	Risk			VOSL		
	Fatality	Severe injury	Slight injury	Fatality	Severe injury	Slight Injury
AT	0.01	0.33	1.51	1 683 000	231 300	18 300
BE	0.02	0.33	1.51	1 606 000	244 000	15 700
DE	0.01	0.21	0.96	1 496 000	209 400	17 100
FR	0.02	0.16	0.73	1 551 000	217 800	16 400
NL	0.01	0.06	0.25	1 672 000	223 600	18 000
UK	0.01	0.32	1.47	1 617 000	211 100	16 800

Table 79: Marginal external cost of accidents for heavy duty trucks larger than 32 tonnes in €2005/vehicle-km

Belgium	0.07337046
The Netherlands	0.02956696
Germany	0.05121686

The results of the calculation can be found in the table below:

Table 80: The effect on road safety in €2005/year, for 2030
Source: own calculations. Negative values equal a cost, positive values a benefit

Country	Historical Iron Rhine 2A	Iron Rhine via A52 2A	Electrified historical Iron Rhine 2A	Electrified Iron Rhine via A52 2A	Historical Iron Rhine 2B
Belgium	687 731	584 485	800 257	637 346	214 539
The Netherlands	222 844	245 959	207 496	155 176	284 459
Germany	81 063	375 719	84 752	402 512	30 278

The prices in the above are in €2005. To convert to €2007 for the overview SCBA table, a factor of 0.9885 has been used.

[74] GRACE = Generalization of Research on Accounts and Cost Estimation, a FP6 research project for the European Commission led by ITS Leeds, 2005-2007, http://www.grace-eu.org

III.4.5. Effect on external costs of emissions

The same methodology and valuations as for rail is used. For road we use yearly emissions factors from the TREMOVE[75] model. These emission factors take into account constant fleet renewal and improvement of technology with respect to emissions (e.g. Euro-standards). Distinction is made between freight traffic and passenger traffic. The table below gives the emission factors for heavy duty trucks.

Table 81: Emission factors for heavy duty trucks, well-to-tank, in g/tonne-km

	2015	2020	2025	2030
BE				
CH_4	0.044	0.041	0.040	0.040
CO	0.425	0.350	0.335	0.333
CO_2	745.067	749.172	750.727	750.750
N_2O	0.064	0.064	0.064	0.064
NMVOC	0.277	0.270	0.268	0.267
NOx	3.170	2.813	2.738	2.719
PM	0.101	0.096	0.095	0.094
SO_2	0.910	0.915	0.917	0.917
NL				
CH_4	0.057	0.046	0.039	0.079
CO	0.834	0.532	0.380	0.006
CO_2	661.127	655.031	651.306	25.616
N_2O	0.060	0.059	0.059	0.000
NMVOC	0.298	0.257	0.240	0.001
NOx	4.279	3.263	2.709	0.016
PM	0.133	0.099	0.086	0.000
SO_2	0.809	0.801	0.797	0.001
DE				
CH_4	0.056	0.047	0.045	0.045
CO	0.568	0.362	0.310	0.310
CO_2	856.113	852.047	851.330	853.144
N_2O	0.071	0.071	0.071	0.071
NMVOC	0.326	0.304	0.300	0.300
NOx	4.282	3.389	3.125	3.108
PM	0.126	0.112	0.108	0.109
SO_2	1.044	1.039	1.039	1.041

For the valuation, the same figures as for rail transport have been used (see III.3.1 page 112).

The emission "blame" matrix allocates emissions of a given country to other countries where damage due to emissions occur. This is adapted here to allocate the external costs to the countries. Paragraph III.3.1.4 on page 116 gives more detail.

The results for the year 2030 are shown in the table below.

[75] www.tremove.org

Table 82: Effect on emissions of road (million €$_{2005}$ in 2030) , scenario "Historical Iron Rhine – 2A"
Source: own calculations

	BE	NL	DE	Other countries
CH_4	0.000	0.000	0.000	0.000
CO	0.000	0.000	0.000	0.000
CO_2	0.013	0.007	0.052	0.000
N_2O	0.000	0.000	0.001	0.000
NMVOC	0.000	0.000	0.000	0.001
NOx	0.003	0.003	0.017	0.027
PM	0.001	0.001	0.004	0.005
SO_2	0.003	0.001	0.008	0.010

Due to the modal shift effect we also see a decrease in emissions for the other modes leading to a benefit. This is a second order effect compared to the effect on rail.

The scenarios do not differ very much, therefore only one scenario is given as an example. However, the emissions do differ in time. The truck emissions will drop down drastically now and in the near future, due to the introduction of Euro standards for emissions.

III.4.6. Effect on external costs of noise

The change of external noise cost of road transport is also calculated. Marginal noise cost values are taken from the UNITE project[76] and multiplied with the change in road transport activity. Results for 2030 are shown in the table below.

Table 83: The effect on noise in €$_{2005}$, for 2030
Source: Own calculations. Negative values equal a cost, positive values a benefit

Country	Historical Iron Rhine 2A	Iron Rhine via A52 2A	Electrified historical Iron Rhine 2A	Electrified Iron Rhine via A52 2A	Historical Iron Rhine 2B
Belgium	474 168	396 780	475 753	403 238	390 140
The Netherlands	191 168	187 923	185 405	183 793	214 304
Germany	782 125	747 372	768 001	748 044	796 237

III.4.7. Effect on marginal external wear & tear

The effect on marginal external infrastructure costs (this is the additional road wear and tear caused by heavy trucks) is calculated by multiplying the change in tonne-km with the marginal external infrastructure costs. The values of the marginal external infrastructure costs are shown in Table 84 and are based on the GRACE project. In this project, several methods have been compared and applied to case studies through Europe, leading to a marginal costs per (loaded) tonne-km for each country in Europe.

[76] UNITE = UNIfication of accounts and marginal costs for Transport Efficiency, a FP5 research project for the European Commission led by ITS Leeds, 2001-2002, http://www.its.leeds.ac.uk/projects/UNITE

Table 84: Marginal external infrastructure cost, in €$_{2005}$/tonne-km
Source: own calculations based on GRACE project, Deliverable 3 pages 12-37

Country	Marginal external infrastructure costs in €/tonne-km (loaded weight)	Average load factor of the largest truck size class (+32 tonnes)
Belgium	0.0034	11.3
Netherlands	0.0033	11.3
Germany	0.0042	11.3

This gives for the year 2020 and 2030, and for the net present value (NPV) for 2015-infinite the following results.

Table 85: Change in marginal external road wear & tear, historical Iron Rhine, in €$_{2005}$
Source: own calculations

Country	2020	2030	NPV 2007 (discount rate 4%)	NPV 2007 (discount rate 5.5%)
Belgium	13 982	17 065	294 699	189 352
Netherlands	6 034	7 445	128 084	82 202
Germany	75 750	95 391	1 629 697	1 043 648
Total	95 766	119 901	2 052 480	1 315 202

For the other scenarios, the calculations are similar.

The values above are lower than the values in the CE study "*De prijs van de reis*", 2004. In that study, 0.12335 €/vkm is suggested for combined trucks, and 0.0512 €/vkm for regular trucks above 12 tonne. However, in this study the average variable infrastructure cost is used, and it includes also costs for noise and accident mitigation, thus more than only the marginal road wear & tear costs.

III.5. Effects on inland waterways

The effects on inland waterways can be calculated as follows:

Indirect effect on market inland waterways = (net tax – marginal external costs) x variation in volume

III.5.1. Effect on tax revenues

The net tax is the tax revenue minus the marginal cost for the infrastructure manager of the inland waterways. We will calculate this effect for the four countries where we see an effect of the Iron Rhine being activated. These countries are Belgium, Germany, The Netherlands and France.

For the level of the taxes we rely on results of UNITE and personal communication Promotie Binnenvaart (20/05/2008). Note that in general, the level of taxes and charges for inland waterways are not well known. Although UNITE is slightly outdated we have opted to used this data as they are consistent over the different countries. Given the tendencies in Belgium, this means that we are overestimating the effect on tax revenue losses. Given the relatively low importance of the total effect, this should not be a major problem.

Belgium

Taxes and charges mainly consist of an infrastructure fee and an energy tax. The infrastructure fee are 0.000247894 $€_{2008}$/tonne-km in Flanders and 0 €/tonne-km in Wallonia. Inland waterways do not pay fuel duties but pay a small energy tax amounting to 0.013634 €/litre. In UNITE the total of charges and taxes amount to 6.18 million $€_{1998}$ in 2005. Given 5935 million tonne-km, this amount to an average tax of 0.00104 $€_{1998}$/tonne-km.

Germany

As in Belgium, there are no fuel taxes for inland waterways in Germany. In 1998 total charges amounted to 75 million €. On average – using 64 billion tonne-km – we then obtain an average charge of 0.00117 $€_{1998}$/tonne-km.

France

The total revenue of tax in France was 76 million $€_{1998}$. At the same time a subsidy was paid to the shippers of 20 million €. Total tax hence amounts to 56 million €. We divide this by the 73 billion tonne-km and obtain an average charge of 0.000767123 €/tonne-km.

The Netherlands

There is no tax on inland shipping in The Netherlands.

Table 86 shows the change in tonne-km, the tax per tonne-km and the difference in revenue for the year 2020. Note that the effect is largest in Germany. The total net present value (NPV) equals 64421 €.

Table 86: Change in taxes paid by inland shipping, historical Iron Rhine – 2A, effect for 2030, €$_{2005}$
Source: Unite, own calculations
Negative values are costs, positive values are benefits.

country	tonne-km	tax per tonne-km	difference in revenue
Belgium	271 395	0.00104	282.25
Netherlands	1 076 436	0	0
Germany	2 927 232	0.00117	3 424.86
France	26 653	0.00077	20.45
Total			**3 727.56**

For the other scenarios, similar calculations have been made.

Note that these tax benefits also occur as a cost at the government level (see chapter III.5.1 on page 146), and in the MCPF calculation (see chapter III.7.2 on page 150).

III.5.2. Effect on external costs of emissions

Note that the focus there lies on environmental costs as this is the major cost component for this mode. Noise and accident costs are negligible and the methodology for estimating marginal external infrastructure costs and congestion costs is not yet complete and very space specific[77].

The methodology and valuation for the calculation of the change in emissions is the same as for rail and road. For inland waterways yearly emission factors are taken from the EMMOSS[78] model. As with TREMOVE, fleet renewal and technology improvement are taken into account. The table below shows the results of the calculation.

The emission "blame" matrix allocates emissions of a given country to other countries where damage due to emissions occur. This is adapted here to allocate the external costs to the countries. Paragraph III.3.1.4 on page 116 gives more detail.

Table 87: Effect on emissions of inland waterways (million €$_{2005}$ in 2030), scenario "Historical Iron Rhine – 2A"
Source: own calculations

	BE	NL	DE	Other countries
CH_4	0.000	0.000	0.000	0.000
CO	0.000	0.000	0.000	0.000
CO_2	0.000	0.002	0.005	0.000
N_2O	0.000	0.000	0.000	0.000
NMVOC	0.000	0.000	0.000	0.000
NOx	0.001	0.001	0.004	0.007
PM	0.000	0.000	0.001	0.001
SO_2	0.000	0.000	0.001	0.001

The other scenarios have similar calculations.

[77] GRACE Inland waterways deliverable
[78] Kris Vanherle et. al., (2007), TML: "*EMissieMOdel voor Spoorverkeer en Scheepvaart in Vlaanderen, EMMOSS*" (emission model for maritime, inland waterway and rail for Flanders)

III.6. Other sectors

There can be an effect on sectors, different to the transport sector or the government. E.g. this is the case where monopolies are affected by transport policies.

In this SCBA, 2 such cases have been identified: operational margins in the ports, and margins in train maintenance. By lack of data and knowledge, a calculation on the effect could not be made. These 2 topics are therefore included as "pro memori".

III.7. Government

III.7.1. The investment costs

The investment costs are fully described in "Annex L: Investment costs" on page 259.

Given that the costs up to 2008 are already spent and hence will not influence the choice of reactivating the Iron Rhine, we do not take these costs into account in the SCBA. However, for completeness, they can be found in the annex.

Costs that will occur anyway (that are thus part of the reference scenario), are also subtracted.

The table below gives an overview of the total investment costs, cumulated over the years. All cost as VAT excluded. The net present value (NPV) is calculated for 2 cases: a discount rate of 4% (Bekgium practice) and of 2.5% (Dutch practice).

Note that for Belgium, one can have a negative total, but a positive NPV. This is due to the fact that in Belgium new investments (Iron Rhine) occur around the year 2015, and saved investments (no investment needed in Aarschot) occur around 2020. The net present value of values later in time is lower than the ones closer in time.

Table 88: Investment costs by location, million €$_{2007}$
Source: Infrabel, ProRail, DB Netz, own calculations

	In Belgium	In The Netherlands	In Germany	Total
Historical Iron Rhine – 2A and 2B versus Reference scenario – 2A and 2B				
Total investment costs	-45.88	514.00	120.00	588.12
NPV 2007 investment costs (discount rate 4%)	0.90	391.04	94.56	480.61
NPV 2007 investment costs (discount rate 2.5%)	-2.50	432.54	103.26	533.30
Electrified historical Iron Rhine – 2A versus Reference scenario – 2A				
Total investment costs	-5.88	563.30	150.00	707.42
NPV 2007 investment costs (discount rate 4%)	32.42	428.55	118.20	567.67
NPV 2007 investment costs (discount rate 2.5%)	31.92	474.03	129.08	635.03
Iron Rhine via A52 – 2A versus Reference scenario – 2A				
Total investment costs	-45.88	240.00	455.00	649.12
NPV 2007 investment costs (discount rate 4%)	0.90	182.59	358.54	536.14
NPV 2007 investment costs (discount rate 2.5%)	-2.50	201.97	391.53	591.00
Electrified Iron Rhine via A52 – 2A versus Reference scenario – 2A				
Total investment costs	-5.88	277.00	480.00	751.12
NPV 2007 investment costs (discount rate 4%)	32.42	210.73	378.24	609.89
NPV 2007 investment costs (discount rate 2.5%)	31.92	233.10	413.04	678.06

Note that 87.88 million euro of investments on the Montzen route can be saved when the Iron Rhine is build. Details can be found in "Annex R: Capacity in Aarschot (Montzen route)" on page 288. This explains the negative figures for Belgium.

Note that the A52 figures are based on the IVV estimation of 480 million €, according to DB Netz the costs could be as high as 900 million €.

III.7.2. Marginal costs of public funds

When the investment cost has to be financed by public funds, this requires in general an increase in taxes. When these taxes imply an increase in labour taxes, there is an extra distortion on the labour market and this is an extra cost element called the "marginal cost of public funds" (called MCPF here). This MCPF of public funds is in general larger than 1 so that this increases the total investment cost and affects the SCBA results. It is clear that the value of the MCPF is also an important element in the pricing of transport projects and in the use of the revenues of transport projects[79].

The OEI guidelines[80] ask to check the type of taxes used to finance the project and to analyse whether these taxes lead to additional efficiency effects. It is considered as a complex matter but CPB and SEO have in the past already integrated efficiency effects of labour taxes into cost benefit analysis. The MCPF value used was 1.25.

RAILPAG mentions the problem as important but too complex for their general guide. They recommend continuing to study it and to harmonize the use of the MCPF within the European Union. So they see the problem as important, ask to integrate it but do not suggest a specific value.

In "Annex O: Marginal cost of public funds" there is an attempt to estimate a value for the MCPF that could be used in this study. No agreement could be reached on the precise value for the MCPF. Therefore this cost is listed as a "pro memori" in the final SCBA table. This means that the value of the MCPF used is 1 and that one de facto assumes there is no additional inefficiency effect associated to the extra labour taxes necessary to finance the Iron Rhine project.

Using a value of 1.4, the marginal cost of public funds has been calculated for all scenarios. The dominant factor in the MCPF is the investment cost. Road and inland shipping taxes have a small contribution.

The table reads as follows: in Belgium, for the scenario "Electrified historical IR- 2A", the government will have to invest money in to the Iron Rhine, and will have some money in return (taxes on fuel). Net, the government will loose money, which needs to be taken form the general public budget. To keep this in balance, income taxes (and other taxes) need to be raised. This has a negative effect on the economy, it basically costs money to increase the government budget. This cost is estimated at 13.59 million euro.

[79] See De Palma A., Lindsey R., Proost S. (Eds.), Investment and the use of tax and toll revenues in the transport sector, Elsevier Science, 2007 – where the MCPF approach is used to assess the net benefits and optimal pricing of investment projects in several EU countries.

[80] Ministerie van Verkeer en Waterstaat en Ministerie van Economische Zaken Nederland (2004),"Indirecte effecten infrastructuurprojecten – aanvullingen op de Leidraad OEI", p33 en 34

Table 89: Marginal cost of public funds, all scenarios, NPV, in million euro2007

	Total	Belgium	The Netherlands	Germany
Discount rate 4%				
Historical IR - 2A	-198.11	-0.75	-156.65	-40.71
Historical IR - 2B	-198.92	-0.83	-156.70	-41.39
Electrified historical IR- 2A	-237.24	-13.59	-171.69	-51.96
IR via A52 - 2A	-223.99	-1.09	-73.32	-149.58
Electrified IR via A52 - 2A	-257.53	-13.89	-84.61	-159.04
Discount rate 2.5-4-5.5%				
Historical IR - 2A	-215.57	0.75	-173.17	-43.15
Historical IR - 2B	-216.04	0.71	-173.20	-43.55
Electrified historical IR- 2A	-257.46	-13.15	-189.78	-54.53
IR via A52 - 2A	-240.99	0.54	-80.97	-160.56
Electrified IR via A52 - 2A	-276.91	-13.35	-93.44	-170.12

IV The social cost benefit analysis

IV.1. Overview and conclusions

This section contains the overview of the SCBA for 5 variants:

- SCBA historical Iron Rhine - 2A
- SCBA historical Iron Rhine - 2B
- SCBA electrified historical Iron Rhine - 2A
- SCBA Iron Rhine via A52- 2A
- SCBA electrified Iron Rhine via A52 - 2A

Every variant has two tables: one with a NPV calculated with a discount rate of 4%, and one with a discount rate of 2.5-4-5.5% (for discount rates: see III.1.2.3 on page 101).

Through the whole report, positive numbers indicate a benefit, negative numbers indicate a cost.

It is clear that the SCBA is negative in all variants. Basically, the cost of the new infrastructure (net present value of 486.51 million € in the variant "historical Iron Rhine - 2A / 4%") is much higher than the benefits.

The reason for the negative benefits (excluding the investment costs) is mainly due the fact that the Iron Rhine is a quasi perfect substitute to the Montzen route. Trains shift from the Montzen route to the Iron Rhine, with some benefits for the consumers (less travel time and costs, however not very much, as the Iron Rhine is only slightly better than the Montzen route) and causing damage to society (the Iron Rhine is a diesel route and therefore more pollution than the electrified Montzen route).

The other environmental impacts are rather small, or even positive. The reason for this is that quite some mitigation measures are foreseen in the project itself. Also, the Iron Rhine route is somewhat shorter, with positive overall effects on e.g. noise in Belgium.

The modal shift from road and inland shipping to rail is very low (again due to the relative small benefits of the Iron Rhine versus the Montzen route). Road congestion and time losses at road-rail crossings both improve. The first due to a few less trucks on motorways, and the second due to foreseen mitigation measures in the project.

The "historical Iron Rhine – 2B" has lower impacts on transport and environment due to a background scenario with more stringent transport policy.

The "Iron Rhine via A52" is a less negative variant, but here most investment costs are in Germany compared to The Netherlands in the historical variant. It has a slightly stronger transport and environmental impact, with a small positive total benefit when excluding the massive investment costs.

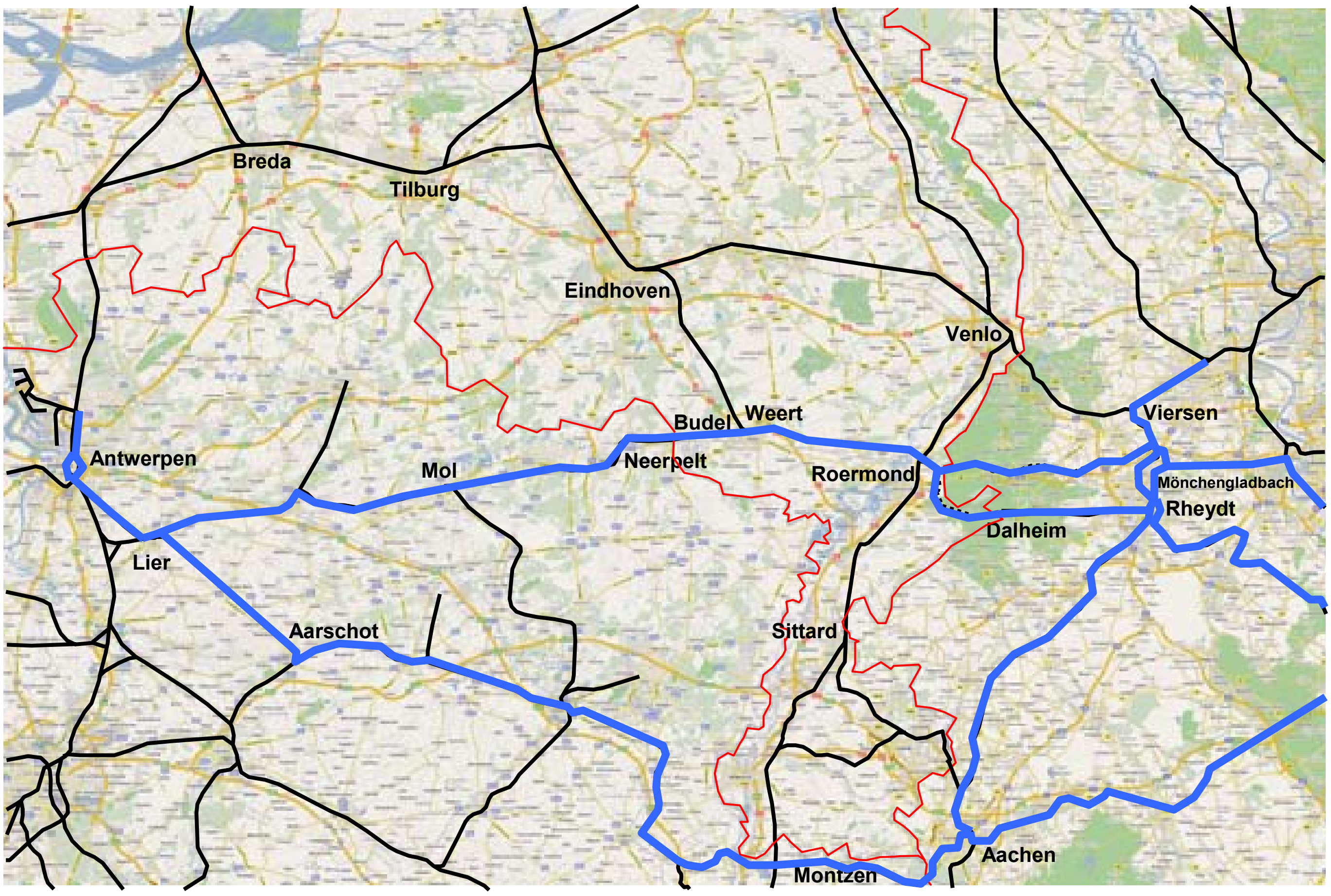
The electrified variants are the only ones where the benefits of the investment are actually clear benefits. This is due to the fact that in these variants, the electric trains on the Montzen route that go to the Iron Rhine remain electric trains, resulting in a quasi zero effect on emissions. The effect on emissions is s small increase, due to small differences in the power mix of electricity and the remaining share of diesel trains on the electrified tracks. All other environmental effects balance each other, the remaining consumer benefits however are still much lower than the investment cost.

Overall, the "Electrified Iron Rhine via A52" is the least negative variant, which requires the largest investment in the tree countries (at least € 850 million). However note that the A52 figures are based on the IVV estimation of 480 million €, according to DB Netz the costs could be as high as 900 million €.

Note that the tables show also the effect per country (Belgium, The Netherlands, Germany, all other countries) on the territorial basis. This is especially valid for the investment costs: they have been allocated by country based on the location, and not based on who should pay for them.

Note also that figures related to the rail track (accidents, emissions, noise, recreation, maintenance, infrastructure fee) are based on the following links:

Figure 19: Links taken into account in the SCBA (blue)



IV.2. SCBA historical Iron Rhine - 2A

Table 90: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2007}$, discount rate 4%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	94.21	48.40	0.00	32.83	12.98
Direct effect on infrastructure manager	Infrastructure fee	-6.85	-19.92	20.62	-7.56	NA
	Costs renewal	-15.90	0.00	-15.90	NA	NA
	Costs maintenance	31.29	91.34	-60.05	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-138.20	-19.28	-10.48	-39.00	-69.44
	Noise	24.79	8.12	3.29	13.39	NA
	Accidents	16.94	11.75	3.83	1.36	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-5.63	-0.41	-3.14	-2.08	0.00
	Vibrations	0.12	0.65	-0.77	0.24	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.48	-3.48	0.00	0.00	0.00
	Soil and water	3.00	0.00	3.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-7.12	PM	-7.12	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	18.73	4.40	2.35	11.98	NA
	Time at crossings	12.71	7.46	4.40	0.86	NA
	Taxes paid	-8.71	-0.98	-0.58	-7.15	NA
Effect on society	Emissions	2.89	0.37	0.22	1.51	0.81
	Noise	1.67	0.21	0.34	1.12	NA
	Accidents	1.80	0.58	0.18	1.04	NA
	Wear & tear	2.11	0.30	0.13	1.68	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.07	-0.01	0.00	-0.06	0.00
Effect on society	Emissions	0.48	0.03	0.06	0.22	0.18
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**24.80**	**129.54**	**-59.64**	**10.39**	**-55.48**
Effects on the government						
Direct effect	Investment costs	-486.51	-0.90	-391.04	-94.56	0.00
TOTAL		**-461.70**	**128.63**	**-450.69**	**-84.17**	**-55.48**

Table 91: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro2007, discount rate 2.5-4-5.5%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	62.76	32.23	0.00	21.85	8.68
Direct effect on infrastructure manager	Infrastructure fee	-4.38	-12.99	13.50	-4.89	NA
	Costs renewal	-15.90	0.00	-15.90	NA	NA
	Costs maintenance	31.29	91.34	-60.05	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-88.34	-12.23	-6.72	-24.92	-44.46
	Noise	15.67	5.13	2.08	8.46	NA
	Accidents	10.69	7.42	2.42	0.85	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	-3.70	-0.27	-2.06	-1.36	0.00
	Vibrations	0.11	0.58	-0.68	0.21	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.10	-3.10	0.00	0.00	0.00
	Soil and water	2.68	0.00	2.68	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-4.55	PM	-4.55	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	11.38	2.67	1.43	7.28	NA
	Time at crossings	8.03	4.71	2.78	0.54	NA
	Taxes paid	-5.57	-0.63	-0.37	-4.57	NA
Effect on society	Emissions	1.87	0.23	0.14	0.97	0.53
	Noise	1.07	0.14	0.22	0.72	NA
	Accidents	1.16	0.37	0.12	0.67	NA
	Wear & tear	1.35	0.19	0.08	1.07	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.04	0.00	0.00	-0.04	0.00
Effect on society	Emissions	0.31	0.02	0.04	0.14	0.12
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**22.78**	**115.80**	**-64.87**	**6.98**	**-35.13**
Effects on the government						
Direct effect	Investment costs	-533.30	2.50	-432.54	-103.26	0.00
TOTAL		**-510.52**	**118.31**	**-497.42**	**-96.28**	**-35.13**

IV.3. SCBA historical Iron Rhine - 2B

Table 92: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2B", NPV for 2007, million euro$_{2007}$, discount rate 4%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	28.78	15.18	0.00	10.00	3.60
Direct effect on infrastructure manager	Infrastructure fee	-1.74	-6.18	6.88	-2.44	NA
	Costs renewal	-14.76	0.00	-14.76	NA	NA
	Costs maintenance	32.59	75.01	-42.42	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-45.45	-6.11	-3.40	-13.06	-22.88
	Noise	29.32	8.70	4.38	16.24	NA
	Accidents	11.26	4.83	5.81	0.61	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	-5.63	-0.41	-3.14	-2.08	0.00
	Vibrations	-0.11	0.09	-0.23	0.03	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.48	-3.48	0.00	0.00	0.00
	Soil and water	3.00	0.00	3.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-2.36	PM	-2.36	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	13.32	3.41	1.62	8.28	NA
	Time at crossings	8.80	2.10	6.44	0.27	NA
	Taxes paid	-10.72	-1.16	-0.71	-8.84	NA
Effect on society	Emissions	3.54	0.44	0.26	1.86	0.98
	Noise	2.05	0.26	0.41	1.39	NA
	Accidents	2.20	0.69	0.22	1.29	NA
	Wear & tear	2.59	0.36	0.16	2.07	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.08	-0.01	0.00	-0.08	0.00
Effect on society	Emissions	0.60	0.04	0.07	0.27	0.22
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**53.73**	**93.76**	**-37.76**	**15.81**	**-18.08**
Effects on the government						
Direct effect	Investment costs	-486.51	-0.90	-391.04	-94.56	0.00
TOTAL		**-432.78**	**92.86**	**-428.80**	**-78.75**	**-18.08**

Table 93: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2B", NPV for 2007, million euro$_{2007}$, discount rate 2.5-4-5.5%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	20.31	10.69	0.00	7.07	2.55
Direct effect on infrastructure manager	Infrastructure fee	-1.27	-4.39	4.79	-1.68	NA
	Costs renewal	-14.76	0.00	-14.76	NA	NA
	Costs maintenance	32.59	75.01	-42.42	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-30.88	-4.14	-2.31	-8.86	-15.57
	Noise	19.53	5.88	2.90	10.75	NA
	Accidents	7.52	3.27	3.85	0.40	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	-3.70	-0.27	-2.06	-1.36	0.00
	Vibrations	-0.10	0.08	-0.21	0.03	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.10	-3.10	0.00	0.00	0.00
	Soil and water	2.68	0.00	2.68	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-1.57	PM	-1.57	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	8.03	2.02	0.98	5.04	NA
	Time at crossings	5.86	1.42	4.27	0.18	NA
	Taxes paid	-6.74	-0.73	-0.45	-5.56	NA
Effect on society	Emissions	2.24	0.28	0.17	1.17	0.63
	Noise	1.29	0.16	0.26	0.87	NA
	Accidents	1.39	0.43	0.14	0.81	NA
	Wear & tear	1.63	0.23	0.10	1.30	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.05	0.00	0.00	-0.05	0.00
Effect on society	Emissions	0.38	0.03	0.05	0.17	0.14
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**41.29**	**86.86**	**-43.60**	**10.29**	**-12.26**
Effects on the government						
Direct effect	Investment costs	-533.30	2.50	-432.54	-103.26	0.00
TOTAL		**-492.02**	**89.36**	**-476.15**	**-92.98**	**-12.26**

IV.4. SCBA electrified hist. Iron Rhine - 2A

Table 94: Social cost benefit analysis: overview, scenario "Electrified Iron Rhine – 2A", NPV for 2007, million euro$_{2007}$, discount rate 4%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	140.72	71.60	0.00	45.71	23.41
Direct effect on infrastructure manager	Infrastructure fee	-7.35	-22.75	23.45	-8.05	NA
	Costs renewal	-22.71	-3.80	-18.91	NA	NA
	Costs maintenance	2.20	78.67	-76.47	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-7.53	-0.59	-0.97	-2.01	-3.96
	Noise	23.81	7.90	3.10	12.82	NA
	Accidents	18.14	13.25	3.47	1.41	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-5.63	-0.41	-3.14	-2.08	0.00
	Vibrations	0.15	0.79	-0.90	0.26	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.48	-3.48	0.00	0.00	0.00
	Soil and water	3.00	0.00	3.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-8.25	PM	-8.25	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	27.63	6.86	2.66	18.11	NA
	Time at crossings	13.58	8.63	4.03	0.92	NA
	Taxes paid	-13.82	-1.56	-0.67	-11.60	NA
Effect on society	Emissions	4.52	0.58	0.28	2.42	1.25
	Noise	2.54	0.34	0.38	1.82	NA
	Accidents	2.82	0.92	0.21	1.69	NA
	Wear & tear	3.35	0.48	0.15	2.72	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.11	-0.01	0.00	-0.10	0.00
Effect on society	Emissions	0.73	0.05	0.07	0.34	0.27
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**174.30**	**157.47**	**-68.52**	**64.39**	**20.96**
Effects on the government						
Direct effect	Investment costs	-579.18	-32.42	-428.55	-118.20	0.00
TOTAL		**-404.88**	**125.04**	**-497.07**	**-53.81**	**20.96**

Table 95: Social cost benefit analysis: overview, scenario "Electrified Iron Rhine – 2A", NPV for 2007, million euro2007, discount rate 2.5-4-5.5%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	92.24	46.93	0.00	29.97	15.34
Direct effect on infrastructure manager	Infrastructure fee	-4.66	-14.63	15.17	-5.20	NA
	Costs renewal	-22.71	-3.80	-18.91	NA	NA
	Costs maintenance	2.20	78.67	-76.47	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-5.00	-0.38	-0.65	-1.33	-2.63
	Noise	14.92	4.94	1.94	8.04	NA
	Accidents	11.35	8.29	2.18	0.89	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-3.70	-0.27	-2.06	-1.36	0.00
	Vibrations	0.13	0.70	-0.80	0.23	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.10	-3.10	0.00	0.00	0.00
	Soil and water	2.68	0.00	2.68	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-5.21	PM	-5.21	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	16.46	4.07	1.60	10.78	NA
	Time at crossings	8.50	5.40	2.53	0.58	NA
	Taxes paid	-8.57	-0.96	-0.42	-7.18	NA
Effect on society	Emissions	2.82	0.36	0.18	1.50	0.79
	Noise	1.58	0.21	0.24	1.12	NA
	Accidents	1.75	0.57	0.13	1.05	NA
	Wear & tear	2.08	0.30	0.10	1.68	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.07	-0.01	0.00	-0.06	0.00
Effect on society	Emissions	0.46	0.03	0.05	0.21	0.17
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**104.15**	**127.31**	**-77.75**	**40.92**	**13.66**
Effects on the government						
Direct effect	Investment costs	-635.03	-31.92	-474.03	-129.08	0.00
TOTAL		**-530.88**	**95.40**	**-551.78**	**-88.16**	**13.66**

IV.5. SCBA Iron Rhine via A52 - 2A

Table 96: Social cost benefit analysis: overview, scenario "Iron Rhine via A52 – 2A", NPV for 2007, million euro$_{2007}$, discount rate 4%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	130.61	66.59	0.00	41.89	22.13
Direct effect on infrastructure manager	Infrastructure fee	1.00	-15.49	22.59	-6.10	NA
	Costs renewal	-4.70	0.00	-4.70	NA	NA
	Costs maintenance	55.99	88.31	-32.32	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-157.96	-22.68	-11.89	-44.06	-79.33
	Noise	22.83	6.81	3.21	12.80	NA
	Accidents	20.70	10.05	4.21	6.44	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-1.83	-0.41	-1.42	NA	0.00
	Vibrations	-0.19	0.48	-0.84	0.17	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.48	-3.48	0.00	0.00	0.00
	Soil and water	0.33	0.00	0.33	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-8.83	PM	-8.83	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	32.21	7.56	2.79	21.86	NA
	Time at crossings	15.29	6.37	4.83	4.09	NA
	Taxes paid	-17.81	-1.81	-0.71	-15.28	NA
Effect on society	Emissions	5.83	0.69	0.33	3.18	1.63
	Noise	3.21	0.40	0.41	2.40	NA
	Accidents	3.53	1.07	0.22	2.23	NA
	Wear & tear	4.31	0.56	0.16	3.58	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.14	-0.01	0.00	-0.13	0.00
Effect on society	Emissions	0.93	0.06	0.08	0.44	0.34
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**101.80**	**145.08**	**-21.56**	**33.52**	**-55.23**
Effects on the government						
Direct effect	Investment costs	-542.04	-0.90	-182.59	-358.54	0.00
TOTAL		**-440.23**	**144.17**	**-204.16**	**-325.02**	**-55.23**

Table 97: Social cost benefit analysis: overview, scenario "Iron Rhine via A52 – 2A", NPV for 2007, million euro$_{2007}$, discount rate 2.5-4-5.5%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	89.46	45.58	0.00	28.62	15.27
Direct effect on infrastructure manager	Infrastructure fee	0.59	-10.14	14.75	-4.02	NA
	Costs renewal	-4.70	0.00	-4.70	NA	NA
	Costs maintenance	55.99	88.31	-32.32	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-100.76	-14.36	-7.61	-28.10	-50.69
	Noise	14.42	4.31	2.03	8.09	NA
	Accidents	13.08	6.35	2.66	4.07	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-1.20	-0.27	-0.93	NA	0.00
	Vibrations	-0.17	0.43	-0.75	0.16	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.10	-3.10	0.00	0.00	0.00
	Soil and water	0.30	0.00	0.30	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-5.63	PM	-5.63	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	19.46	4.56	1.69	13.21	NA
	Time at crossings	9.66	4.03	3.05	2.58	NA
	Taxes paid	-11.40	-1.16	-0.46	-9.78	NA
Effect on society	Emissions	3.77	0.44	0.21	2.05	1.07
	Noise	2.05	0.26	0.26	1.53	NA
	Accidents	2.26	0.69	0.14	1.43	NA
	Wear & tear	2.76	0.36	0.10	2.29	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.09	-0.01	0.00	-0.08	0.00
Effect on society	Emissions	0.60	0.04	0.05	0.29	0.22
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**87.35**	**126.31**	**-27.17**	**22.34**	**-34.13**
Effects on the government						
Direct effect	Investment costs	-591.00	2.50	-201.97	-391.53	0.00
TOTAL		**-503.64**	**128.81**	**-229.13**	**-369.19**	**-34.13**

IV.6. SCBA electr. Iron Rhine via A52 - 2A

Table 98: Social cost benefit analysis: overview, scenario "Electrified Iron Rhine via A52 – 2A", NPV for 2007, million euro$_{2005}$, discount rate 4%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	188.26	95.25	0.00	57.95	35.05
Direct effect on infrastructure manager	Infrastructure fee	0.78	-16.90	24.80	-7.12	NA
	Costs renewal	-10.76	-3.80	-6.96	NA	NA
	Costs maintenance	27.72	70.93	-43.21	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-2.35	0.01	-0.59	-0.42	-1.34
	Noise	22.43	6.71	3.10	12.62	NA
	Accidents	20.00	10.56	2.62	6.81	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-1.83	-0.41	-1.42	NA	0.00
	Vibrations	-0.16	0.57	-0.94	0.21	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.48	-3.48	0.00	0.00	0.00
	Soil and water	0.33	0.00	0.33	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-9.15	PM	-9.15	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	39.25	9.48	3.05	26.72	NA
	Time at crossings	14.74	7.07	3.10	4.56	NA
	Taxes paid	-22.27	-2.29	-0.78	-19.19	NA
Effect on society	Emissions	7.26	0.87	0.39	3.98	2.02
	Noise	3.96	0.50	0.45	3.01	NA
	Accidents	4.40	1.36	0.24	2.80	NA
	Wear & tear	5.39	0.71	0.18	4.50	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.17	-0.01	0.00	-0.16	0.00
Effect on society	Emissions	1.14	0.07	0.10	0.55	0.42
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**285.47**	**177.20**	**-24.73**	**96.85**	**36.15**
Effects on the government						
Direct effect	Investment costs	-621.39	-32.42	-210.73	-378.24	0.00
TOTAL		**-335.93**	**144.78**	**-235.46**	**-281.39**	**36.15**

Table 99: Social cost benefit analysis: overview, scenario "Electrified Iron Rhine via A52 – 2A", NPV for 2007, million euro$_{2005}$, discount rate 2.5-4-5.5%

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	126.01	63.75	0.00	38.77	23.50
Direct effect on infrastructure manager	Infrastructure fee	0.58	-10.85	16.10	-4.67	NA
	Costs renewal	-10.76	-3.80	-6.96	NA	NA
	Costs maintenance	27.72	70.93	-43.21	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-0.82	0.11	-0.35	-0.06	-0.52
	Noise	14.09	4.20	1.95	7.94	NA
	Accidents	12.55	6.61	1.65	4.29	NA
	External safety	-0.01	NA	-0.01	NA	NA
	Recreation	-1.20	-0.27	-0.93	NA	0.00
	Vibrations	-0.14	0.51	-0.84	0.19	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	-3.10	-3.10	0.00	0.00	0.00
	Soil and water	0.30	0.00	0.30	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-5.85	PM	-5.85	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	23.54	5.68	1.84	16.02	NA
	Time at crossings	9.25	4.43	1.95	2.87	NA
	Taxes paid	-14.09	-1.45	-0.50	-12.14	NA
Effect on society	Emissions	4.64	0.55	0.25	2.54	1.31
	Noise	2.51	0.32	0.29	1.90	NA
	Accidents	2.79	0.86	0.15	1.77	NA
	Wear & tear	3.41	0.45	0.11	2.85	NA
Effects on the iww market						
Indirect effect on iww users	Taxes paid	-0.11	-0.01	0.00	-0.10	0.00
Effect on society	Emissions	0.73	0.05	0.06	0.35	0.27
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**192.01**	**138.95**	**-34.01**	**62.52**	**24.55**
Effects on the government						
Direct effect	Investment costs	-678.06	-31.92	-233.10	-413.04	0.00
TOTAL		**-486.05**	**107.03**	**-267.10**	**-350.53**	**24.55**

V Sensitivity analysis

The Iron Rhine is a transport project with a long lead time whose benefits are uncertain because they depend on demand forecasts in the very distant future. Also the costs remain uncertain. In this chapter we calculated a restricted number of sensitivity studies that help to check the robustness of the outcome of the SCBA.

We discuss first the uncertainties on the valuation of the external emission costs, next a deferral of the project with 5 years and finally the demand scenario. For every sensitivity analysis we discuss and comment on the results.

All sensitivity analyses have been performed on the scenario "historical Iron Rhine – 2A".

V.1. Sensitivity on the external cost values for emissions

In the regular SBCA, the external costs for emissions have been calculated with the rather low values of the possible valuation bandwidth. In this sensitivity analysis, the high values are used.

This includes high values for air pollutant cost, for rail emission, road emissions and inland shipping emissions. The table below gives an overview. The values are derived from the same source as the low variants: CAFE-ExternE[81] cost values (€/tonne of emitted pollutant). ExternE claims the low values as the most realistic, however high values are also given because of the great uncertainty of the valuation of air pollution. The values differ between countries because the population density and the value of life differ between countries.

Table 100: Overview of valuation of air pollutant emissions (in €$_{2005}$/tonne of pollutant)

	LOW			HIGH		
Pollutant	**Belgium**	**Germany**	**Netherlands**	**Belgium**	**Germany**	**Netherlands**
CH_4	2 500	1 700	1 900	7 100	5 100	5 400
CO	0	0	0	0	0	0
NMVOC	2 500	1 700	1 900	7 100	5 100	5 400
NOx	5 200	9 600	6 600	14 000	26 000	18 000
PM	61 000	48 000	63 000	180 000	140 000	180 000
SO_2	11 000	11 000	13 000	31 000	32 000	39 000

Table 101: Overview of valuation of greenhouse gas emissions (in €$_{2005}$/tonne of pollutant)

	LOW			HIGH		
Pollutant	**Belgium**	**Germany**	**Netherlands**	**Belgium**	**Germany**	**Netherlands**
CH_4	920	920	920	3 680	3 680	3 680
N_2O	11 840	11 840	11 840	47 360	47 360	47 360
CO_2	40	40	40	160	160	160

[81] Rainer Friedrich, Peter Bickel, Environmental External costs of Transport, 2001.

The resulting SCBA can be found in the next two tables. The values are given the difference with the "Historical Iron Rhine – 2A". It is clear that the negative "benefits" of the Iron Rhine become even more negative when the shift from electric trains on the Montzen route to more polluting diesel trains on the Iron Rhine route is valuated higher. The order of magnitude is high: using high instead of low valuation gives a difference that is worth half of the investment cost.

Table 102: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2005}$, discount rate 4% - SENSITIVITY higher external costs of emissions

Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	0.00	0.00	0.00	0.00	0.00
Direct effect on infrastructure manager	Infrastructure fee	0.00	0.00	0.00	0.00	NA
	Costs renewal	0.00	0.00	0.00	NA	NA
	Costs maintenance	0.00	0.00	0.00	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-250.31	-35.15	-19.19	-70.96	-125.01
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	0.00	0.00	0.00	0.00	0.00
	Vibrations	0.00	0.00	0.00	0.00	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.00	0.00	0.00	0.00	0.00
	Soil and water	0.00	0.00	0.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	0.00	PM	0.00	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	0.00	0.00	0.00	0.00	NA
	Time at crossings	0.00	0.00	0.00	0.00	NA
	Taxes paid	0.00	0.00	0.00	0.00	NA
Effect on society	Emissions	8.02	1.18	0.65	4.75	1.43
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	Wear & tear	0.00	0.00	0.00	0.00	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	0.00	0.00	0.00	0.00	0.00
Effect on society	Emissions	1.16	0.08	0.18	0.59	0.31
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-241.14**	**-33.90**	**-18.36**	**-65.63**	**-123.26**
Effects on the government						
Direct effect	Investment costs	0.00	0.00	0.00	0.00	0.00
TOTAL		**-241.14**	**-33.90**	**-18.36**	**-65.63**	**-123.26**

Table 103: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2005}$, discount rate 2.5-4-5.5% - SENSITIVITY higher external costs of emissions
Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	0.00	0.00	0.00	0.00	0.00
Direct effect on infrastructure manager	Infrastructure fee	0.00	0.00	0.00	0.00	NA
	Costs renewal	0.00	0.00	0.00	NA	NA
	Costs maintenance	0.00	0.00	0.00	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-159.93	-22.30	-12.30	-45.33	-79.99
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	0.00	0.00	0.00	0.00	0.00
	Vibrations	0.00	0.00	0.00	0.00	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.00	0.00	0.00	0.00	0.00
	Soil and water	0.00	0.00	0.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	0.00	PM	0.00	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	0.00	0.00	0.00	0.00	NA
	Time at crossings	0.00	0.00	0.00	0.00	NA
	Taxes paid	0.00	0.00	0.00	0.00	NA
Effect on society	Emissions	5.16	0.76	0.42	3.04	0.94
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	Wear & tear	0.00	0.00	0.00	0.00	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	0.00	0.00	0.00	0.00	0.00
Effect on society	Emissions	0.75	0.05	0.12	0.38	0.20
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-154.02**	**-21.50**	**-11.77**	**-41.90**	**-78.85**
Effects on the government						
Direct effect	Investment costs	0.00	0.00	0.00	0.00	0.00
TOTAL		**-154.02**	**-21.50**	**-11.77**	**-41.90**	**-78.85**

V.2. Sensitivity on the "blame" matrix

In this sensitivity analyses, we explain the effects of the project when the emissions are allocated to the emitting countries, and not to the countries where the damage occurs (as in the regular SBCA). The calculation without the "blame" matrix, as described in this chapter, allocates thus the emission to the emitting country. This reflects one of the EU policies, where each country is responsible for abating emission on the territory basis.

The table below gives the emissions per impact country, as applied in the SCBA (see also section III.3.1 on page 112).

Table 104: Effect on emissions of rail (million €$_{2005}$ in 2030), scenario "Historical Iron Rhine – 2A", allocated to the country where the impact occurs
Source: own calculations

	BE		NL		DE		Other countries
	Iron Rhine	Montzen	Iron Rhine	Montzen	Iron Rhine	Montzen	
CH_4	-0.005	0.162	-0.003	0.000	-0.003	0.187	0.000
CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	-1.693	1.248	-1.149	0.000	-1.520	0.977	0.000
N_2O	-0.002	0.000	-0.001	0.000	-0.002	0.000	0.000
NMVOC	-0.008	0.001	-0.009	0.001	-0.026	0.002	-0.057
NOx	-0.346	0.034	-0.275	0.022	-1.086	0.110	-2.054
PM	-0.064	0.007	-0.061	0.004	-0.169	0.020	-0.214
SO_2	-0.812	0.075	-0.282	0.015	-1.164	0.110	-1.575

The table below gives the emissions per emitting country, as applied in this sensitivity analysis. Note that the effect is the largest for NOx and SO_2. For greenhouse gasses, the "blame" matrix was not applied anyway.

Table 105: Effect on emissions of rail (million €$_{2005}$ in 2030), scenario "Historical Iron Rhine – 2A", allocated to the emitting country
Source: own calculations

	BE		NL		DE		Other countries
	Iron Rhine	Montzen	Iron Rhine	Montzen	Iron Rhine	Montzen	
CH_4	-0.005	0.162	-0.003	0.000	-0.003	0.187	0.000
CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	-1.693	1.248	-1.149	0.000	-1.520	0.977	0.000
N_2O	-0.002	0.000	-0.001	0.000	-0.002	0.000	0.000
NMVOC	-0.050	0.007	-0.026	0.000	-0.031	0.004	0.000
NOx	-1.302	0.181	-1.122	0.000	-2.158	0.249	0.000
PM	-0.243	0.030	-0.171	0.000	-0.172	0.033	0.000
SO_2	-1.711	0.197	-1.373	0.000	-1.536	0.198	0.000

The sensitivity analysis shows that the costs in Belgium, The Netherlands and Germany are some 20 to 40 million higher, because now more emissions are allocated to these countries. The total cost is also higher, because in the regular SCBA the emissions that were allocated to the sea (damage location) were not included in the table.

Table 106: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2005}$, discount rate 4% - SENSITIVITY no "blame" matrix for emissions
Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	0.00	0.00	0.00	0.00	0.00
Direct effect on infrastructure manager	Infrastructure fee	0.00	0.00	0.00	0.00	NA
	Costs renewal	0.00	0.00	0.00	NA	NA
	Costs maintenance	0.00	0.00	0.00	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-21.22	-30.92	-38.40	-21.34	69.44
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	0.00	0.00	0.00	0.00	0.00
	Vibrations	0.00	0.00	0.00	0.00	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.00	0.00	0.00	0.00	0.00
	Soil and water	0.00	0.00	0.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	0.00	PM	0.00	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	0.00	0.00	0.00	0.00	NA
	Time at crossings	0.00	0.00	0.00	0.00	NA
	Taxes paid	0.00	0.00	0.00	0.00	NA
Effect on society	Emissions	0.19	0.12	0.06	0.83	-0.81
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	Wear & tear	0.00	0.00	0.00	0.00	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	0.00	0.00	0.00	0.00	0.00
Effect on society	Emissions	0.05	0.00	0.07	0.16	-0.18
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-20.98**	**-30.81**	**-38.28**	**-20.35**	**68.46**
Effects on the government						
Direct effect	Investment costs	0.00	0.00	0.00	0.00	0.00
TOTAL		**-20.98**	**-30.81**	**-38.28**	**-20.35**	**68.46**

Table 107: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2005}$, discount rate 2.5-4-5.5% - SENSITIVITY higher external costs of emissions
Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	0.00	0.00	0.00	0.00	0.00
Direct effect on infrastructure manager	Infrastructure fee	0.00	0.00	0.00	0.00	NA
	Costs renewal	0.00	0.00	0.00	NA	NA
	Costs maintenance	0.00	0.00	0.00	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-13.57	-19.65	-24.75	-13.62	44.46
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	0.00	0.00	0.00	0.00	0.00
	Vibrations	0.00	0.00	0.00	0.00	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.00	0.00	0.00	0.00	0.00
	Soil and water	0.00	0.00	0.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	0.00	PM	0.00	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	0.00	0.00	0.00	0.00	NA
	Time at crossings	0.00	0.00	0.00	0.00	NA
	Taxes paid	0.00	0.00	0.00	0.00	NA
Effect on society	Emissions	0.13	0.07	0.04	0.54	-0.53
	Noise	0.00	0.00	0.00	0.00	NA
	Accidents	0.00	0.00	0.00	0.00	NA
	Wear & tear	0.00	0.00	0.00	0.00	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	0.00	0.00	0.00	0.00	0.00
Effect on society	Emissions	0.03	0.00	0.04	0.11	-0.12
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-13.41**	**-19.58**	**-24.67**	**-12.97**	**43.82**
Effects on the government						
Direct effect	Investment costs	0.00	0.00	0.00	0.00	0.00
TOTAL		**-13.41**	**-19.58**	**-24.67**	**-12.97**	**43.82**

V.3. Sensitivity on the starting date

For a project like the Iron Rhine, with a large investment cost upfront and benefits that are likely to grow over time, it is always interesting to consider delaying the start of the project. This has two types of benefits. First there is an option value because one can decide not to take on the project because of new information on demand or technology. Second one saves on capital costs when the project has only low benefits during the first years.

We performed a sensitivity variant where the Iron Rhine would be build 5 years later (in use in 2020 instead of 2015). This practical choice means in no way to express any idea of the more or less probability of any starting date. For the starting date, the Dutch and Belgian authorities have different opinions. The steering group was unable to make its own probability analysis of the planning and therefore could not conclude anything on the probability of the starting dates.

The table below shows the net present value of the investment costs for a starting date in 2020. This table can be compared with Table 88 on page 149.

Table 108: Investment costs by location for a starting date in 2020, million €$_{2007}$
Source: Infrabel, ProRail, DB Netz, own calculations

	In Belgium	In The Netherlands	In Germany	Total
Historical Iron Rhine – 2A and 2B versus Reference scenario – 2A and 2B				
Total investment costs	-45.88	514.00	120.00	588.12
NPV 2007 investment costs (4%)	-4.99	283.92	77.72	356.65
NPV 2007 investment costs (2.5%)	-6.70	329.60	91.27	414.17
Electrified historical Iron Rhine – 2A versus Reference scenario – 2A				
Total investment costs	-5.88	563.30	150.00	707.42
NPV 2007 investment costs (4%)	20.92	311.14	97.15	429.21
NPV 2007 investment costs (2.5%)	23.72	361.19	114.08	499.00
Iron Rhine via A52 – 2A versus Reference scenario – 2A				
Total investment costs	-45.88	240.00	455.00	649.12
NPV 2007 investment costs (4%)	-4.99	132.56	294.70	422.27
NPV 2007 investment costs (2.5%)	-6.70	153.89	346.06	493.25
Electrified Iron Rhine via A52 – 2A versus Reference scenario – 2A				
Total investment costs	-5.88	277.00	480.00	751.12
NPV 2007 investment costs (4%)	20.92	152.96	310.89	484.77
NPV 2007 investment costs (2.5%)	23.72	177.57	365.07	566.36

All other effects (emissions, consumer benefits, …) will also only start in 2020, giving lower net present values.

The effect of having a later start date is mainly on the investments cost, which have a 25% lower net present value. The other effects remain more or less the same. Thus, postponing the project is from a SCBA point of view, beneficial.

Table 109: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro₂₀₀₅, discount rate 4% - SENSITIVITY starting date 2020
Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	-18.25	-9.34	0.00	-6.36	-2.55
Direct effect on infrastructure manager	Infrastructure fee	0.98	3.42	-3.66	1.22	NA
	Costs renewal	0.35	0.00	0.35	NA	NA
	Costs maintenance	1.82	-8.66	10.47	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	15.77	2.00	1.24	4.43	8.08
	Noise	-2.35	-0.77	-0.31	-1.27	NA
	Accidents	-1.59	-1.10	-0.37	-0.12	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	1.02	0.07	0.57	0.38	0.00
	Vibrations	-0.02	-0.12	0.14	-0.04	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.62	0.62	0.00	0.00	0.00
	Soil and water	-0.53	0.00	-0.53	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	1.01	PM	1.01	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	-1.48	-0.34	-0.18	-0.96	NA
	Time at crossings	-1.20	-0.70	-0.42	-0.08	NA
	Taxes paid	1.27	0.15	0.09	1.04	NA
Effect on society	Emissions	-0.46	-0.05	-0.03	-0.23	-0.15
	Noise	-0.24	-0.03	-0.05	-0.16	NA
	Accidents	-0.27	-0.09	-0.03	-0.15	NA
	Wear & tear	-0.31	-0.05	-0.02	-0.24	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	0.01	0.00	0.00	0.01	0.00
Effect on society	Emissions	-0.08	-0.01	-0.01	-0.03	-0.03
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-3.93**	**-14.98**	**8.26**	**-2.57**	**5.35**
Effects on the government						
Direct effect	Investment costs	129.85	5.89	107.12	16.84	0.00
TOTAL		**125.92**	**-9.08**	**115.38**	**14.27**	**5.35**

Table 110: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2005}$, discount rate 2.5-4-5.5% - SENSITIVITY starting date 2020
Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	-15.83	-8.10	0.00	-5.52	-2.21
Direct effect on infrastructure manager	Infrastructure fee	0.85	2.97	-3.17	1.05	NA
	Costs renewal	0.35	0.00	0.35	NA	NA
	Costs maintenance	1.82	-8.66	10.47	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	13.56	1.72	1.07	3.81	6.95
	Noise	-2.02	-0.66	-0.27	-1.09	NA
	Accidents	-1.37	-0.95	-0.32	-0.10	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	0.89	0.06	0.50	0.33	0.00
	Vibrations	-0.02	-0.14	0.16	-0.05	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.73	0.73	0.00	0.00	0.00
	Soil and water	-0.63	0.00	-0.63	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	0.87	PM	0.87	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	-1.28	-0.29	-0.16	-0.83	NA
	Time at crossings	-1.03	-0.60	-0.36	-0.07	NA
	Taxes paid	1.10	0.13	0.07	0.90	NA
Effect on society	Emissions	-0.40	-0.05	-0.03	-0.20	-0.13
	Noise	-0.21	-0.03	-0.04	-0.14	NA
	Accidents	-0.23	-0.08	-0.02	-0.13	NA
	Wear & tear	-0.27	-0.04	-0.02	-0.21	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	0.01	0.00	0.00	0.01	0.00
Effect on society	Emissions	-0.07	0.00	-0.01	-0.03	-0.03
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-3.18**	**-13.98**	**8.48**	**-2.26**	**4.58**
Effects on the government						
Direct effect	Investment costs	119.13	4.20	102.94	11.99	0.00
TOTAL		**115.95**	**-9.78**	**111.42**	**9.73**	**4.58**

V.4. Sensitivity on the transport volumes

The tables on the next page show a sensitivity analysis where the transport volumes in all years are 20% higher compared to the scenario "Historical Iron Rhine – 2A". Both the reverence case and the project variant have a 20% higher transport volume. This scenario has been developed after several discussions on the comparison of the transport statistics and forecasts used in the Trans-Tools model, and those of e.g. the Port of Antwerp (see "Annex I: Comparison of the TRANS-TOOLS results and the Port of Antwerp scenario"). The result of the discussion was that uncertainty about the assumptions on transport volumes exists, and that a sensitivity analysis is useful.

The value of a 20% higher transport is chosen as an educated guess of a possible upper boundary of the uncertainty.

This scenario has not been calculated with Trans-Tools, but conversion factors have been applied to the Trans-Tools results of the "Historical Iron Rhine – 2A" scenario.

The main effect of this scenario, compared to "Historical Iron Rhine – 2A", is that most effects that are related to the transport volumes are 20% larger. Some non-linearities exist: congestion (hardly visible) and maintenance costs (effect much less than 20% due to a large share of fixed costs). There are more infrastructure fee losses in Belgium, as 20% more trains will shift from the longer Montzen route to the shorter Iron Rhine and thus cause a larger loss.

The investment costs and the related external effects on vibrations, landscape etc., obviously do not differ.

Overall, the effect of a larger transport volume is small. The benefits and costs to the users, infrastructure manager and environment are already balanced (or slightly negative) in the base scenario "Historical Iron Rhine – 2A", and thus also in this scenario.

Table 111: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro$_{2005}$, discount rate 4% - SENSITIVITY transport volume
Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	18.84	9.68	0.00	6.57	2.60
Direct effect on infrastructure manager	Infrastructure fee	-1.37	-3.98	4.12	-1.51	NA
	Costs renewal	-0.64	0.00	-0.64	NA	NA
	Costs maintenance	-2.16	4.50	-6.65	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-27.64	-3.86	-2.10	-7.80	-13.89
	Noise	2.87	1.28	0.19	1.41	NA
	Accidents	5.50	5.01	-0.07	0.56	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	0.00	0.00	0.00	0.00	0.00
	Vibrations	0.00	0.00	0.00	0.00	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.00	0.00	0.00	0.00	0.00
	Soil and water	0.00	0.00	0.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-3.13	PM	-3.13	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	3.75	0.88	0.47	2.40	NA
	Time at crossings	0.00	0.00	0.00	0.00	NA
	Taxes paid	-1.74	-0.20	-0.12	-1.43	NA
Effect on society	Emissions	0.58	0.07	0.04	0.30	0.16
	Noise	0.33	0.04	0.07	0.22	NA
	Accidents	0.36	0.12	0.04	0.21	NA
	Wear & tear	0.42	0.06	0.03	0.34	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	-0.05	0.00	0.00	-0.05	0.00
Effect on society	Emissions	0.10	0.01	0.01	0.04	0.04
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-3.98**	**13.60**	**-7.74**	**1.25**	**-11.10**
Effects on the government						
Direct effect	Investment costs	0.00	0.00	0.00	0.00	0.00
TOTAL		**-3.98**	**13.60**	**-7.74**	**1.25**	**-11.10**

Table 112: Social cost benefit analysis: overview, scenario "Historical Iron Rhine – 2A", NPV for 2007, million euro₂₀₀₅, discount rate 2.5-4-5.5% - SENSITIVITY transport volume

Note: numbers indicate the difference with the "Historical Iron Rhine – 2A". Positive = more benefits (or less costs), negative = more costs (or less benefits)

		Total	In Belgium	In The Netherlands	In Germany	In others countries
Direct effects on freight rail market						
Direct effect on consumers	Consumer surplus	12.55	6.45	0.00	4.37	1.74
Direct effect on infrastructure manager	Infrastructure fee	-0.88	-2.60	2.70	-0.98	NA
	Costs renewal	-0.64	0.00	-0.64	NA	NA
	Costs maintenance	-2.16	4.50	-6.65	NA	NA
External effects related to the building and use of the rail						
Effect on society	Emissions	-17.67	-2.45	-1.34	-4.98	-8.89
	Noise	1.36	0.64	0.06	0.66	NA
	Accidents	3.32	3.10	-0.12	0.35	NA
	External safety	0.00	NA	0.00	NA	NA
	Recreation	0.00	0.00	0.00	0.00	0.00
	Vibrations	0.00	0.00	0.00	0.00	0.00
	Loss of living environment	0.00	0.00	0.00	0.00	0.00
	Landscape	0.00	0.00	0.00	0.00	0.00
	Ecology	0.00	0.00	0.00	0.00	0.00
	Soil and water	0.00	0.00	0.00	0.00	0.00
	Agriculture	0.00	0.00	0.00	0.00	0.00
Effects on passenger rail						
	Delay time	-2.00	PM	-2.00	0.00	0.00
Effects on the road market						
Indirect effect on road users	Congestion time	2.28	0.53	0.29	1.46	NA
	Time at crossings	0.00	0.00	0.00	0.00	NA
	Taxes paid	-1.11	-0.13	-0.07	-0.91	NA
Effect on society	Emissions	0.37	0.05	0.03	0.19	0.11
	Noise	0.21	0.03	0.04	0.14	NA
	Accidents	0.23	0.07	0.02	0.13	NA
	Wear & tear	0.27	0.04	0.02	0.21	NA
Effects on the iww market			0.00	0.00	0.00	0.00
Indirect effect on iww users	Taxes paid	-0.03	0.00	0.00	-0.03	0.00
Effect on society	Emissions	0.06	0.00	0.01	0.03	0.02
Effects on the government						
Indirect effect	MCPF correction	PM	PM	PM	PM	PM
Effects on other sectors						
Indirect effect		PM	PM	PM	PM	PM
SUBTOTAL		**-3.83**	**10.24**	**-7.68**	**0.64**	**-7.03**
Effects on the government						
Direct effect	Investment costs	0.00	0.00	0.00	0.00	0.00
TOTAL		**-3.83**	**10.24**	**-7.68**	**0.64**	**-7.03**

VI Conclusions

1. For all the 5 variants considered (historic route & A52, diesel & electric, background assumptions A & B), this project produces a negative benefit for society as a whole. The negative benefit has been obtained after accounting for modal shifts from road to rail and taking into account all important externalities. The net present value of the costs to society varies from 335 to 530 million euro. For this, an investment of 440 to 680 million is need by the 3 countries, which is the net present value of an investment of about 590 to 750 million euro.

2. The major reason why the project performs so poorly is that it mainly substitutes rail traffic on the existing Montzen route that has not yet reached its capacity limits. The user cost advantage of switching between the two lines is limited and there is only a small reduction of congestion on the road. These small benefits can never compensate the large investment cost. Even if the growth of rail traffic from Antwerp to Germany is much stronger than expected by the models, the benefits are too small to compensate the large investment cost.

3. On top of that, the substitute from the electrified Montzen route to the diesel Iron Rhine route causes extra emission costs.

4. If one wants to take on the project anyway, society's losses are minimized when the start of the project is postponed, when one electrifies the whole Iron Rhine and when one selects the A52 route. Note that the A52 figures are based on the IVV estimation of 480 million €, according to DB Netz the costs could be as high as 900 million €.

5. Belgium and Germany are the main beneficiaries of lower user costs. The main investment costs are situated in The Netherlands. So the net losses are highest for The Netherlands.

Annex A: Background scenario

This annex describes the backgrounds of the socio-economic and transport developments which are used as input for the transport forecasts. During the course of the forecast study it was agreed on with the corresponding actors to use these starting points.

A.1. Population

The quantification of the population scenario is originating from the project TRANS-TOOLS, carried out for the European Commission. The scenario has been based on a normal development of Europe. The underlying figures from TRANS-TOOLS have been based on the PRIMES energy model and on forecasts of EUROSTAT. These figures are given in the report "European Energy and transport trends to 2030" - update 2005.

The table below shows the EC-projection for population increase by country up to 2030. The population increase is fairly stable over this period. The Belgian population grows with 0.2% per year up to 2015, and afterwards with 0.1% per year, slightly higher than the European average. The Dutch population grows faster. It is assumed that the population growth by country is divided proportionally over regions and provinces.

Table 113: Average population increase (%) per country
Source: European Energy and transport trends to 2030 – update 2005

	2005-2015	2005-2030
Belgium	0.2%	0.1%
Netherlands	0.5%	0.3%
Germany	0.2%	0.1%
Total EU25	0.1%	0.0%

A.2. Economic growth

The quantification of the GDP scenario is originating from the project TRANS-TOOLS, carried out for the European Commission. The scenario has been based on a normal development of Europe. The underlying figures from TRANS-TOOLS have been based on the PRIMES energy model and on forecasts of EUROSTAT. These figures are given in the report "European Energy and transport trends to 2030" - update 2005.

The table below shows the projections of the increase of the total GDP (in market prices) by country up to 2030. These are the most recent projections of the European Commission, which are among others used in their long term transport - and energy forecasts. Projections are something lower than earlier forecasts, because they take into account the most recent developments. The average economic growth is 2.03% up to 2030 for EU25. The 10 new EU members have an increase of more than 3% for this period.

Table 114: Annual growth GDP (%), per country
Source: European Energy and transport trends to 2030 – update 2005

	2020-2005	2030-2020	2030-2005
BE	2,18%	1,55%	1,93%
NL	1,94%	1,45%	1,74%
DE	1,75%	1,03%	1,46%
Total EU25	**2.30%**	**1.63%**	**2.03%**

The increase of traffic from and to ports, and the increase in the hinterland transport, is determined endogenously from the economic growth, especially in Western-Europe. The maritime increase depends on the foreigner trade, which coincides with the increase of internal production. In general, the overseas trade grows faster than the GDP.

In the previous study "*Vervoerprognoses IJzeren Rijn*", the above figures were used as the middle scenario 2. At that time, low and high economic growth scenarios (1 and 3) have also been considered.

Scenario 1 had a lower growth than scenario 2. On average, it is 0.5% lower Europe-wide: 1.80% yearly instead of 2.30% for EU25 (in 2005-2020). Scenario 3 had 0.5% higher growth.

A.3. Crude oil price

The energy costs have been derived from the Energy Outlook crude oil prices and refinery costs. All fuel prices (and future evolution) have been made consistent with the Energy Outlook (June 2005). This projection shows a most crude oil price growth.

Fuel resource costs differ per country depending on the refinery costs.

Excise taxes are assumed to remain constant from 2003 onwards[82], except for a strong tax-exemption for biofuels[83]. CNG excise taxes are derived from DG TAXUD statistics and are assumed constant over time. The table below gives the crude oil prices that we have used.

Table 115: Energy import prices in (2000)$ / boe: preliminary 2005 energy baseline

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Oil	18.49	22.01	19.97	13.16	18.16	28.24	23.67	23.79	28.13	35.75	44.56	43.42	41.77	40.11	38.48	36.82
Gas	9.09	12.99	13.36	13.36	13.36	13.36	22.70	15.75	27.61	30.48	36.97	35.48	33.99	32.49	31.07	29.57
Coal	11.40	11.51	10.43	9.23	8.04	7.60	7.49	7.82	7.91	8.09	9.23	9.32	9.40	9.48	9.57	9.66

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil	36.85	36.93	36.97	36.98	37.06	37.54	38.06	38.63	39.15	39.66	40.66	41.76	42.81	43.88	44.92	45.45	46.02	46.48	46.99	47.54
Gas	29.81	30.07	30.41	30.64	30.91	31.30	31.77	32.09	32.50	32.95	33.79	34.72	35.60	36.50	37.39	37.96	38.64	39.27	39.87	40.51
Coal	9.83	9.90	10.01	10.16	10.29	10.39	10.53	10.66	10.80	10.84	10.91	10.94	11.08	11.10	11.23	11.25	11.36	11.35	11.43	11.51

[82] EU harmonisation of CNG, LPG and kerosene taxes is foreseen in the DG TREN White Paper, but in in the ASSESS project this was considered as one of the measures that is not implemented and neither on the track of being implemented in the near future. The same holds for the harmonization of truck diesel taxes and VAT on fuels.
[83] To enable that biofuels have the same consumer price as oil-based fuels.

A.4. Transport policy

Depending on transportation mode and cargo (technological) developments have influence on transportation cost and time.

For this reason two different scenarios will be analyzed in this study
- Scenario A: Moderate transportation policy, continuation current policy.
- Scenario B: Extended transportation policy, further liberalization of rail in combination with toll collection on European motorways.

Both scenario's are used by the EU and applied in TEN-STAC[84].

Table 116: Overview assumptions in the two scenario's 2A and 2B

	Scenario 2A	**Scenario 2B**
Yearly growth GDP in % (EU25) between 2005 and 2020	2.3%	2.3%
Yearly growth GDP in % (EU25) between 2005 en 2030	2.0%	2.0%
Increase of road and rail capacity until 2020	All planned projects, including Liefkenshoek rail tunnel and second rail connexion to the port of Antwerp.	
Increased capacity for roads after 2020	Capacity growth = (Share of personal transport in passenger car units * yearly population growth) + (share of transport of goods in passenger car units * yearly growth in BPP).	
Increased capacity of rail after 2020	No new infrastructure, however there are no capacity problems.	
Rail Infrastructure charges	€ 3.30 / train-kilometre	
Internalisation of external costs (all modes) – for rail by means of usage compensation, for road and internal waterways by means of a tax	German electronic toll (0.15 €/vehicle-km) applied to Europe.	Extra charge of 0.15 €/vehicle-km by 2030 for trucks, 0.01 €/tonne-km for rail by 2030, similar extra charges for cars, busses, inland ships and air transport
Far-reaching impact of track liberalisation – partially by means of usage compensation	No	Decreased rail transport times by 19% and rail costs by 5%.

A.4.1. Scenario A: Moderate transportation policy

Scenario A is a moderate scenario based on continuation of the current policy. In accordance to the policy as described in the White Paper of September 2001 supplemented with Keep Europe Moving of June 2006 and relevant national policy (long-range programs and policy plans of the Dutch, Belgium and German governments)

A.4.1.1. Transportation policy

Besides socio economic and technological developments the transportation market is changing due to European transportation policy. The most important objectives are described by the European commission in "White Paper, European transport policy for 2010: time to decide" and complemented in "Keep

[84] TEN-STAC: Traffic Forecasts and Analyses of Corridors on the Trans-European transport Network is executed by NEA incorporation with, website: www.nea.nl/ten-stac.

Europe Moving". An important goal is the shift for road transport to other modes in order to prevent negative effects of road transportation.

Most important developments in accordance with the European transportation policy:

- Construction of infrastructural projects supported by accompanying measures;
- Continued effects of deregulation transportation market;
- Harmonization of transportation policy;
- Environmental sustainability;
- Integration of new member states and nominated country's;
- Implementation and integration of information technology in the transportation sector;
- The introduction of toll collection on European main roads. Analogue to the German MAUT trucks will be charged € 0.15 per km.

Besides these expected developments "White Paper" and "Keep Europe Moving" suggest several accompanying measures for infrastructural railroad projects. The most important measures are:

- Improved railroad management;
- Intermodal policy;
- A railroad network tuned to transportation of cargo.

Scenario A is limited to planed political measures which are executed before 2020/2030 as described in "White Paper" and "Keep Europe Moving". The ASSESS P scenario will be used as source as with TRANS-TOOLS.

Quantification of this scenario should be fitted on specific model aspects. Both consortia will fit this scenario separately concerning the mentioned reference points. The next chapters will discus this in more detail.

A.4.1.2. User charge of railways

Expected is that the method of charging for the use of the railway will change. In 2006, the use of one km railway costs in the Netherlands is € 0.68 per km, and in Belgium it is € 1.63 per km. Compared to other countries, for instance Germany with a km-price of € 3.30, this is relative low. In several Eastern European countries the charged price is based in the total cost per km, resulting in a higher price per km compared to the current average European km-price. There is no information on future charging level in Belgium, The Netherlands or Germany.

In agreement with the steering group, the assumption has made that the km-price in Europe in 2020 and 2030 will be equal to the current (2006) German price of € 3.30 per km.

The model TRANS-TOOLS, used for the forecast, makes use of a price per tonne/km instead of driven km. This means that in the future the average price per tonne/km for light trains will be relative high compared to the forecast.

The price per train-kilometre can be divided in a fixed amount per train-kilometre and a variable part depending on tonne-kilometre. Based on analyses, conducted by ProRail, this ratio should be 50%. This means that the fixed and variable price per train/km respectively tonne/km is € 1.65. The average gross weight of a train is 1140 tonne thereof is, on average, 570 tonne cargo. The variable price per gross tonne-km is in this example: 0.0014474 € (1.65/1140).

Table 117: Model dependent user charge of railways

				Input to the modal (€ per tonne-km)		
		Tariff rate		Tariff rate		
	Tonne gross (incl. train)	Tonne-km	Train-km	Tonne-km	Train-km to tonne-km	Total (average per tonne-km)
Dry bulk	1 725	0.0014474	1.65	0.0014474	0.000957	0.00240
Wet bulk	1 270	0.0014474	1.65	0.0014474	0.001299	0.00275
Containers	1 360	0.0014474	1.65	0.0014474	0.001213	0.00266
Average	1 140	0.0014474	1.65	0.0014474	0.001447	0.00289

A.4.1.3. Toll collection on European main roads

Two assumptions are made for this scenario. One is the aspect of an additional road tax of € 0.15 per km for trucks (in accordance to the European transportation policy and de German MAUT). The other assumption is the replacement of purchase tax on cars and the MOT for a fixed price per km highway. This fixed price is € 0.075 and will be charged after 2020 for every driven km on a European highway.

A.4.2. Scenario B: Extended transport policy

This scenario exists of scenario A plus internalisation of external costs plus far-reaching impact of the liberalisation of the rail transport.

A.4.2.1. Internalisation of external costs

It is assumed that all road -, water - and rail users will get an extra levy imposed, with as aim to internalise the external costs of transport. The background scenario B means that the government will make each mode of transport more expensive by means of levies, where the road transport will experience a higher levy then track and inland waterways transport. Because there will be in this background scenario less road traffic and less congestion then in background scenario A, the impact on the Iron Rhine will be significantly different.

The figures which are presented in this paragraph are general, overall figures. The presented figures are a realistic *estimation* of the external costs. For making a background scenario for the forecasts this information is sufficient. In the CBA study these figures will be elaborated in more detail.

The aim of the internalisation of external costs, is that the user pays the real social costs, and therefore also takes into account all possible impacts of its transport behaviour, and not only those impacts who interest himself. The social costs are always larger than its own costs, the difference (taxes excluded) is called "external costs".

It concerns mainly external costs because of air pollution, climate change, noise hindrance, accidents and traffic-jams. Please notice that there are also partially internal costs (own costs) are to e.g. accidents, by the insurance premium, and to traffic-jams, by its own loss of time.

At this moment users pay already more than their own costs: they pay taxes on fuel, road taxes etc.. There is, in other words, already a part internalised.
In scenario B it is assumed that all users pay their total social costs in 2030, with a smooth transition, to start in 2020.

The difficulties or uncertainties hereby are:

- Determine the level of air pollution, noise hindrance, and climate change as a result of transport in 2020 and 2030.
  - Determine the increase of transport.
  - Determine the evolution of technology.
  - Differentiate by transport mode.
- Determine the level of congestion in 2020 en 2030.
  - Differentiate to motorway en other roads.
  - Differentiate by transport mode.
- Determine the external costs of sound and accidents in 2020, and 2030.
- Determine the taxes on transport in 2020, and 2030, (with the aim to determine the degree of internalisation).
  - Differentiate by transport mode.

These figures are at the moment not available at the necessary detail level for each country in Europe. There is only fragmented information available, on basis of which we make an estimation of the levy, which in Europe could be applied in a transport scenario which takes into account the internalization of the external costs.

a. Road transport

The setting-up of road pricing is intended, both for person cars and freight trucks. Road pricing will be implemented for passenger cars smoothly as from 2020, to reach the complete implementation of the marginal external cost in 2030. For freight trucks the policy for 2020 (Eurovignette as described such as in keep Europe Moving) will be further implemented after 2030 with complete internalisation. The movement has probably the following external costs and taxes in 2030:

Table 118: Estimation of the external costs and taxes for road transport in 2030

	Passenger car	Freight truck	Bus
External congestion costs	0.32 €/vehicle-km	0.17 €/vehicle-km	0.10 €/vehicle-km
External environmental costs	0.01 €/vehicle-km	0.02 €/vehicle-km	0.01 €/vehicle-km
Other external costs	0.04 €/vehicle-km	0.04 €/vehicle-km	0.04 €/vehicle-km
Regular taxes, e.g. on fuel	*0.04 €/vehicle-km*	*0.02 €/vehicle-km*	*-0.04 €/vehicle-km (subsidy)*

These numbers for congestion are determined on basis of calculation of INFRAS[85], where the extrapolation is done in line with the traffic density to 2020 and 2030. In particular, a yearly growth of congestion costs of 0.14 for passengers and for freight transport 0.18%.

[85] External costs of transport, Update study, 2004, INFRAS & IWW

It must be stated that the INFRAS 2004 estimates are very high, especially for congestion. Though at the time the background scenarios were made (2006), this was the only available source at the European level. Nowadays (end 2008), new studies have been performed showing lower congestion costs.

A new study by CE Delft "Handbook on estimation of external costs in the transport sector"[86] has been published by the European Commission. This study recommends lower values, depending on the situation (urban or non-urban motorway).

The scenario B taxes most probably will overshoot the external cost issue (while in the current situation taxes undershoot). This is not a problem though, as the scenario is meant to be a background scenario, "what if" policy makers would introduce a high tax.

Further we assume that the noise - and accident costs remain constant up to 2020 and 2030, and that the external environment costs decrease with 1% per year as a result of technological improvements. This is a continuation of the current recent developments, as in TERM and TREMOVE can be found.

In scenario B the levy for road transport becomes incorporated as follows in the model:

Table 119: Model input (scenario B) extra taxes as a result of internalisation of external costs road transport

	Person car	Freight truck	Bus
2020	0.10 €/vehicle-km	0.075 €/vehicle-km	0.05 €/vehicle-km
2030	0.20 €/vehicle-km	0.15 €/vehicle-km	0.10 €/vehicle-km

The levies in 2020 are half of those of 2030. The figures have been reflected by really charged barrel of goods or passengers. The levies have been assessed on the low side, to anticipate on the impact of a shift to a new balance (decrease of the transport volume). For buses the levy is counted on top of current, subsidised, situation.

b. Rail transport

The estimation of external costs of rail transport are shown in the table below.

Table 120: Estimation of external costs rail transport in 2030

	Passengers train	Freight train
External congestion costs	PM	PM
External environmental costs	<0.01 €/passenger-km	<0.01 €/tonne-km
Other external costs	0.01 €/passenger-km	0.01 €/tonne-km

In scenario B a tax of 0.01 € is assumed per passenger- or tonne-km in 2030. In 2020 it will be 0,005 €/km.

The tax is assigned to the operator via the normal user fee and added to the 3.30 € per train kilometre as defined in scenario A. The taxes are not related to subsidies for passenger transport.

[86] Handbook on estimation of external costs in the transport sector, February 2008, CE Delft with INFRAS, IWW, ISI, University of Gdansk, for DG TREN, European Commission.
http://ec.europa.eu/transport/costs/handbook/index_en.htm

Table 121: Model input (scenario B): additional taxes resulting from internalisation external costs

	Rail
2020	0.005 €/passenger-km or tonne-km
2030	0.010 €/passenger-km or tonne-km

The extra taxes due to an internalization policy have been further differentiated by traction type (diesel – electric), as the use of a uniform tax then lead to the somewhat counterintuitive result that more traffic was shifted towards the Iron Rhine/diesel traction as the Iron Rhine is shorter.

Based on the actual difference in emissions by diesel and electric trains, and assuming a stepwise introduction of this tax (50% of taxes in 2020 and 100% of taxes in 2030) the following taxes are applied.

In 2020:
- Electric 0.0035 €/tonne-km
- Diesel: 0.008€/tonne-km

In 2030:
- Electric 0.007€/tonne-km
- Diesel: 0.016€/tonne-km

c. Inland shipping and aviation

Inland shipping and aviation do also have external costs:

Table 122: Estimation of external costs inland shipping and aviation in 2030

	Inland shipping	Aviation
External congestion costs	PM	PM
External environmental costs	0.02 €/tonne-km	0.01 €/passenger-km
Other external costs	0.00 €/tonne-km	<0.01 €/passenger-km

Scenario B has an additional tax for inland shipping and aviation of 0.01 €/tonne-km in 2030. In 2020 halve of these values are used.

Table 123: Model input (scenario B): additional taxes resulting from internalisation external costs

	Inland shipping	Aviation
2020	0.005 €/tonne-km	0.005 €/passenger-km
2030	0.010 €/tonne-km	0.010 €/passenger-km

A.4.2.2. Far-reaching effects liberalisation rail transport

Additional to the policy in scenario A special focus is given to the far-reaching effects of liberalisation of rail transport in scenario B. In short, this implies that the scenario assumes that measures with respect to liberalisation (also planned in A) will have a larger impact on costs and travel times in rail transport.

In summary:
- Increased interoperability rail sector and improved "quality of services"
- Far-reaching liberalisation impacts: complete separation between rail infrastructure and operations,

through whole Europe
- Complete opening of the goods market and the international passenger market in Europe.

Quantification of these measures has been carried out in ASSESS, and used in TRANS-TOOLS (policy scenario 3). The figures show the differences in costs between scenario A en B, in 2020 en 2030.

Table 124: Quantification liberalisation measures in scenario B, compared to scenario A
Source: TRANS-TOOLS, elaboration from ASSESS, Final Report Annex V (Martens et al., 2005)

Measure	Implementation
Updating the interoperability directives on high-speed and conventional railway networks	- Rail freight travel time: -2%
Third railway package: improving quality of the rail freight services	- Rail freight travel time: -10%
First railway package: separated functions of management of infrastructure and service operation and opened access to international services	- Rail freight travel cost: -2% - Rail freight travel time: -2%
Second railway package: opening up the national and international freight market	- Rail freight travel cost: -3% - Rail freight travel time: -5%
Third railway package: gradual opening-up of international passengers services	- Rail passenger cost: -2%

Annex B: Rail routes

B.1. Analysis of possible rail routes in Germany

In the different scenarios, we make a separation between a situation with the Iron Rhine and a situation without an Iron Rhine. In order to do this, separate networks are made for the forecast year. Each of these networks is used as input for the rail assignment mode. In the future networks, other planned infrastructure projects are also taken into account.

For the trains from Antwerp in the direction of Germany and the related calculation of the Generalised Costs it is important to know which route is chosen on the network in Germany. This is especially important since in the case of routes in Southern direction along the historical Iron Rhine the trains have to be turned or make large detours. The same holds for if the Montzen route is chosen. Since the A52 variant has a curve to the south this analysis is not relevant in that case.

The possible routes are detailed with maps for both the Iron Rhine and the Montzen route. The maps below are thus not a result but an **input** to the Trans-Tools model.

This information is used in chapter II.2.3.3 "The general assignment model" on page 72.

Figure 20: Change of direction in Aachen for southern bound routes in Germany via the Montzen route

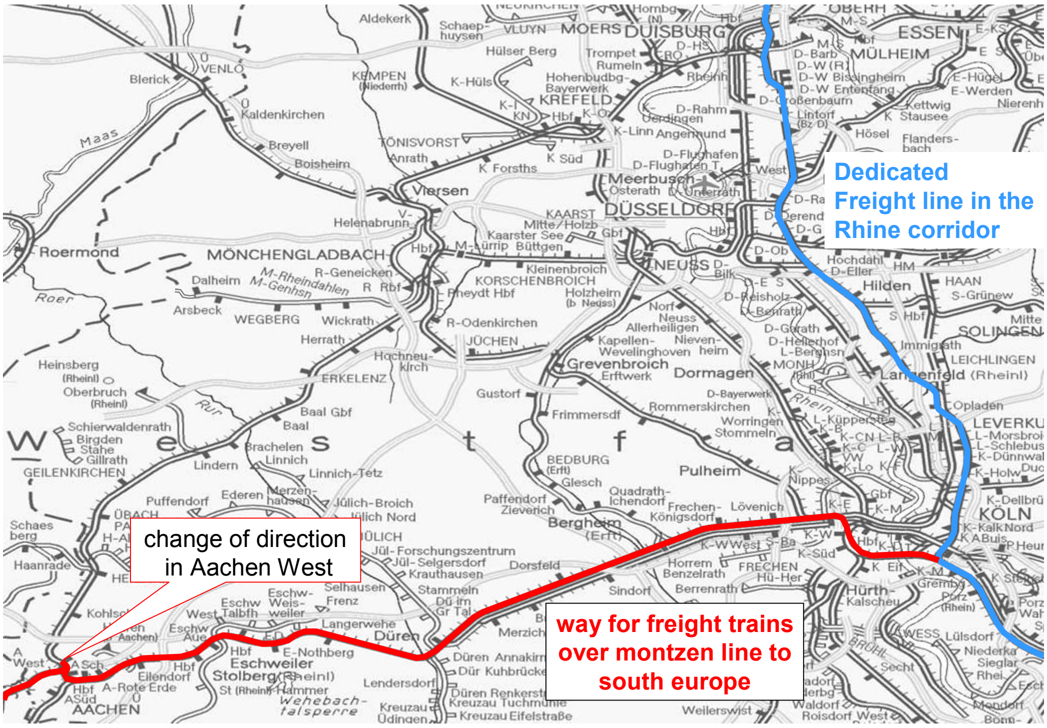


Figure 21: Northern bound routes in Germany via the Iron Rhine

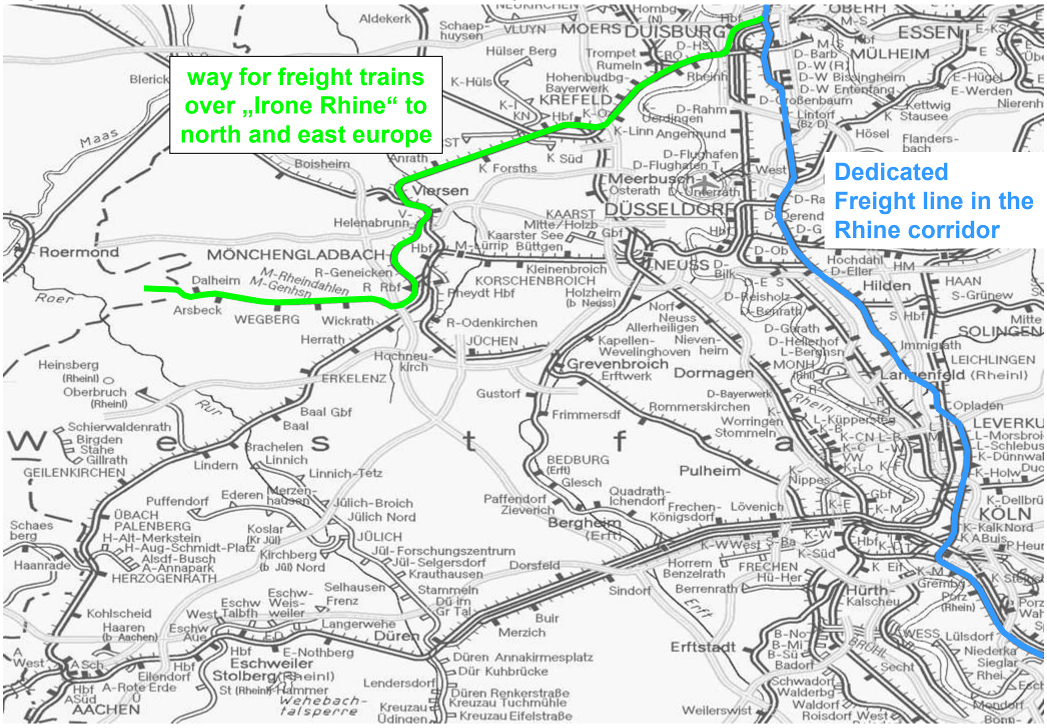
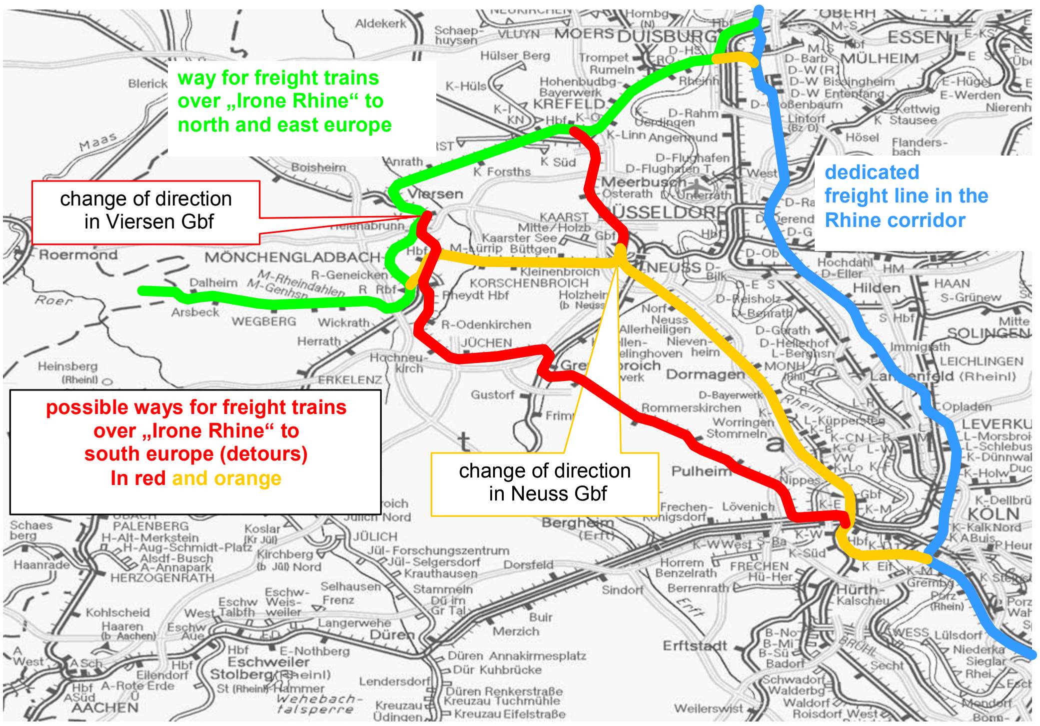


Figure 22: Change of direction in Neuss for southern bound routes in Germany via the Iron Rhine, compared to alternatives



The option for a change of direction in Neuss has been determined by comparing it with a change of direction in Viersen and longer routes without requiring a change of direction. The option via Neuss has the lowest generalised costs, and will therefore always be used. The red option will not be used.

B.2. Rail routes in variant “Historical Iron Rhine – 2A”

The flows **resulting** from the calculations with the trade and modal-split model of TRANS-TOOLS and the combination with the results from the ECORYS/CPB container model (described in the previous section) are assigned to the rail network. For the TRASN-TOOLS flows an all-or-nothing assignment routine is applied on basis of transport distances taking into account a border resistance. The flows resulting from this assignment on the Iron Rhine and on the Montzenroute are considered as the common potential for the Iron Rhine and the Montzenroute. In a next step the assignment of flows to either the Iron Rhine or the Montzenroute is made based on the Generalised Costs method as described in section II.2.4; the results of the generalised costs method are not shown in this section but will be discussed in the next section.

By a selected link analysis it is determined which OD flows are assigned to the Iron Rhine and which are assigned to the Montzen route. In the figures below the selected link analyses is shown from the all-or-nothing assignment routine, which should be considered an intermediate result. Figure 25 shows the flows of the Iron Rhine and Figure 24 the flows of the Montzen route. Both figures represent the 2A 2020 scenario in the case of reactivation of the Iron Rhine. In Figure 23 the flows on the Montzen route are shown in the case of no reactivation of the Iron Rhine.

It can be noted that when comparing the selected link analysis of the Iron Rhine and the Montzen route with reactivation of the Iron Rhine the main differences can be found on the Belgium side. The area covered on German side is comparable.

In the figure below we see the selected link analysis for the potential of the Montzen route and the Iron Rhine with the base variant for the year 2020 under the 2A scenario. The first map is the Montzen route without reactivation of the Iron Rhine and the other two maps are respectively the Montzen route and the Iron Rhine after reactivation. An interesting difference to note between the situation without and with reactivation of the Iron Rhine is that the Iron Rhine attracts flows from France that would otherwise go in the direction of the German-French border.

Comparing the potential of the Montzen and the Iron Rhine after reactivation we see that the main difference of the hinterland lies on the Western side where the Iron Rhine serves the routes through the more Northern part of Belgium and the Montzen route the more southern parts. On the eastern side the aggregated hinterland is similar.

Figure 23: Transport flows on the Montzen route in scenario 2A 2020 without reactivation Iron Rhine (only links with more than 25000 tonne)

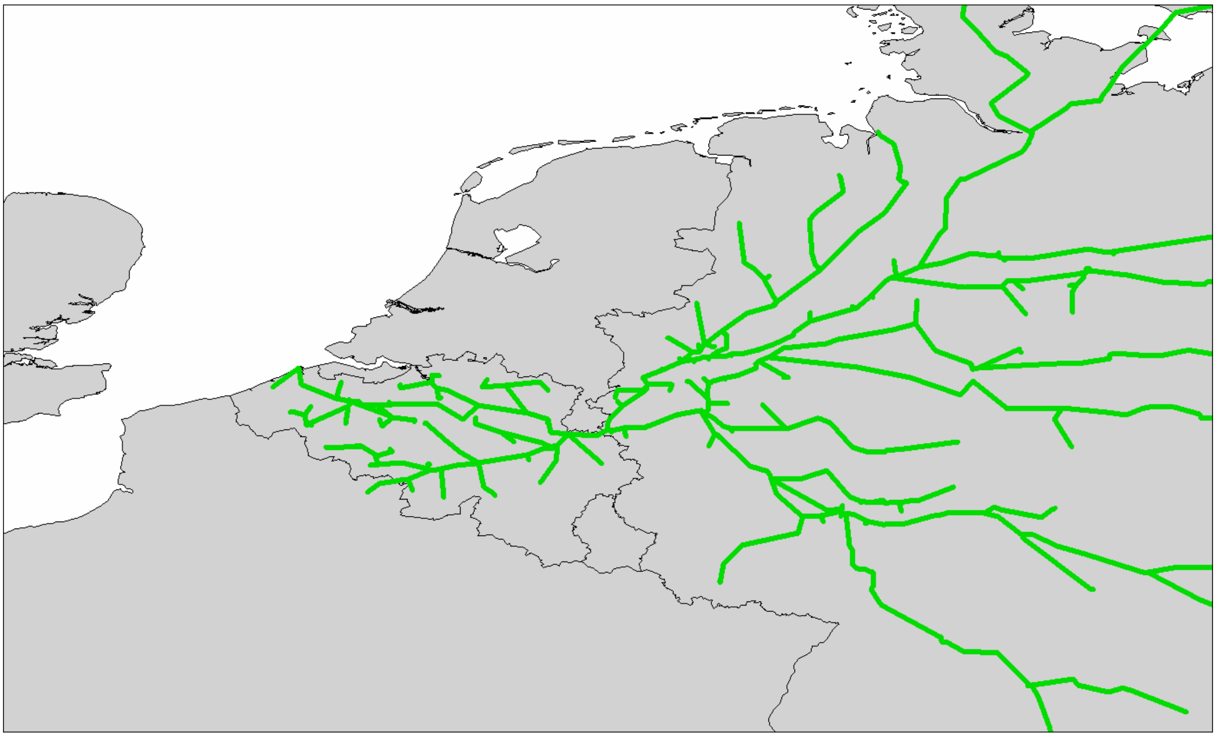


Figure 24: Transport flows on the Montzen route in scenario 2A 2020 with reactivation Iron Rhine (only links with more than 25000 tonne)

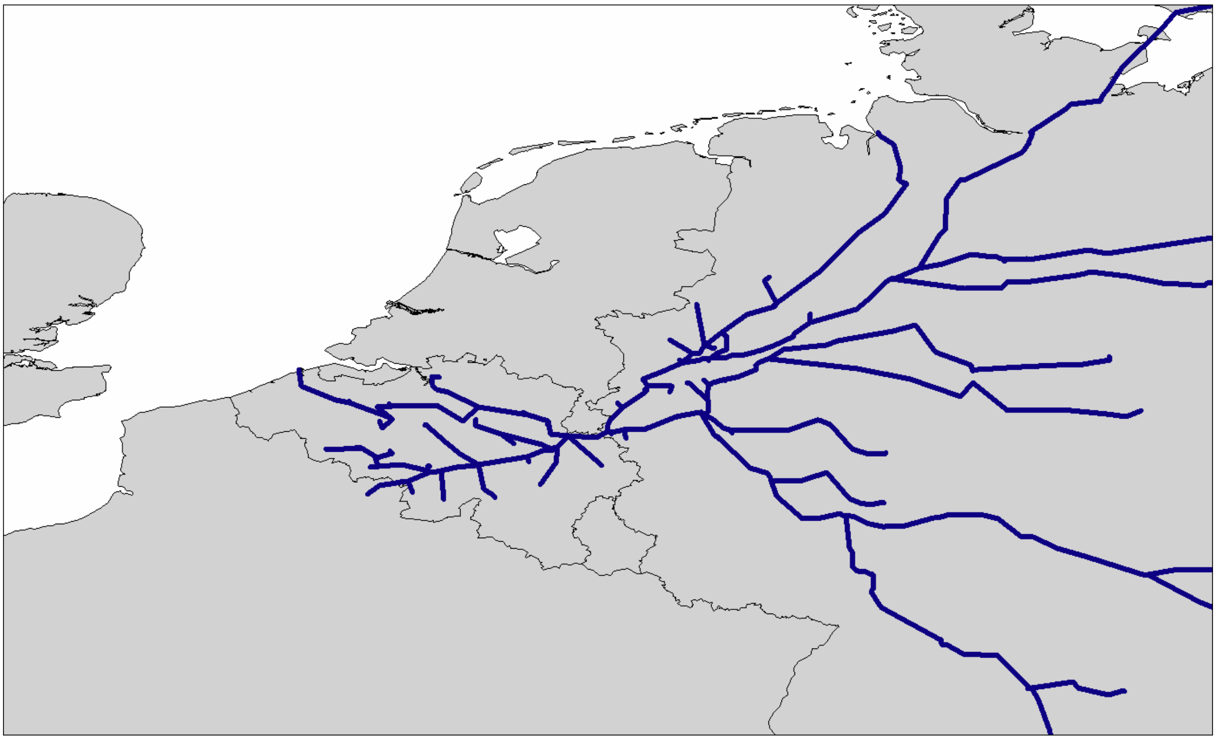
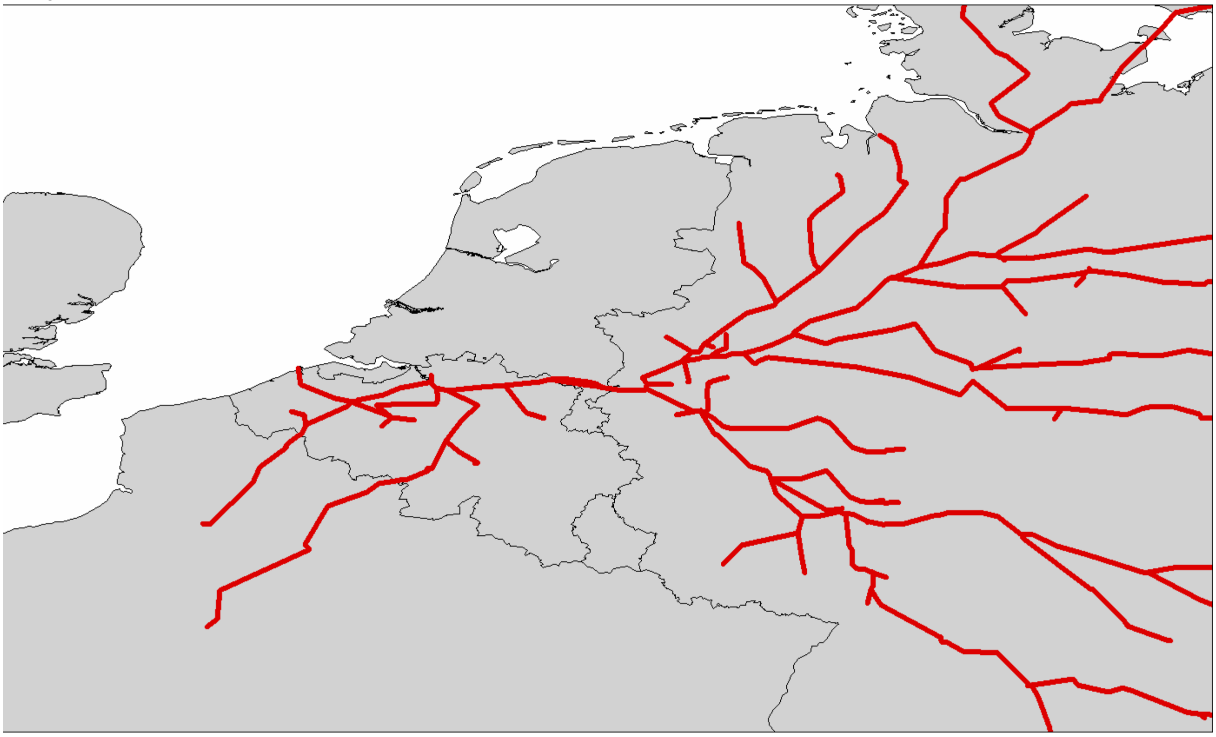


Figure 25: Transport flows on the historical Iron Rhine in scenario 2A 2020 with reactivation Iron Rhine (only links with more than 25000 tonne)



The table below contains the main flows on the Iron Rhine and Montzen route, for 2030 in the scenario "Historical Iron Rhine – 2A". The unit of the figures is the amount of transported tonnes.

Table 125: Flows from and to Belgium per route, in tonnes, 2030, scenario "Historical Iron Rhine – 2A"
Note: limited to relations with Germany, Poland, Russia, Austria, Hungary, Italy, France, Denmark, Czech Republic, Sweden, Norway, Slovakia, Bulgaria. Flows to other countries and through traffic is not included.

Flows to Belgium				Flows from Belgium			
origin	destination	Iron Rhine	Montzen	origin	destination	Iron Rhine	Montzen
Bulgaria	Prov. Antwerpen	163.819		Prov. Antwerpen	Denmark	35.626	4.787
Russia		196			Russia	24.264	
Germany		1.869.293	440.885		Austria	659.281	213.092
Czech Republic		69.142	13.304		Czech Republic	6.632	7.370
Poland		69.071	1.904		Germany	2.327.765	508.983
Sweden		11.670	2.382		Hungary	30.962	22.285
Slovakia		4.458	5.928		Italy	43.670	
Austria		417.593	224.335		Norway	1.500	
Finland		1.586			Poland	380.520	819
Hungary		16.179	33.946		Sweden	86.990	
Italy		45.023			Slovakia	4.420	242
Norway		238		Prov. Brabant Wallon	Denmark		659
Germany	Prov. Brabant Wallon	103	11.801		Russia		1.164
Sweden			199.928		Czech Republic		822
Norway			399		Germany	43.730	65.515
Russia	Prov. Hainaut		492		Norway		5.383
Germany		732	159.928		Sweden		75.453
Czech Republic			10.725	Prov. Hainaut	Denmark		11.738
Poland			402.572		Russia		11.261

Flows to Belgium				Flows from Belgium			
origin	destination	Iron Rhine	Montzen	origin	destination	Iron Rhine	Montzen
Sweden			515.883		Czech Republic		3.113
Norway			1.067		Germany	10.161	256.210
Germany	Prov. Liège	19	36.019		Norway		16.896
Czech Republic			13.780		Poland		11.502
Poland			1.674		Sweden		3.901
Sweden			189.336	Prov. Liège	Denmark		1.364
Slovakia			909		Austria		831
Austria			3.861		Czech Republic		2.790
Italy			27.173		Germany	34.697	727.419
Germany	Prov. Limburg (B)	206.578	348.321		Italy		20.004
Czech Republic		4.184	13.106		Norway		3.289
Poland		16.908	52.965		Poland		16.589
Sweden		2.219	6.950		Sweden		11.985
Slovakia		3.926	12.298		Slovakia		442
Austria		5.930	18.552	Prov. Limburg (B)	Denmark	573	926
Hungary		1.313	4.115		Russia	5.680	5.041
Italy		12.425	30.548		Austria	12.971	39.076
Norway		54	171		Czech Republic	2.372	6.903
Russia	Prov. Luxembourg (B)		286		Germany	123.314	107.219
Germany		48	13.406		Hungary	1.029	3.222
Slovakia			238		Italy	27.288	56.117
Austria			440		Norway	634	546
Germany	Prov. Namur	61	7.012		Poland	3.026	7.016
Germany	Prov. Oost-Vlaanderen	183.858	21.650		Sweden	1.754	1.575
Czech Republic		5.273	586		Slovakia	1.783	5.586
Poland		20.149		Prov. Luxembourg (B)	Denmark		193
Sweden		396.446			Russia		600
Slovakia		2.857	5.184		Austria		3.104
Austria		1.219	4.474		Germany	1.042	16.338
Hungary		3.739	142.899		Slovakia		113
Germany	Prov. Vlaams-Brabant	32.566	46.399	Prov. Namur	Ukraine		259
Poland		134	79		Czech Republic		101
Sweden		15.940	9.351		Germany	68.895	373.252
Slovakia		257	2.825		Poland		906
Austria			1.737	Prov. Oost-Vlaanderen	Denmark	9.904	
Germany	Prov. West-Vlaanderen	120.606	56.721		Ukraine	1.125	
Czech Republic		31.258	14.030		Austria	9.409	9.242
Poland		564	90		Czech Republic	4.089	3.855
Sweden		20.006	247		Germany	771.934	30.162
Slovakia		467	4.764		Hungary	5.579	5.579
Austria		4.522	32.234		Norway	895	
Hungary			44.694		Poland	4.667	
					Sweden	222.621	
					Slovakia	84	142
				Prov. Vlaams-Brabant	Austria	790	1.589
					Germany	5.526	4.849
					Italy		1.794
					Norway	369	217
					Sweden	154	91
				Prov. West-Vlaanderen	Denmark	5.729	1.206

Flows to Belgium				Flows from Belgium			
origin	destination	Iron Rhine	Montzen	origin	destination	Iron Rhine	Montzen
					Russia	1.554	323
					Austria	250	3.015
					Germany	80.680	34.583
					Hungary		20.411
					Norway	7.772	2.102
					Poland	37.273	7.754
					Sweden	2.261	345
					Slovakia	263	1.102

B.3. Calculation of the generalised costs for different routes

The selected routes in Germany in section B.1. of this annex, especially the location of the turn that has to be made in order to reach specific relations, and the common potential determined as described in section B.2. are inputs to the calculation of the Generalised costs. The calculation of the generalised costs is much broader and uses all other relevant cost aspects. The method applied is described in section II.2.4 on page 73 and the specific cost elements are described in detail in annex C and D.

In order to have insight in the way the generalised costs are calculated an illustrative computation is made as shown in Table 126. In this example we consider the transport of goods of *category 9* (machinery etc.) from *Antwerp* to *Dortmund*, transported in *containers*.

Table 126: Illustration of generalised costs from Antwerp to Dortmund by rail

	Montzen	Iron Rhine
Distance (km)	339	273
Average speed (km/h)	70	70
Total time needed (h)	4.84	3.90
Average volume per train (tonne/train)	815	815
Fuel	Diesel	Electric
Average fixed costs train operator (€/train-hour)	180.00	179.00
Total fixed costs (€/train-hour)	**871.71**	**698.10**
Average variable (€/train km)	3.70	3.70
Average energy costs (€/train km)	2.30	3.80
Average infrastructure fee (€/train km)	3.30	3.30
Total variable costs (€/train)	**3152.70**	**2948.40**
Extra costs last mile for changing direction (€/train)	236.35	
Extra costs last mile for electric shunting cost (€/train)	145.01	
Value of the goods (€/train)	642.86	484.11
Total cost for a train	**5048.64**	**4130.61**
Total cost per tonne	**6.19**	**5.07**

As can be seen in Table 126, the shorter distance for the Iron Rhine is the main difference between the two alternatives. This shorter distance means smaller fixed costs of renting rail equipment and smaller variable costs (infrastructure fee+energy). A second advantage is that the use of diesel trains on the Iron Rhine allows to avoid the cost of the last mile that has to be done using a diesel locomotive. The total cost difference is 1.12 € per net tonne transported.

In this example, the generalized costs via the Iron Rhine costs are only 78% of the costs via the Montzen route. The majority of the traffic that switches from the Montzen route to the Iron Rhine has however a cost advantage lower than presented in this example.

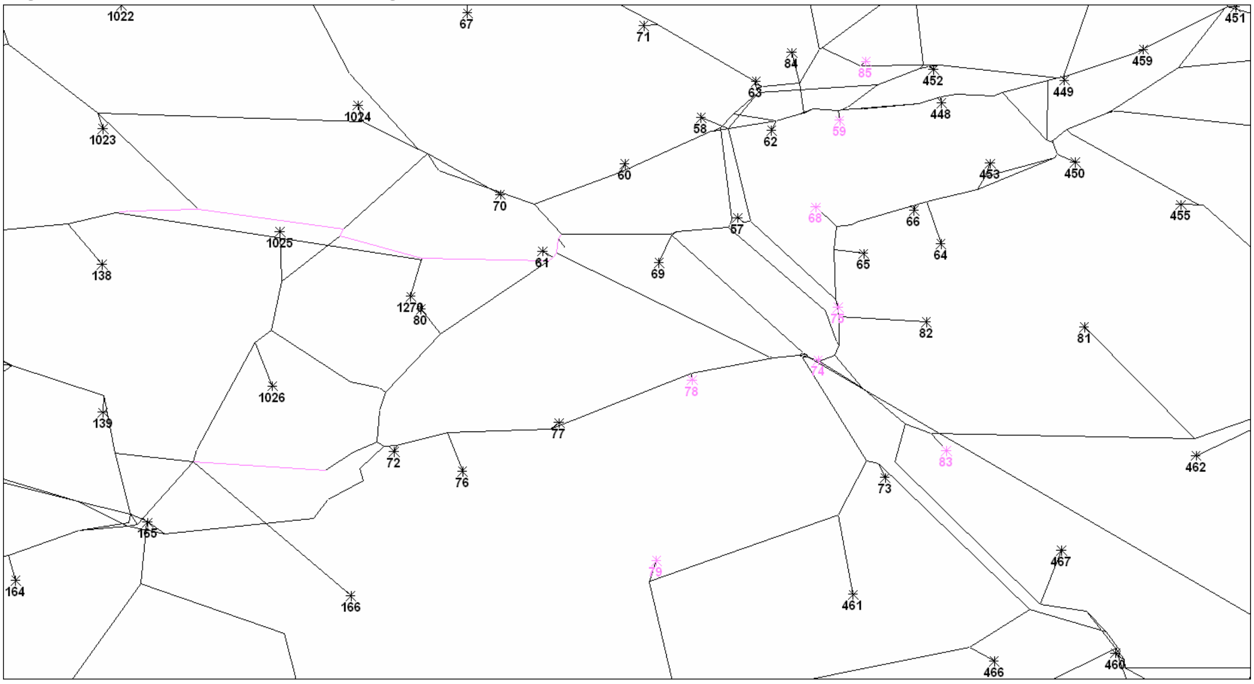
Some more examples for routes between Antwerp and Germany are shown in the following table. The location (corresponding to the codes in the table) of where the regions feed into the rail network are shown are shown in the figure below.

In the table below, some examples are show all in relation with Antwerp. It is clear from this table that for Antwerp the Iron Rhine is in most cases the best alternative. For other regions in Belgium the Montzen might be a better route. For Essen the costs for all loading types are shown where for the other regions in the table only one loading type is selected plus for all the container costs are shown.

Table 127: Generalised costs for the Iron Rhine and the Montzen Route for a selection of region in relation with Antwerp, 2020

Region	Code	Loading type	Cost for Iron Rhine	Cost for Montzen	Difference
Essen, Kreisfreie Stadt	59	Aggro/food	2.69	3.95	1.26
Essen, Kreisfreie Stadt	59	Coal/bulk	2.65	3.90	1.26
Essen, Kreisfreie Stadt	59	Ore	2.67	3.93	1.26
Essen, Kreisfreie Stadt	59	Metal	2.58	3.79	1.21
Essen, Kreisfreie Stadt	59	Chemical	2.54	3.72	1.18
Essen, Kreisfreie Stadt	59	Containers	4.34	5.37	1.02
Mettmann	68	Metal	2.84	3.65	0.81
Mettmann	68	Containers	4.33	4.56	0.23
Köln, Kreisfreie Stadt	74	Coal/bulk	2.78	3.55	0.78
Köln, Kreisfreie Stadt	74	Containers	4.53	4.79	0.26
Leverkusen, Kreisfreie Stadt	75	Ore	2.94	3.74	0.80
Leverkusen, Kreisfreie Stadt	75	Containers	4.80	5.03	0.23
Erftkreis	78	Aggro/food	2.87	3.42	0.56
Erftkreis	78	Containers	4.62	4.45	-0.16
Euskirchen	79	Aggro/food	3.93	4.69	0.77
Euskirchen	79	Containers	6.31	6.39	0.08
Rhein-Sieg-Kreis	83	Coal/bulk	2.98	3.81	0.84
Rhein-Sieg-Kreis	83	Containers	4.87	5.10	0.23
Gelsenkirchen, Kreisfreie Stadt	85	Chemical	2.72	3.89	1.17
Gelsenkirchen, Kreisfreie Stadt	85	Containers	4.65	5.64	0.99

Figure 26: Locations where the regions feed into the rail network



The purple line on the top left of the figure is where the Iron Rhine is located and the purple line on the bottom left of the figure is where the Montzen route is located. In the figure one can see that the NUTS 3 regions are selected in such a way that all northern and southern directions for both the Iron Rhine and the Montzen route are covered. Destination further away will have similar cost differences.

B.4. Capacity of rail routes

This paragraph describes our assumptions on the rail capacity.

B.4.1. Capacity on the Iron Rhine route

Infrabel and ProRail state that, based upon the actual track layout (to a large extent single track) the Iron Rhine (historical track) will have a maximum capacity of 72 freight trains per day in both directions together, in all variants. See Annex T: Advice 2007 “Commissie Onafhankelijke Deskundigen IJzeren Rijn” on page 298 for more details. Additionally, DB Netz states that it is unrealistic to consider a low capacity line (i.e. of 72 trains per day) for a new constructed or an upgraded infrastructure of Iron Rhine in Germany.

B.4.2. Capacity on the Montzen route

We do not know what the maximum capacity is on the Montzen route. Infrabel states that in all scenarios, the Montzen route has enough capacity to cope with the number of trains that is forecasted, taking into account the planned investments (see L.1.1. Reference scenario on page 259). The forecasted number of trains can be found in the table below.

Table 128: Number of freight trains on the Montzen route if the Iron Rhine will not be build

	Reference scenario – 2A		**Reference scenario – 2B**		**Reference scenario – 2A sensitivity analysis +20%**	
	2020	**2030**	**2020**	**2030**	**2020**	**2030**
Antwerp - Aarschot	88.6	102.9	92.2	111.7	106.3	123.5
Aarschot - Hasselt	92.3	104.9	95.4	112.8	110.8	125.9
Hasselt - Tongeren	79.4	91.4	82.6	99.5	95.3	109.7
Tongeren - Montzen	77.5	89.4	80.8	97.7	93.0	10.3
Montzen - Germany	71.8	83.1	75.6	93.0	86.2	99.7

B.4.3. Capacity in Germany

DB Netz states that in all scenarios, the German existing rail links have enough capacity to cope with the number of trains that are forecasted.

Annex C: Composition of costs of rail operators

We consider three types of costs:

- average fixed costs (€/h): costs locomotive, wagon, personnel and overhead
- average variable costs (€/train-km): infrastructure fee, shunting costs, externality tax (only in background scenario 2B)
- average energy costs (€/train-km): distinguishing diesel from electric traction.

We have calculated these costs for 4 types of loads: container, general cargo, dry bulk and wet bulk. All costs are expressed in €2005

C.1. Average fixed costs

We used the assumptions below to come to a cost in €/h for locomotive, wagon and personnel.

C.1.1. Locomotive

Table 129: General assumptions for the operator costs for locomotives

Source: "*Vergelijkingskader modaliteiten*" and own calculations

type	diesel	electric
	Class 66	**BR 152**
purchase price per piece (including safety system) €	2469882	3252011
number of locomotives	1	1
depreciation (number of years)	20	20
maintenance costs(%)	6.25	6.25
insurance cost (%)	1.5	1.5
rest value (%)	10	10
number of working days	300	300
number of working hours/day	6.5	6.5

C.1.2. Wagon

Table 130: General assumptions for the costs for wagons

Source: "*Vergelijkingskader modaliteiten*" and own calculations

type	container		general cargo		wet bulk		dry bulk	
	diesel	**electric**	**diesel**	**electric**	**diesel**	**electric**	**diesel**	**electric**
	Sgns 691	**Sgns 692**	**Hbbillns 305**	**Hbbillns 306**	**Zaces**	**Zaces**	**Falns 183**	**Falns 183**
number per train	29	29	25	25	18	18	30	30
loading capacity per wagon (TEU) or tonne	3	3	28.5	28.5	58.3	58.3	65	65
rental price per day	21.40	21.40	17.39	17.39	24.70	24.70	15.85	15.85
number of working hours per day	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5

We have added for the container wagons value of time of 3 containers at 0.65 € each.

C.1.3. Personnel

For this, only the cost of the driver at 50 €/h (source is personnel communication ERS) is taken into account. Other personnel costs are included in shunting costs?

On top of these three cost elements, an overhead of 20% is assumed. This leads to the following fixed costs.

Table 131: Average fixed operator costs for personnel
Source: own calculations

	container		General cargo		wet bulk		dry bulk	
	diesel	electric	diesel	electric	diesel	electric	diesel	electric
average fixed costs (€/h)	178.56	179.816	144.256	145.52	146.06	147.32	151.76	153.02

C.2. Average variable costs

C.2.1. Infrastructure fee

For the infrastructure fee, 3.30 €/train-km is assumed. We know that this does not corresponds to today's reality, but it is supposed to be the case in 2015.

In the B policy option this infrastructure fee is increased with an externality tax:

Table 132: Externality tax
Source: ASSESS study

2020	0,005 €/ tonne-km
2030	0,010 €/ tonne-km

The extra taxes due to an internalization policy have been further differentiated by traction type (diesel – electric), as the use of a uniform tax then lead to the somewhat counterintuitive result that more traffic was shifted towards the Iron Rhine/diesel traction as the Iron Rhine is shorter.

Based on the actual difference in emissions by diesel and electric trains, and assuming a stepwise introduction of this tax (50% of taxes in 2020 and 100% of taxes in 2030) the following taxes are applied.

In 2020:
- Electric 0.0035 €/tonne-km
- Diesel: 0.008€/tonne-km

In 2030
- Electric 0.007€/tonne-km
- Diesel: 0.016€/tonne-km

C.2.2. Shunting costs

For the shunting costs, we assumed a cost of 411.65 €/train for diesel and electric trains, including the personnel costs. In order to get a number for train-km, we assumed that average international train trip is about 1000 km long.

The additional shunting costs for electric trains related to the first and last km are not included in the costs presented here but will be added depending on the need for turning of the train. It will be made sure that for an electric train always 30 minutes at the start and 30 minutes at the end of the trip will be added. So in case of turning the train in Neuss or Aachen no double count will be included, but then only once 30 minutes will be added at the other end of the electric train trip.

Table 133: Shunting costs and distance
Source: "*Vergelijkingskader modaliteiten*" and own calculations

	diesel	electric
shunting costs (including personnel)	411.65	411.65
number of km (average)	1000	1000

This gives an average variable costs of:

Table 134: Average variable operator costs for shunting
Source: "*Vergelijkingskader modaliteiten*" and own calculations

variable costs (€/train-km)	**container**		**General cargo**		**wet bulk**		**dry bulk**	
	diesel	**electric**	**diesel**	**electric**	**diesel**	**electric**	**diesel**	**electric**
For background scenario 2A	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71
For background scenario 2B in 2020	8.40	8.40	7.71	7.71	9.71	9.71	10.21	10.21
For background scenario 2B in 2030	13.09	13.09	11.71	11.71	15.71	15.71	16.71	16.71

Annex D: Cost model for energy costs of diesel and electricity

We have applied a cost model that gives for an exogenous crude price the expected diesel price and electricity price for freight rail traction.

This model is the TransCar model. It derives detailed energy prices for rail operations from the oil price forecast of the EIA, and cost and efficiency data for the production of electricity by gas powered stations.

D.1. Energy costs for rail operations

The tables below give an overview of the calculation results for diesel and electric trains.

Major assumptions are:
- The average crude oil price is 60.80$ for 2020 and 71.76$ for 2030 (price level 2005).
- Electricity is produced with a new power station running on natural gas.
- The spread between diesel and crude oil is stable.
- Natural gas prices stand in a fixed proportion to crude oil prices.
- CO_2 permits are needed for natural gas and for diesel (40 €/tonne of CO2).

Table 135: Energy costs
Source: TransCar model and own calculations

	container		general cargo		wet bulk		dry bulk	
	diesel	**electric**	**diesel**	**electric**	**diesel**	**electric**	**diesel**	**electric**
electric kWh or diesel litre per km	7.11	27.43	4.81	19.29	5.38	22.86	8.66	44.54
cost per kWh or per litre(€) 2020	0.54	0.08	0.54	0.08	0.54	0.08	0.54	0.08
cost per kWh or per litre (€) 2030	0.64	0.09	0.64	0.09	0.64	0.09	0.64	0.09

Table 136: Average variable operator costs for energy
Source: own calculations

	container		general cargo		wet bulk		dry bulk	
	diesel	**electric**	**diesel**	**electric**	**diesel**	**electric**	**diesel**	**electric**
average energy costs (€/train-km) 2020	3.85	2.31	2.60	1.63	2.91	1.93	4.69	3.75
average energy costs (€/train-km) 2030	4.53	2.53	3.07	1.78	3.43	2.10	5.52	4.10

The assumptions on the diesel prices and natural gas prices as a function of the crude oil prices can be found in the paragraphs below.

D.2. Detailed model calculations for diesel

We take the diesel price before taxes, international quotations (London). The following relation was estimated for the period January 2001 to January 2008. In this period, crude oil prices varied between 19 en 97 $/bbl *(barrel of oil).*

*diesel price (in $/bbl) = 0.953 + 1.20 * [crude oil price for Brent (in $/bbl)]*

diesel price per liter = [price per barrel] / 159

For 1 MWh *(megaWatthour)* power input in a diesel locomotive one needs 3.41 MMBtu and there are 5.825 MMBtu in a bbl.

This gives:

*price of 1 MWh diesel input in a locomotive = 3.41 / 5.825 * [diesel price (per/bbl)]*

thermal efficiency of diesel locomotive is 30% .

CO_2 permit cost = 33 €/MWh

D.3. Detailed model calculations for electricity

D.3.1. Natural gas cost of 1 MWh produced in power station

We take that natural gas prices delivered to electric power stations are equal to 80% of the crude oil prices.

conversion efficiency of natural gas in a power station = 55%

*energy only price of 1 MWh elec input in a locomotive = (0.8 / 0.55) * (3.41/5.825) * [crude oil price]*

D.3.2. Non energy cost of 1 MWh electricity

This consists of a transmission cost, a power plant cost and a CO_2 permit cost

The transmission cost = 8 €/MWh (average cost of Elia, rail is not a base load consumer and the consumption is spread over the territory, so there is no need to give a discount.

Elia revenue (2007)	714	million €
Belgian power market	90	TWh
Implied transmission tariff	7.93	€/MWh
Transmission tariff (rounded)	**8**	**€/MWh**

The non fuel cost of the power plant equals:

Non-fuel cost		
Plant construction cost	600	€ /kW
Utilization (no base load)	50%	
Depreciation period power plant	20	years
Yearly capital cost (r=7.5%)	58.86	€ /kW
Power production	4.38	MWh/kW
Capital cost per MWh	13.44	€/MWh
Plant maintenance cost	5.00	€/MWh
Total plant non-fuel cost	18.44	€/MWh
Transmission cost	8.00	€/MWh
Total non-fuel cost	26.44	€/MWh

The CO_2 permit cost (40 €/tonne CO_2 in 2020) is 12.75 €/MWh.
The sum is 34.44 €/MWh +12.75 €/MWh

D.4. Comparing diesel and electricity

Comparing diesel and electricity per MWh of power delivered in to locomotive.

Electricity price (€/MWh) = fixed part + energy part
= 34.44 + [CO_2 permit cost] + (0.8 / 0.55) * (3.41/5.825) * [crude oil price in €]
= 34.44+ 12.75 + 0.8515 * [crude oil price in € per barrel]

Diesel price (€/MWh)
= (1/0.30) * (3.41/5.825) * [crude oil price in € per barrel] + [CO_2 permit cost]
= 1.95 * [crude oil price in € per barrel] + 33

Example:
For an oil price of 50 €/bbl, one has:
Electricity cost = 97.2 €/MWh
Diesel cost = 130.5 €/MWh

The driving forces behind the differences are:
- The poor efficiency of the energy conversion in the diesel loc (30% versus 55% in natural gas plant).
- Higher CO_2 permit cost of diesel because of its larger CO_2 emission content and the poorer energy conversion efficiency.

Annex E: Container model

E.1. Introduction

When developing the ECORYS/CPB model a lot of work and time was used to determine the cost matrix and the data about the container flows between all hinterland regions and ports. Within this study it was not considered necessary to repeat this exercise. Therefore TNO has delivered to ECORYS the changes in generalised costs due to the reactivation of the Iron Rhine. This has been used by ECORYS as input to make changes to the already existing cost matrices. With this input ECORYS has run the model for the years 2020 and 2033 using data about the transport flows from the study "*Verruiming van de vaarweg van de Schelde*".

In this SCBA, the container modal has been used to determine the modal shift. The total transport flows were calculated by Trans-Tools and remained as they were. The Trans-Tools modal shift was modified by the container model shift.

E.2. Development of the container model by ECORYS/CPB

The data about container flows in the container model is based on the years 1997 and 2002. This data has been based on data sources such as:

- Freight transport statistics;
- "*Transport Economisch Model*"(TEM);
- Transhipment data for the ports of Rotterdam, Antwerp, Le Havre, Hamburg and Bremen;
- Modal-split data for the ports of Rotterdam, Antwerp, Le Havre, Hamburg and Bremen;
- Shares of containerised transport in the ports;
- For German regions volume in tonnes for the year 1997 per hinterland region, per port and per direction.
- For Antwerp data about hinterland flows from the Port of Antwerp (GHA).

All these sources have been used to construct per port the volumes of containerised transport by hinterland region and by hinterland mode. The volumes in tonnes have been translated into the volumes in TEU by applying tonne/TEU ratios (dependent on the port, these ratios vary between 9.5 - 11.5 tonnes per TEU).

Based on this data a logit model has been calibrated that predicts the market shares of the ports and the market shares of the modes in the hinterland transport. A detailed description of the model can be found in the report "*Ontwikkeling marktaandeelmodel containersector*", ECORYS, 15 January 2004.

Forecasts of the container flows for the years 2020 and 2033 have been made for the study "*Verruiming van de Schelde*". This has been done by extrapolating trends from the past to the future. In this forecasting method, for Antwerp the reactivation of the Iron Rhine is not taken into account.

In the next two tables, overviews are given of the volume of container flows in TEU between the port of Antwerp and the hinterland regions[87].

Table 137: Volume container transport in 1000 TEU between Antwerp and hinterland regions by mode of transport in the year 2020
Source: ECORYS, result from study "Verruiming van de Schelde"

	2020	**roads**	**rail**	**inland waterways**	**Antwerp**
	x 1000 TEU				
1	Schleswig-Holstein	0.6	0.4	0.2	1
2	Hamburg	14.6	9.8	0.0	24
3	Niedersachsen-Nord	0.0	0.0	10.0	10
4	Niedersachsen-West	2.9	0.0	4.9	8
5	Niedersachsen-Süd-Ost	5.4	0.0	0.0	5
6	Bremen	1.4	0.3	8.3	10
7	Nordrhein-Westfalen-Nord	21.4	0.0	0.3	22
8	Ruhrgebiet	94.8	24.2	304.2	423
9	Nordrhein-Westfalen-Süd-West	92.1	65.7	171.6	329
10	Nordrhein-Westfalen-Ost	46.8	0.6	0.0	47
11	Hessen	13.0	1.4	126.6	141
12	Rheinland-Pfalz	39.1	0.0	132.3	171
13	Baden-Württemberg-Nord-West	3.4	0.0	99.0	102
14	Baden-Württemberg-Ost	4.6	0.0	24.1	29
15	Baden-Württemberg-Süd-West	2.2	0.0	0.0	2
16	Nordbayern	6.9	0.0	0.2	7
17	Ostbayern	0.1	1.4	0.6	2
18	Südbayern	4.8	59.4	0.0	64
19	Saarland	14.1	0.0	0.0	14
20	Berlin	2.5	0.0	0.0	3
21	Mecklenburg-Vorpommern	0.2	0.0	0.0	0
22	Brandenburg	0.0	0.0	0.0	0
23	Sachsen-Anhalt	0.5	0.0	0.0	1
24	Thüringen	1.0	0.0	0.0	1
25	Sachsen	1.1	0.9	0.0	2
26	Groningen	3.6	0.0	0.0	4
27	Friesland	5.9	0.0	0.0	6
28	Drente	4.6	0.0	0.0	5
29	Overijssel	9.6	0.0	0.0	10
30	Flevoland	7.9	0.0	0.0	8
31	Gelderland	26.4	0.0	12.8	39
32	Noord-Brabant	172.1	0.0	42.0	214
33	Limburg	37.1	0.0	0.0	37
34	Noord-Holland	20.8	0.0	52.2	73
35	Utrecht	4.9	0.0	2.6	8
36	Zuid-Holland (excl. Rijnmond)	139.0	0.0	0.0	139
37	Rijnmond (Rotterdam)	48.2	368.4	1 346.6	1763

[87] The volume of container transport by rail between Antwerp and Limburg appeared to be too high in the container volumes in 2020 and 2033. From statistics and practice it is known that currently there are no volumes of container transport by rail between Antwerp and Limburg. Therefore, these results have been corrected by replacing these figures by zero.

	2020 x 1000 TEU	roads	rail	inland waterways	Antwerp
38	Zeeland	33.3	2.4	60.2	96
39	Luik	82.5	29.9	1.5	114
40	Limburg	150.3	8.5	58.9	218
41	Provincie Luxemburg	16.4	100.4	0.0	117
42	Namen	30.0	0.0	0.0	30
43	Provincie Antwerp	446.1	101.4	273.1	821
44	Brabant	176.5	2.9	0.0	179
45	Henegouwen	70.8	12.3	0.0	83
46	West-Vlaanderen	256.3	33.6	6.3	296
47	Oost-Vlaanderen	454.9	0.0	3.1	458
48	**Antwerp stad***	0.0	0.0	0.0	0
49	Zeebrugge	3.3	490.6	3.9	498
50	Nord-Ouest	378.7	37.0	46.8	462
51	Nord-Est	119.5	39.6	32.8	192
52	Sud-Ouest	5.6	15.6	0.0	21
53	Sud-Est	19.7	34.5	0.0	54
54	Overig	19.1	531.0	88.5	639
	total	**3 117**	**1 972**	**2 913**	**8 003**

Table 138: Volume container transport in 1000 TEU between Antwerp and hinterland regions by mode of transport in the year 2033
Source: ECORYS, result from study "Verruiming van de Schelde"

	2033 x 1000 TEU	roads	rail	inland waterways	Antwerp
1	Schleswig-Holstein	1.0	0.5	0.1	2
2	Hamburg	22.8	6.3	0.0	29
3	Niedersachsen-Nord	0.0	0.0	17.1	17
4	Niedersachsen-West	5.6	0.0	5.2	11
5	Niedersachsen-Süd-Ost	6.6	0.2	0.0	7
6	Bremen	3.5	0.2	11.4	15
7	Nordrhein-Westfalen-Nord	25.9	0.0	0.3	26
8	Ruhrgebiet	215.6	23.2	387.6	626
9	Nordrhein-Westfalen-Süd-West	193.4	59.0	202.0	454
10	Nordrhein-Westfalen-Ost	57.7	0.2	0.0	58
11	Hessen	35.2	1.4	191.3	228
12	Rheinland-Pfalz	88.1	0.0	167.0	255
13	Baden-Württemberg-Nord-West	9.9	0.0	162.1	172
14	Baden-Württemberg-Ost	11.5	0.0	33.7	45
15	Baden-Württemberg-Süd-West	2.7	0.0	0.0	3
16	Nordbayern	8.8	0.0	0.1	9
17	Ostbayern	0.3	1.9	1.1	3
18	Südbayern	15.4	80.4	0.0	96
19	Saarland	17.8	0.0	0.0	18
20	Berlin	3.2	0.0	0.0	3
21	Mecklenburg-Vorpommern	0.3	0.0	0.0	0
22	Brandenburg	0.0	0.0	0.0	0
23	Sachsen-Anhalt	0.6	0.0	0.0	1
24	Thüringen	1.3	0.0	0.0	1
25	Sachsen	1.9	0.7	0.0	3
26	Groningen	4.3	0.0	0.0	4

	2033 x 1000 TEU	roads	rail	inland waterways	Antwerp
27	Friesland	7.0	0.0	0.0	7
28	Drente	5.4	0.0	0.0	5
29	Overijssel	11.2	0.0	0.0	11
30	Flevoland	9.2	0.0	0.0	9
31	Gelderland	38.3	0.0	10.4	49
32	Noord-Brabant	229.3	0.0	31.5	261
33	Limburg	82.1	0.0	0.0	82
34	Noord-Holland	42.4	0.0	60.0	102
35	Utrecht	7.3	0.0	2.1	9
36	Zuid-Holland (excl. Rijnmond)	163.9	0.0	0.0	164
37	Rijnmond (Rotterdam)	145.1	497.5	2271.5	2914
38	Zeeland	65.5	2.2	66.2	134
39	Luik	126.7	20.6	1.2	149
40	Limburg	238.1	6.1	52.3	296
41	Provincie Luxemburg	52.4	143.5	0.0	196
42	Namen	38.8	0.0	0.0	39
43	Provincie Antwerp	782.2	79.8	267.4	1129
44	Brabant	230.8	1.8	0.0	233
45	Henegouwen	98.7	7.7	0.0	106
46	West-Vlaanderen	363.5	21.3	5.0	390
47	Oost-Vlaanderen	590.3	0.0	2.3	593
48	**Antwerp stad***	0.0	0.0	0.0	0
49	Zeebrugge	13.4	906.2	8.9	928
50	Nord-Ouest	526.7	23.2	36.4	586
51	Nord-Est	197.9	29.4	30.4	258
52	Sud-Ouest	14.4	17.8	0.0	32
53	Sud-Est	44.5	34.9	0.0	79
54	Overig	70.9	883.3	184.1	1 138
	total	**4 929**	**2 849**	**4 209**	**11 988**

E.3. Input from the Iron Rhine study for the container model

TNO has delivered to ECORYS the changes in generalized costs due to the reactivation of the Iron Rhine. The calculation of the generalized costs method as described in section II.2.4 on page 73 and in section II.3.2.2on page 82. This has been used by ECORYS as input to make changes to the already existing cost matrices. With this input ECORYS has run the model for the years 2020 and 2033 using data about the transport flows from the study "*Verruiming van de vaarweg van de Schelde*".

E.4. Adding results of the container model to TRANS-TOOLS results

The container model computes the changes due to the reactivation of the Iron Rhine. These changes are compared to the initial situation as in the tables in chapter 2 of this annex describing the example of flows in relation with Antwerp. This initial situation is not identical to the forecasts as done with the TRANS-TOOLS model since different source and assumptions are used in the two models. For this reason the relative changes are determined; so the tonnes on a specific relation in the results with reactivation of the Iron Rhine are divided by the tonnes on this relation in the initial situation. For instance we have in the year 2020 between Antwerp and Ruhrgebiet by rail 24.2 thousand TEU. In the results of the reactivation of the Iron Rhine in scenario 2A on the same relation there are 19.7 thousand TEU more. The relative change is therefore 1+19.7/24.2 =1.814. This change includes a port choice effect and a modal-shift effect.

In TRANS-TOOLS we now take the aggregation of the container flows on the same relation by rail in the scenario with reactivation of the Iron Rhine. To avoid that the modal-split effect that was already determined in TRANS-TOOLS is counted double we first remove this effect from this specific flow. Now we have the flow without modal-shift effect (and without port choice effect). This flow (in tonnes) in multiplied with the 1.814 resulting in the flow including a modal-split and port choice effect.

This is repeated for all relations and modes where changes have been found in the container model.

E.5. Results of the container model

The results of the container model have been delivered to TNO. In the next two tables the results of the container model are described for the years 2020 and 2033.

In these tables the shifts (in 1000 TEU) resulting from the reactivation of the Iron Rhine are presented for both the shifts between transport modes and the shifts between ports. The volumes are for both directions together (to the hinterland region and from the hinterland region).

The table can be read as follows. In the left column the regions are shown in relation with which the port flows take place. The first set of regions are German regions, the second the Dutch regions followed by the Belgium regions and finally the French regions and a rest category. To the right of the region names there is a set of columns related to the road transport. For each port which are coded with the first character of the name (see legend on top of the table) the change in road transport between the port and the region selected in the first column is shown in terms of 1000 TEU. After the set of columns related to road a similar set of columns by port is shown for rail and inland navigation. In the last set of columns the total for all ports is shown. When looking at the final row at the bottom of the table the total change for the mode port combinations can be found.

For instance in the year 2020 in scenario 2A we see for the hinterland transport in relation with the region Nordrhein-Westfalen-Süd-West the following developments:

- Rail transport to and from Antwerp increases with 43900 TEU;
- Rail transport to and from Rotterdam, Hamburg and Bremen decreases;
- Road transport to and from Hamburg, Bremen, Rotterdam, Antwerp and Zeebrugge decreases;
- Inland waterways transport to and from Rotterdam, Zeebrugge and Antwerp decreases.

The container model is a logit model that determines the market shares of ports and hinterland modes simultaneously. As a consequence this model shifts flows between ports and hinterland modes, but the total volume does not change. Therefore, the sum of the changes on one row in the table is equal to zero.

In total, the volume of container transport by rail to and from Antwerp increases in the year 2020 with 75 000 TEU. Most of this increase is caused by a shift from road and inland waterways to rail, not only in relation with Antwerp, but also on the relations with Rotterdam, Bremen and Hamburg.

In the year 2033, the volume of container transport by rail to and from Antwerp increases with 64 000 TEU. This is a remarkable result. Since the transport volumes in 2033 are higher than in 2020, it is expected that the volume of container transport that shifts from other transport modes to rail transport will be higher in 2033. This result is caused by the difference in market shares of the port of Antwerp in 2020 and 2033. The market share of Antwerp compared to the market share of Rotterdam in 2033 is lower than in 2020. The development in market shares of these ports is caused by the use of very large container vessels in the period 2020-2033 that can be handled in Rotterdam, but not in Antwerp because the maximum depth is limited to 13.1 meter for the port of Antwerp.

Table 139: Results of the container model. shift of container flows in 1000 TEU in the year 2020 as a result of the reactivation of the Iron Rhine. policy option 2A (Source: ECORYS)

Legend ports: H = Hamburg. B = Bremen. R = Rotterdam. A = Antwerp. Z = Zeebrugge. LH = LeHavre

2020	roads						rail						inland waterways						total						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**tot**
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Hamburg	-	1.0-	0.2-	0.1-	-	-	-	1.7-	0.1-	3.3	-	-	-	-	-	-	-	-	-	2.8-	0.3-	3.1	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.1-	2.0-	2.0-	1.6-	-	-	1.2-	1.2-	0.2-	19.7	-	-	-	0.0	5.5-	5.1-	0.0	-	2.2-	3.2-	7.6-	13.1	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	4.1-	7.4-	9.2-	2.8-	0.6-	-	3.3-	3.4-	3.6-	43.9	5.9	-	-	-	9.9-	5.2-	0.2-	-	7.4-	10.7-	22.8-	35.9	5.0	-	**0**
Nordrhein-Westfalen-Ost	0.1-	0.1-	0.1-	0.0	-	-	0.0	0.0	-	0.4	-	-	-	-	-	-	-	-	0.1-	0.2-	0.1-	0.3	-	-	**0**
Hessen	0.1-	0.1-	0.0	0.0	-	-	0.0	0.0	0.0	0.3	-	-	-	-	0.1-	0.0	-	-	0.1-	0.1-	0.1-	0.3	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Südbayern	1.1-	1.4-	0.2-	0.1-	0.0	-	1.9-	1.4-	0.5-	6.7	0.0	-	-	-	-	-	-	-	3.1-	2.8-	0.7-	6.7	0.1-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.1-	0.3-	-	-	-	0.8	0.1-	0.1-	-	-	-	-	0.0	0.2-	-	-	0.0	0.8	0.2-	0.5-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	1.7-	-	-	0.7	1.2	-	0.2-	-	-	-	-	-	0.0	0.0	-	0.7	1.2	-	1.9-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-7**	**-12**	**-12**	**-7**	**-1**	**0**	**-6**	**-6**	**-4**	**75**	**6**	**0**	**0**	**0**	**-15**	**-11**	**0**	**0**	**-13**	**-18**	**-32**	**57**	**5**	**0**	**0**

Table 140: Results of the container model. shift of container flows in 1000 TEU in the year 2033 as a result of the reactivation of the Iron Rhine. policy option 2A (Source: ECORYS)

Legend ports: H = Hamburg. B = Bremen. R = Rotterdam. A = Antwerp. Z = Zeebrugge. LH = LeHavre

2033	roads						rail						inland waterways						total						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**tot**
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Hamburg	-	0.7-	0.1-	0.1-	-	-	-	1.0-	0.0	2.0	-	-	-	-	-	-	-	-	-	1.7-	0.2-	1.9	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	0.0	0.0	0.0	0.0	-	-	0.0	0.0	-	0.1	-	-	0.0	-	-	-	-	-	0.0	0.0	0.0	0.1	-	-	**0**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.0-	1.7-	2.2-	2.0-	-	-	0.8-	0.9-	0.1-	17.0	-	-	-	0.0	4.7-	3.5-	0.0	-	1.8-	2.6-	7.0-	11.5	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	3.7-	6.3-	9.9-	3.4-	0.5-	-	2.4-	2.6-	2.8-	35.6	8.0	-	-	0.0	8.3-	3.6-	0.2-	-	6.1-	8.9-	21.0-	28.7	7.3	-	**0**
Nordrhein-Westfalen-Ost	0.0	0.0	0.0	0.0	-	-	0.0	0.0	-	0.1	-	-	-	-	-	-	-	-	0.0	0.1-	0.0	0.1	-	-	**0**
Hessen	0.1-	0.1-	0.0	0.0	-	-	0.0	0.0	0.0	0.3	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.1-	0.2	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.1-	0.0	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Südbayern	1.7-	1.8-	0.4-	0.2-	0.0	-	2.3-	1.6-	0.7-	8.6	0.1-	-	-	-	-	-	-	-	3.9-	3.4-	1.0-	8.5	0.1-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	-	-	-	0.1-	0.0	0.0	0.1	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.3-	0.6-	-	-	-	1.2	0.1-	0.1-	-	-	-	-	0.0	0.2-	-	-	0.0	1.2	0.4-	0.8-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	2.6-	-	-	0.8	2.0	-	0.2-	-	-	-	-	-	0.0	0.0	-	0.8	2.0	-	2.8-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-7**	**-11**	**-13**	**-9**	**-1**	**0**	**-5**	**-3**	**-4**	**64**	**8**	**0**	**0**	**0**	**-13**	**-7**	**0**	**0**	**-11**	**-14**	**-30**	**48**	**7**	**0**	**0**

Table 141: Results of the container model. shift of container flows in 1000 TEU in the year 2020 as a result of the reactivation of the Iron Rhine. policy option 2B (Source: ECORYS)

Legend ports: H = Hamburg. B = Bremen. R = Rotterdam. A = Antwerp. Z = Zeebrugge. LH = LeHavre

2020	**roads**						**rail**						**inland waterways**						**total**						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**tot**
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	0.0	-	-	0.0	0.0	0.0	0.1	-	-	**0**
Hamburg	-	0.5-	0.1-	0.1-	-	-	-	0.8-	0.0	1.5	-	-	-	-	-	-	-	-	-	1.3-	0.2-	1.5	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Bremen	0.0	-	0.0	0.0	-	-	0.0	-	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.0	-	0.0	0.0	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	0.4-	0.7-	0.7-	0.5-	-	-	0.4-	0.4-	0.1-	6.7	-	-	-	0.0	1.9-	1.7-	0.0	-	0.8-	1.1-	2.6-	4.5	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	1.4-	2.5-	3.1-	0.9-	0.2-	-	1.1-	1.1-	1.2-	16.3	0.4	-	-	-	3.3-	1.8-	0.1-	-	2.5-	3.6-	7.7-	13.6	0.1	-	**0**
Nordrhein-Westfalen-Ost	0.0	0.1-	0.0	0.0	-	-	0.0	0.0	-	0.1	-	-	-	-	-	-	-	-	0.0	0.1-	0.0	0.1	-	-	**0**
Hessen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	-	-	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	**0**
Südbayern	0.5-	0.6-	0.1-	0.0	0.0	-	0.9-	0.6-	0.2-	3.1	0.0	-	-	-	-	-	-	-	1.4-	1.3-	0.3-	3.0	0.0	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	-	-	-	0.0	0.0	0.0	0.1	-	-	**0-**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.0	0.1-	-	-	-	0.2	0.0	0.0	-	-	-	-	0.0	0.0	-	-	0.0	0.2	0.1-	0.1-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-2**	**-4**	**-4**	**-2**	**0**	**0**	**-2**	**-3**	**-2**	**28**	**0**	**0**	**0**	**0**	**-5**	**-4**	**0**	**0**	**-5**	**-7**	**-11**	**23**	**0**	**0**	**0**

Table 142: Results of the container model. shift of container flows in 1000 TEU in the year 2033 as a result of the reactivation of the Iron Rhine. policy option 2B (Source: ECORYS)

Legend ports: H=Hamburg. B=Bremen.R=Rotterdam. A=Antwerp. Z=Zeebrugge.LH=LeHavre

2033	**roads**						**rail**						**inland waterways**						**total**						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**totl**
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	-	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	**0**
Hamburg	-	0.2-	0.0	0.0	-	-	-	0.3-	0.0	0.7	-	-	-	-	-	-	-	-	-	0.6-	0.1-	0.6	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	0.0	0.0	0.0	0.0	-	-	0.0	0.0	-	0.0	-	-	0.0	-	-	-	-	-	0.0	0.0	0.0	0.0	-	-	**0**
Bremen	0.0	-	0.0	0.0	-	-	0.0	-	0.0	0.0	-	-	-	-	0.0	0.0	-	-	0.0	-	0.0	0.0	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	0.2-	0.3-	0.4-	0.3-	-	-	0.1-	0.1-	0.0	2.7	-	-	-	0.0	0.7-	0.6-	0.0	-	0.3-	0.4-	1.1-	1.8	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	0.7-	1.2-	1.9-	0.6-	0.1-	-	0.4-	0.5-	0.5-	7.9	0.4	-	-	0.0	1.6-	0.7-	0.0	-	1.2-	1.7-	4.0-	6.6	0.3	-	**0**
Nordrhein-Westfalen-Ost	0.0	0.0	0.0	0.0	-	-	0.0	0.0	-	0.0	-	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	-	-	**0**
Hessen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	-	-	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	**0**
Südbayern	0.5-	0.5-	0.1-	0.0	0.0	-	0.6-	0.4-	0.2-	2.4	0.0	-	-	-	-	-	-	-	1.1-	0.9-	0.3-	2.3	0.0	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	-	-	-	-	-	0.0	0.0	0.0	0.0	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.0	0.0	-	-	-	0.1	0.0	0.0	-	-	-	-	0.0	0.0	-	-	0.0	0.1	0.0	0.1-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-1**	**-2**	**-2**	**-1**	**0**	**0**	**-1**	**-1**	**-1**	**14**	**0**	**0**	**0**	**0**	**-2**	**-1**	**0**	**0**	**-3**	**-4**	**-6**	**12**	**0**	**0**	**0**

Table 143: Results of the container model. shift of container flows in 1000 TEU in the year 2020 as a result of the reactivation of the Iron Rhine. policy option 2A. A52variant (Source: ECORYS)

Legend ports: H=Hamburg. B=Bremen. R=Rotterdam. A=Antwerp. Z=Zeebrugge. LH=LeHavre

2020	roads						rail						inland waterways						total						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**totl**
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.2	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Hamburg	-	1.5-	0.3-	0.2-	-	-	-	2.4-	0.1-	4.6	-	-	-	-	-	-	-	-	-	3.9-	0.5-	4.4	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.1-	-	0.0	0.2	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.3-	2.3-	2.4-	1.9-	-	-	1.4-	1.4-	0.2-	23.4	-	-	-	0.0	6.5-	6.0-	0.0	-	2.7-	3.8-	9.1-	15.5	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	5.7-	10.2-	12.8-	3.9-	0.8-	-	4.6-	4.7-	5.0-	60.6	8.5	-	-	-	13.8-	7.2-	0.3-	-	10.3-	14.9-	31.6-	49.5	7.3	-	**0**
Nordrhein-Westfalen-Ost	0.1-	0.2-	0.1-	0.1-	-	-	0.0	0.0	-	0.5	-	-	-	-	-	-	-	-	0.1-	0.2-	0.1-	0.4	-	-	**0**
Hessen	0.1-	0.1-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.5	-	-	-	-	0.1-	0.1-	-	-	0.2-	0.2-	0.1-	0.4	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Südbayern	1.7-	2.1-	0.3-	0.1-	0.1-	-	2.9-	2.1-	0.8-	10.1	0.1-	-	-	-	-	-	-	-	4.6-	4.2-	1.1-	10.0	0.1-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.1-	0.0	0.0	-	-	0.1-	0.0	0.0	0.2	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.2-	0.4-	-	-	-	1.1	0.1-	0.1-	-	-	-	-	0.0	0.3-	-	-	0.0	1.1	0.3-	0.8-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	3.1-	-	-	1.2	2.4	-	0.4-	-	-	-	-	-	0.1-	0.0	-	1.2	2.4	-	3.6-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-9**	**-17**	**-16**	**-10**	**-1**	**0**	**-8**	**-7**	**-6**	**100**	**8**	**0**	**0**	**0**	**-20**	**-14**	**0**	**0**	**-17**	**-24**	**-43**	**77**	**7**	**0**	**0**

Table144: Results of the container model. shift of container flows in 1000 TEU in the year 2033 as a result of the reactivation of the Iron Rhine. policy option 2A. A52 variant (Source:ECORYS)

Legendports: H=Hamburg. B=Bremen. R=Rotterdam. A=Antwerp. Z=Zeebrugge. LH=LeHavre

2033	**roads**						**rail**						**inland waterways**						**total**						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**tot**
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Hamburg	-	0.8-	0.2-	0.1-	-	-	-	1.2-	0.0	2.4	-	-	-	-	-	-	-	-	-	2.1-	0.2-	2.3	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	0.0	0.0	0.0	0.0	-	-	0.0	0.0	-	0.1	-	-	0.0	-	-	-	-	-	0.0	0.1-	0.0	0.1	-	-	**0**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.0-	1.7-	2.2-	2.0-	-	-	0.8-	0.9-	0.1-	17.0	-	-	-	0.0	4.7-	3.5-	0.0	-	1.8-	2.6-	7.0-	11.5	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	4.1-	6.9-	10.8-	3.7-	0.6-	-	2.6-	2.8-	3.0-	39.2	8.6	-	-	0.0	9.1-	3.9-	0.2-	-	6.7-	9.7-	23.0-	31.6	7.8	-	**0**
Nordrhein-Westfalen-Ost	0.0	0.1-	0.0	0.0	-	-	0.0	0.0	-	0.1	-	-	-	-	-	-	-	-	0.0	0.1-	0.0	0.1	-	-	**0**
Hessen	0.1-	0.1-	0.0	0.0	-	-	0.0	0.0	0.0	0.4	-	-	-	-	0.1-	0.1-	-	-	0.1-	0.1-	0.1-	0.3	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Südbayern	2.2-	2.3-	0.5-	0.2-	0.1-	-	3.0-	2.1-	0.9-	11.2	0.1-	-	-	-	-	-	-	-	5.1-	4.4-	1.3-	11.0	0.1-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.3-	0.7-	-	-	-	1.5	0.1-	0.1-	-	-	-	-	0.0	0.2-	-	-	0.0	1.5	0.5-	1.0-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	3.6-	-	-	1.4	2.5	-	0.2-	-	-	-	-	-	0.0	0.0	-	1.4	2.5	-	3.9-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-7**	**-12**	**-14**	**-10**	**-1**	**0**	**-5**	**-3**	**-4**	**71**	**9**	**0**	**0**	**0**	**-14**	**-8**	**0**	**0**	**-13**	**-15**	**-32**	**53**	**8**	**0**	**0**

Table145: Results of the container model. shift of container flows in 1000 TEU in the year 2020 as a result of the reactivation of the Iron Rhine. policy option 2A. electrified (Source:ECORYS)

Legend ports: H=Hamburg. B=Bremen. R=Rotterdam. A=Antwerp. Z=Zeebrugge. LH=LeHavre

2020	roads						rail						inland waterways						total						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	totl
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Hamburg	-	1.2-	0.3-	0.2-	-	-	-	2.1-	0.1-	3.9	-	-	-	-	-	-	-	-	-	3.3-	0.4-	3.7	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.1-	-	0.0	0.2	-	-	**-**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.2-	2.1-	2.1-	1.7-	-	-	1.2-	1.3-	0.2-	20.9	-	-	-	0.0	5.8-	5.4-	0.0	-	2.4-	3.4-	8.1-	13.9	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	4.5-	8.0-	10.0	3.0-	0.6-	-	3.6-	3.6-	3.9-	46.4	7.5	-	-	-	10.8-	5.6-	0.3-	-	8.0-	11.6-	24.7-	37.8	6.6	-	**0**
Nordrhein-Westfalen-Ost	0.1-	0.2-	0.1-	0.0	-	-	0.0	0.0	-	0.4	-	-	-	-	-	-	-	-	0.1-	0.2-	0.1-	0.4	-	-	**0**
Hessen	0.1-	0.1-	0.0	0.0	-	-	0.1-	0.0	0.0	0.4	-	-	-	-	0.1-	0.1-	-	-	0.1-	0.1-	0.1-	0.4	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.1-	0.0	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Südbayern	1.4-	1.7-	0.3-	0.1-	0.0	-	2.4-	1.7-	0.6-	8.2	0.1-	-	-	-	-	-	-	-	3.7-	3.4-	0.9-	8.1	0.1-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.2	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.2-	0.4-	-	-	-	0.9	0.1-	0.1-	-	-	-	-	0.0	0.2-	-	-	0.0	0.9	0.3-	0.7-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	3.1-	-	-	1.2	2.4	-	0.4-	-	-	-	-	-	0.1-	0.0	-	1.2	2.4	-	3.6-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-7**	**-13**	**-13**	**-8**	**-1**	**0**	**-6**	**-5**	**-5**	**80**	**7**	**0**	**0**	**0**	**-17**	**-11**	**0**	**0**	**-14**	**-19**	**-35**	**61**	**6**	**0**	**0**

Table146: Results of the container model. shift of container flows in 1000 TEU in the year 2033 as a result of the reactivation of the Iron Rhine. policy option 2A. electrified (Source:ECORYS)

Legend ports: H=Hamburg. B=Bremen. R=Rotterdam.A=Antwerp. Z=Zeebrugge. LH=LeHavre

2033	**roads**						**rail**						**inland waterways**						**total**						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**totl**
Schleswig-Holstein	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.2	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Hamburg	-	0.9-	0.2-	0.1-	-	-	-	1.3-	0.1-	2.6	-	-	-	-	-	-	-	-	-	2.2-	0.2-	2.5	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	0.0	0.0	0.0	0.0	-	-	0.0	0.0	-	0.1	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.1-	1.9-	2.5-	2.2-	-	-	0.9-	1.0-	0.1-	19.2	-	-	-	0.0	5.3-	4.0-	0.0	-	2.1-	2.9-	8.0-	13.0	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	4.6-	7.8-	12.3-	4.2-	0.7-	-	2.9-	3.2-	3.4-	41.5	12.5	-	-	0.0	10.3-	4.4-	0.3-	-	7.5-	11.0-	26.0-	32.9	11.6	-	**0**
Nordrhein-Westfalen-Ost	0.0	0.1-	0.0	0.0	-	-	0.0	0.0	-	0.2	-	-	-	-	-	-	-	-	0.0	0.1-	0.0	0.1	-	-	**0**
Hessen	0.1-	0.1-	0.0	0.0	-	-	0.0	0.0	0.0	0.4	-	-	-	-	0.1-	0.1-	-	-	0.1-	0.1-	0.1-	0.4	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Südbayern	2.2-	2.3-	0.5-	0.2-	0.1-	-	3.0-	2.1-	0.9-	11.2	0.1-	-	-	-	-	-	-	-	5.1-	4.4-	1.3-	11.0	0.1-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.1	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.3-	0.8-	-	-	-	1.6	0.1-	0.1-	-	-	-	-	0.0	0.3-	-	-	0.0	1.6	0.5-	1.1-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	6.7-	-	-	2.3	4.9	-	0.4-	-	-	-	-	-	0.1-	0.0	-	2.3	4.9	-	7.1-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-8**	**-13**	**-16**	**-14**	**-1**	**0**	**-5**	**-1**	**-5**	**75**	**12**	**0**	**0**	**0**	**-16**	**-9**	**0**	**0**	**-13**	**-15**	**-36**	**52**	**11**	**0**	**0**

Table147: Results of the container model. shift of container flows in 1000 TEU in the year 2020 as a result of the reactivation of the Iron Rhine. policy option 2A. A52 variant. electrified (Source:ECORYS)

Legend ports: H=Hamburg. B=Bremen. R=Rotterdam.A=Antwerp. Z=Zeebrugge. LH=LeHavre

2020	**roads**						**rail**						**inland waterways**						**total**						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**tot**
Schleswig-Holstein	0.0	0.1-	0.0	0.0	-	-	0.0	0.0	0.0	0.2	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Hamburg	-	1.7-	0.4-	0.2-	-	-	-	2.8-	0.2-	5.3	-	-	-	-	-	-	-	-	-	4.5-	0.5-	5.0	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.2	-	-	-	-	0.0	0.0	-	-	0.2-	-	0.0	0.2	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.5-	2.7-	2.8-	2.2-	-	-	1.6-	1.6-	0.2-	27.4	-	-	-	0.1-	7.6-	7.0-	0.0	-	3.1-	4.4-	10.6-	18.2	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	6.5-	11.6-	14.5-	4.4-	0.9-	-	5.2-	5.3-	5.7-	66.6	11.6	-	-	-	15.6-	8.2-	0.4-	-	11.7-	16.9-	35.8-	54.0	10.3	-	**0**
Nordrhein-Westfalen-Ost	0.1-	0.2-	0.1-	0.1-	-	-	0.0	0.0	-	0.6	-	-	-	-	-	-	-	-	0.2-	0.2-	0.1-	0.5	-	-	**0**
Hessen	0.1-	0.2-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.6	-	-	-	-	0.1-	0.1-	-	-	0.2-	0.2-	0.1-	0.5	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.0	0.0	0.0	0.0	-	-	0.1-	0.1-	0.0	0.3	-	-	-	-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.3	-	-	**0**
Südbayern	1.9-	2.4-	0.4-	0.1-	0.1-	-	3.3-	2.4-	0.9-	11.6	0.1-	-	-	-	-	-	-	-	5.3-	4.8-	1.3-	11.5	0.1-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.1-	0.0	0.0	-	-	0.1-	0.0	0.0	0.2	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.2-	0.5-	-	-	-	1.3	0.1-	0.1-	-	-	-	-	0.0	0.3-	-	-	0.0	1.3	0.4-	1.0-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	4.7-	-	-	1.7	3.7	-	0.6-	-	-	-	-	-	0.1-	0.0	-	1.7	3.7	-	5.4-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-10**	**-19**	**-18**	**-12**	**-1**	**0**	**-9**	**-7**	**-7**	**112**	**12**	**0**	**0**	**0**	**-23**	**-16**	**0**	**0**	**-19**	**-26**	**-49**	**84**	**10**	**0**	**0**

Table148: Results of the container model. shift of container flows in 1000 TEU in the year 2033 as a result of the reactivation of the Iron Rhine. policy option 2A. A52 variant. electrified (Source:ECORYS)

Legend ports:H=Hamburg. B=Bremen. R=Rotterdam. A=Antwerp. Z=Zeebrugge. LH=LeHavre

2033	roads						rail						inland waterways						total						
x 1000 TEU	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	H	B	R	A	Z	LH	**tot**
Schleswig-Holstein	0.0	0.1-	0.0	0.0	-	-	0.0	0.0	0.0	0.2	-	-	0.0	-	-	0.0	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Hamburg	-	1.0-	0.2-	0.1-	-	-	-	1.6-	0.1-	3.0	-	-	-	-	-	-	-	-	-	2.6-	0.3-	2.9	-	-	**0**
Niedersachsen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Niedersachsen-Süd-Ost	0.0	0.0	0.0	0.0	-	-	0.0	0.0	-	0.1	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.1	-	-	**0**
Bremen	0.0	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	-	-	0.0	0.0	-	-	0.1-	-	0.0	0.1	-	-	**0**
Nordrhein-Westfalen-Nord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ruhrgebiet	1.3-	2.2-	3.0-	2.7-	-	-	1.1-	1.2-	0.2-	22.8	-	-	-	0.0	6.3-	4.8-	0.0	-	2.4-	3.5-	9.4-	15.4	0.0	-	**0**
Nordrhein-Westfalen-Süd-West	5.5-	9.2-	14.6-	5.0-	0.8-	-	3.5-	3.8-	4.1-	49.1	15.2	-	-	0.0	12.3-	5.2-	0.3-	-	9.0-	13.0-	30.9-	38.9	14.1	-	**0**
Nordrhein-Westfalen-Ost	0.0	0.1-	0.0	0.0	-	-	0.0	0.0	-	0.2	-	-	-	-	-	-	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Hessen	0.1-	0.1-	0.0	0.0	-	-	0.1-	0.0	0.0	0.6	-	-	-	-	0.1-	0.1-	-	-	0.2-	0.2-	0.1-	0.5	-	-	**0**
Rheinland-Pfalz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Nord-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Ost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Baden-Württemberg-Süd-West	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nordbayern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ostbayern	0.1-	0.1-	0.0	0.0	-	-	0.1-	0.1-	0.0	0.3	-	-	-	-	0.0	0.0	-	-	0.2-	0.1-	0.0	0.3	-	-	**0**
Südbayern	2.7-	2.9-	0.6-	0.2-	0.1-	-	3.7-	2.6-	1.1-	13.9	0.1-	-	-	-	-	-	-	-	6.4-	5.5-	1.7-	13.7	0.2-	-	**0**
Saarland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Berlin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mecklenburg-Vorpommern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Brandenburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen-Anhalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Thüringen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sachsen	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.2	-	-	0.0	-	-	-	-	-	0.1-	0.1-	0.0	0.2	-	-	**0**
Groningen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Friesland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Drente	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overijssel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Flevoland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Gelderland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Noord-Holland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Utrecht	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zuid-Holland(excl. Rijnmond)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Rijnmond (Rotterdam)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luik	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Limburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Luxemburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Namen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp	0.0	0.0	0.4-	0.9-	-	-	-	2.0	0.2-	0.1-	-	-	-	-	0.0	0.3-	-	-	0.0	2.0	0.6-	1.4-	-	-	**0**
Brabant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Henegouwen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
West-Vlaanderen	0.0	-	-	8.5-	-	-	3.0	6.2	-	0.5-	-	-	-	-	-	0.1-	0.0	-	3.0	6.2	-	9.1-	0.0	-	**0**
Oost-Vlaanderen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Antwerp stad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Zeebrugge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Nord-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Ouest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Sud-Est	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Overig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total	**-10**	**-16**	**-19**	**-17**	**-1**	**0**	**-6**	**-1**	**-6**	**90**	**15**	**0**	**0**	**0**	**-19**	**-11**	**0**	**0**	**-16**	**-17**	**-43**	**62**	**14**	**0**	**0**

Annex F: Comparison with the freight forecasts included in the COD-advice

In summer 2007 the COD has given an advise (see Annex T: Advice 2007 "Commissie Onafhankelijke Deskundigen IJzeren Rijn") concerning the traffic forecasts and capacity planning for the Iron Rhine based on the following two studies:

- "Vervoerprognoses IJzeren Rijn" by TML/TNO, May 2007
- "Vervoerprognoses IJzeren Rijn" by NEA, April 2007

The reports of these studies can be found on the website of ProRail:
www.prorail.nl/Publiek/Infraprojecten/Limburg/IJzeren%20Rijn/Pages/Actualiseringfase.aspx

In this annex, we compare the transport forecast in this study with the study "Vervoerprognoses IJzeren Rijn" by TML/TNO, May 2007 since this is the basis for this MKBA study.

Changes to the results of the study "Vervoerprognoses IJzeren Rijn"

At start of the SCBA Iron Rhine study it was requested by the COD to fine-tune the methodology as applied in the study "Vervoerprognoses IJzeren Rijn" (TML/TNO May 2007) on some points. The aim was to be able to calculate the benefits more precisely. The changes requested and performed in this study are:

- Fine-tuning of the modal-split model.
- Split on NUTS 3 regions in Germany though which the Iron Rhine as well as the Montzenroute cross.
- Apply a more detailed generalized costs model for determining the potential of the Iron Rhine and Montzen route.
- Extend the methodology with the model of ECORYS/CPB in order to determine the port effects of container flows.

Applying these changes has resulted in some changes in the results. In the following paragraphs, these changes are discussed.

Fine-tuning of the modal-split model

Compared to the modal shift as determined by the other forecasts in the study "Vervoerprognoses IJzeren Rijn" by NEA/UA, the modal shift in "Vervoerprognoses IJzeren Rijn" by TNO/TML with TRANS-TOOLS showed a smaller sensitivity to the cost, time and distance changes made in the scenarios. It was considered an improvement for the TRANS-TOOLS modal-spilt model to bring it more in line with the NEA modal-split model which is part of the NEAC model. The change to the modal-split model was performed by NEA as developer of the modal-split model in TRANS-TOOLS. In the table below it can be seen what has been the effect of the change made. The new model shows a little more sensitivity to the introduction of the Iron Rhine. It also shows more sensitivity to the differences in input between the scenarios 2A and 2B.

Table 149: Modal-split difference between the new and earlier forecasting results, historical line 2A and 2B, 2020, example flows between Western Belgium and NRWF + other hinterland German side, percentages

	2005	2020 intermediate result of trade model – 2A	2020 no Iron Rhine – 2A	2020 histori-cal Iron Rhine – 2A	2020 intermediate result of trade model – 2B	2020 no Iron Rhine – 2B	2020 histori-cal Iron Rhine – 2B
Vervoerprognoses IJzeren Rijn, TML/TNO, May 2007							
Road	61.59	64.54	64.29	64.28	64.54	63.82	63.82
Rail	7.75	8.12	8.24	8.26	8.12	8.44	8.45
Inland waterways	30.66	27.34	27.47	27.46	27.34	27.74	27.73
This SCBA							
Road	61.59	64.54	64.39	64.36	64.54	63.37	63.34
Rail	7.75	8.12	8.10	8.13	8.12	8.51	8.54
Inland waterways	30.66	27.34	27.51	27.51	27.24	28.13	28.12
Difference							
Road	0	0	0.10	0.08	0	-0.45	-0.48
Rail	0	0	-0.14	-0.13	0	0.07	0.09
Inland waterways	0	0	0.04	0.05	0	0.39	0.39

Split on NUTS 3 region in Germany though which the Iron Rhine as well as the Montzenroute cross

For this change made one has to know that within the TRANS-TOOLS model for the assignment an OD matrix is used at the NUTS 3 level. One of these NUTS 3 regions is at the point where the Iron Rhine and Montzen route is crossing through. It was suggested that it makes a difference where this region feeds into the network. For this reason it was made sure that the region was split in such a way into two parts that there is no region where both routes cross through. Since there was no additional information available at the sub-NUTS 3 level it was decided to split the flows originating or going to this NUTS 3 region on a 50-50 basis.

The exact effect of this change is not determined but it can be regarded as a small but not insignificant effect.

Apply a more detailed generalized costs model for determining the potential of the Iron Rhine and Montzen route

During the study "*Vervoerprognoses IJzeren Rijn*" (TML/TNO May 2007) it was concluded that the potential for the Iron Rhine can not reliably be calculated by the assignment models since there are many flows that only have a small difference in distance. The generalized costs approach was introduced to determine the potential for the Iron Rhine and the Montzen route. In this generalized cost approach the main distinguishing cost element introduced was the additional traction needed on the Montzen route. At start of the CBA study it was requested to refine this generalized costs method and also to bring it in line with the cost elements used for the CBA.

Besides a change to the rules to determine the additional traction also other cost aspects were introduced. This method is described in more detail in II.2.4 on page 73.

Important to note is the fact that the Iron Rhine is in its basic variant not electrified and the Montzen route will be. This has resulted in making the difference between electric and diesel locs in costs and capabilities. The use of electric and/or diesel locs has also been optimized by allowing a change from a diesel loc to an electric loc on the German network near the border. A difference in forecast of the energy prices between 2020 and 2030 results in more expensive use of diesel locs and therefore less attractive iron Rhine than in the previous forecasting study.

In the scenario 2B where amongst other measures also the internalization of external costs is introduced in the pricing mechanism a difference is made between pricing of diesel and electric locs. This has resulted in a dramatic change in the results for the 2B scenario.

Another change is that more attention has been paid to manoeuvring (first/last mile, turning) of the trains and the costs involved.

With these changes made we can be confident that the results are representing reality as close as possible.

Extend the methodology with the model of ECORYS/CPB in order to determine the port effects of container flows.

In the study "*Vervoerprognoses IJzeren Rijn*" (TML/TNO May 2007) it was assumed that the effect of port choice due to the reactivation of the Iron Rhine was very small and not significantly of importance. At start of the CBA study it was requested to have a closer look on this issue by applying the model as developed by the CPB and ECORYS for the '*Verdieping van de Westerschelde*' study. With the help of ECORYS this was made possible. In section II.2.5 on page 76, the method of the CPB/ECORYS container model is described. The main reasons for applying this model is to take into account the competition between ports and to quantify the resulting additional potential for the Iron Rhine. The additional rail transport that can be attracted has consequently also an impact on the modal-split in the hinterland of the Port of Antwerp.

In the table below the impact on the results of the container model is described by scenario.

Table 150: Container model results within the Iron Rhine potential by scenario

	Historic Iron Rhine – 2A		Historic Iron Rhine – 2B		Iron Rhine via A52 – 2A		Electrified Historic Iron Rhine – 2A		Electrified Iron Rhine via A52 – 2A	
	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
Without container model	8.76	9.05	3.97	2.45	10.56	11.13	9.30	10.68	11.20	12.40
Container model	0.28	0.27	0.05	0.01	0.33	0.28	0.30	0.34	0.36	0.35
Total	9.04	9.32	4.02	2.46	10.89	11.41	9.60	11.02	11.56	12.75

Overall differences between the two studies

In the table below, the results of the earlier forecasting study "*Vervoerprognoses IJzeren Rijn*" (TML/TNO May 2007) and this SCBA study (indicated as new) are shown and compared.

Table 151: Results of the forecasting study "Vervoerprognoses IJzeren Rijn TML/TNO 2007" and this SCBA study, million tons

	Million tonne	Historic Iron Rhine – 2A		Historic Iron Rhine – 2B	
		2020	2030	2020	2030
New results	**Iron Rhine**	**9.0**	**9.3**	**4.0**	**2.5**
	Montzen	4.5	6.2	9.9	14.3
	total	13.9	15.9	14.3	17.1
Earlier results	**Iron Rhine**	**9.5**	**11.1**	**9.7**	**11.6**
	Montzen	4.3	4.8	4.5	5.1
	total	13.8	15.9	14.2	16.7
New-earlier	**Iron Rhine**	**-0.5**	**-1.8**	**-5.7**	**-9.1**
	Montzen	0.2	1.4	5.4	9.2
	total	0.1	0.0	0.1	0.4

The table above has the same figures as Table 15 on page 80.

What can be seen is that the total potential for Iron Rhine and Montzen route together is nearly the same for the 2A scenario and slightly higher for the 2B scenario. For the 2B scenario this can be explained from the changed modal-split model where the rail share in the modal-split is slightly higher. The additional container flows do not have much impact on the total volume for 2B. For the 2A scenario the rail share in the modal –split is lower but this is compensated by the additional container flows.

For the split of this combined potential to an Iron Rhine and a Montzen potential the effect can be entirely contributed to the changes made in the generalized cost method. The main difference is due to distinguishing between diesel locs and electric locs which especially has an impact in the 2B scenario where the external costs are internalized through a pricing mechanism with higher pricing for diesel locs than for electric locs. Since the Iron Rhine is not electrified in this 2B scenario this implies a significant advantage for the Montzen route.

The eventual differences in terms of number of trains can be found in the following table.

Table 152: Number of trains/day on the historical Iron Rhine comparing TML/TNO 2007 and this forecast
Measured between Budel and Weert, close to the Belgian-Dutch border, see Figure 12 and Figure 13 page 90.

	Historic Iron Rhine – 2A		Historic Iron Rhine – 2B	
	2020	2030	2020	2030
New results	52.6	53.8	23.2	15.4
Earlier results	52.7	62.8	54.2	65.2
New - earlier	-0.1	-9	-31	-49.8

Annex G: Consumer surplus

The table below gives an overview of the CS in 2020, 2025 and 2030 and the NPV of all years. The other variants have similar values.

The prices in the table below are in €$_{2005}$. To convert to €$_{2007}$ for the main SCBA table, a factor of 0.9885 will be used.

The allocation of the CS tot the different users has been done with rule of half: 50% to the origin and 50% to the destination. In case of maritime transport, a shipment from Chine to Germany via Antwerp is allocated to China and Germany. However, statistical data is not very good on this: some of these flows are "cut" in Antwerp, due to change of owner, bunkering, packaging etc. In that case, the CS is allocate to the new "origin" of the goods, Antwerp. This overestimates the CS for Belgium a little, and underestimates the CS for other countries.

Note also that some CS is caused by new users, these are goods that did not travel on either the Montzen route or Iron Rhine route before.

Table 153: Consumer surplus costs in €$_{2005}$ for "historical Iron Rhine – 2A"
Source: own calculations

	NSTR	NPV 4%	2020	2025	2030
existing users - Belgium	0 – agricultural products	582 797.73	33 701.79	32 930.70	29 568.20
	1 – foodstuffs	1 800 439.50	105 659.93	104 128.48	90 013.47
	2 – solid mineral fuels	1 057 542.17	58 645.88	58 887.52	55 382.73
	3 – crude oil	0.00	0.00	0.00	0.00
	4 – ores / metal waste	2 627 986.19	144 650.49	144 103.15	138 654.86
	5 – metal products	13 502 207.52	782 051.75	786 393.32	680 310.27
	6 – building materials	2 156 573.63	123 560.82	121 411.12	110 151.95
	7 – fertilisers	71 426.58	3 933.79	3 995.71	3 753.09
	8 – chemical products	11 535 269.34	649 339.64	684 546.78	589 123.82
	9 – other products	8 974 110.79	541 214.82	530 967.71	437 835.90
	10 – petroleum products	3 859 897.91	214 327.47	219 668.23	201 036.35
	sum	46 168 251.37	2 657 086.38	2 687 032.73	2 335 830.63
new users - Belgium	0 – agricultural products	6 083.11	381.15	334.68	291.59
	1 – foodstuffs	82 133.53	5 022.51	4 518.40	4 019.47
	2 – solid mineral fuels	577.32	31.06	31.08	31.05
	3 – crude oil	0.00	0.00	0.00	0.00
	4 – ores / metal waste	4 138.48	220.54	222.30	223.97
	5 – metal products	176 443.89	9 640.87	9 572.05	9 403.17
	6 – building materials	1 308.01	67.10	69.82	72.50
	7 – fertilisers	219.51	11.87	11.83	11.77
	8 – chemical products	299 856.24	17 253.07	16 352.38	15 399.61
	9 – other products	343 736.47	20 262.54	18 793.40	17 328.01
	10 – petroleum products	4 933.56	251.78	263.48	274.37
	sum	919 430.13	53 142.49	50 169.43	47 055.52
existing users- Germany	0 – agricultural products	469 895.37	27 361.44	26 574.29	23 732.07
	1 – foodstuffs	1 172 914.48	68 740.94	67 093.90	58 832.61

	NSTR	NPV 4%	2020	2025	2030
	2 – solid mineral fuels	1 022 707.71	56 875.94	56 874.59	53 468.75
	3 – crude oil	0.00	0.00	0.00	0.00
	4 – ores / metal waste	2 166 217.51	119 869.12	119 237.15	113 790.48
	5 – metal products	11 310 589.48	653 330.83	658 416.97	571 068.54
	6 – building materials	834 756.44	53 678.12	47 505.04	38 902.49
	7 – fertilisers	21 836.44	1 236.48	1 221.02	1 126.60
	8 – chemical products	7 802 790.21	441 922.42	457 852.41	397 949.80
	9 – other products	4 540 353.14	267 424.70	264 798.39	225 995.71
	10 – petroleum products	1 745 039.69	97 870.25	99 026.44	90 355.38
	sum	31 087 100.47	1 788 310.24	1 798 600.20	1 575 222.43
new users - Germany	0 – agricultural products	5 818.36	366.57	320.41	277.58
	1 – foodstuffs	78 224.53	4 812.44	4 308.05	3 809.06
	2 – solid mineral fuels	577.12	31.06	31.07	31.03
	3 – crude oil	0.00	0.00	0.00	0.00
	4 – ores / metal waste	4 012.19	213.64	215.49	217.25
	5 – metal products	171 122.42	9 366.18	9 286.33	9 109.06
	6 – building materials	893.31	46.28	47.78	49.22
	7 – fertilisers	181.61	9.89	9.80	9.69
	8 – chemical products	259 817.15	15 336.91	14 228.72	13 088.40
	9 – other products	325 940.95	19 294.01	17 827.87	16 376.31
	10 – petroleum products	2 639.03	139.01	141.69	143.92
	sum	849 226.67	49 615.99	46 417.21	43 111.52
existing users – other countries	0 – agricultural products	97 792.21	5 664.45	5 533.35	4 938.24
	1 – foodstuffs	601 412.57	35 601.31	35 583.53	29 718.38
	2 – solid mineral fuels	17 674.87	1 105.03	994.45	841.59
	3 – crude oil	0.00	0.00	0.00	0.00
	4 – ores / metal waste	104 204.58	6 169.89	5 724.83	5 227.21
	5 – metal products	2 214 865.46	131 306.06	129 465.99	109 566.32
	6 – building materials	78 642.71	4 687.38	4 721.29	3 831.04
	7 – fertilisers	54 466.05	4 177.31	2 765.57	2 004.81
	8 – chemical products	3 477 483.63	193 326.16	211 856.60	177 853.32
	9 – other products	4 024 719.27	251 577.30	243 398.94	190 118.34
	10 – petroleum products	1 892 558.88	105 180.87	108 082.08	98 432.58
	sum	12 563 820.21	738 795.75	748 126.61	622 531.84
new users – other countries	0 – agricultural products	245.39	13.57	13.23	12.95
	1 – foodstuffs	3 898.20	209.53	209.77	209.80
	2 – solid mineral fuels	1.80	0.10	0.10	0.09
	3 – crude oil	0.00	0.00	0.00	0.00
	4 – ores / metal waste	89.39	4.97	4.84	4.70
	5 – metal products	5 178.27	267.10	278.01	286.35
	6 – building materials	7.61	0.46	0.42	0.37
	7 – fertilisers	18.40	1.17	0.99	0.87
	8 – chemical products	39 903.86	1 909.23	2 116.42	2 303.71
	9 – other products	16 238.96	887.34	882.20	866.30
	10 – petroleum products	1 888.20	92.76	100.26	107.38
	sum	67 470.09	3 386.24	3 606.24	3 792.52

Annex H: Description of the effect of emissions

The paragraphs below describe the main pollutants, and their effects on human health, climate etc.

H.1. Effect of benzene (C_6H_6)

Benzene, or benzol, is an organic chemical compound and a known carcinogen with the molecular formula C_6H_6. It is sometimes abbreviated Ph–H. Benzene is a colorless and highly flammable liquid with a sweet smell and a relatively high melting point. Because of this, its use as an additive in gasoline is now limited.

Benzene exposure has serious health effects. Outdoor air may contain low levels of benzene from tobacco smoke, automobile service stations, the transfer of gasoline, exhaust from motor vehicles[88], and industrial emissions. Air around hazardous waste sites or gas stations may contain higher levels of benzene.

The short term breathing of high levels of benzene can result in death, while low levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, and death.

The major effects of benzene are chronic (long-term) exposure through the blood. Benzene damages the bone marrow and can cause a decrease in red blood cells, leading to anemia. It can also cause excessive bleeding and depress the immune system, increasing the chance of infection. Benzene causes leukemia and is associated with other blood cancers and pre-cancers of the blood. Human exposure to benzene is a global health problem. Benzene targets liver, kidney, lung, heart and the brain and can cause DNA strand breaks, chromosomal damage etc. Benzene causes cancer in both animals and humans.

H.2. Effect of methane (CH_4)

Methane is a chemical compound with the molecular formula CH_4. It is the simplest alkane, and the principal component of natural gas. Methane is not toxic but it is an important greenhouse gas. 1 gram of CH_4 is equivalent with 4 grams of CO_2 with respect to the global warming potential.

H.3. Effect of carbon monoxide (CO)

Carbon monoxide is a significantly toxic gas and has no odor or color. It is the most common type of fatal poisoning in many countries if the concentration is high. Exposures to low concentrations can lead to significant toxicity of the central nervous system and heart. Following poisoning, long-term sequelae often

[88] The benzene exhaust of diesel trains is negligible and hence it is not included in the graphs.

occur. Carbon monoxide can also have severe effects on the baby of a pregnant woman. Symptoms of mild poisoning include headaches and dizziness at concentrations less than 100 ppm.

Transport is responsible for 50% of total CO emissions. Dangerous concentrations can occur in closed areas such as tunnels and garages.

Note that although car volumes decrease as a result of scenario X, we do see an increase of CO. The reason for this is that due to the policy, there is a shift from diesel to gasoline, which emit 5 times more CO.

H.4. Effect of carbon dioxide (CO_2)

An engine burns fuels which creates CO_2. This makes that CO_2 emissions are directly related to the use of the vehicle. If more fuel is burned, more CO_2 is emitted. This makes that gasoline cars emit more than diesel cars. CO_2 is not a dangerous gas but plays an important role in global warming. It is the main greenhouse gas created by human activity.

H.5. Effect of nitrous oxide (N_2O)

Nitrous oxide, unlike other oxides (apart from carbon dioxide), is a major greenhouse gas. While its radiative warming effect is substantially less than CO_2, nitrous oxide's persistence in the atmosphere, when considered over a 100 year period, per unit of weight, has 310 times more impact on global warming than that per mass unit of carbon dioxide (CO_2). The emission depends on the fuel type and the katalysator type and is not legislated.

H.6. Effect of non-methane volatile organic compounds (NMVOC)

Non-methane volatile organic compounds is a generic term for a large variety of chemically different compounds, like for example, benzene, ethanol, formaldehyde, cyclohexane, 1,1,1-trichloroethane or acetone. Essentially, NMVOCs are identical to VOCs, but with methane excluded. Sometimes NMVOC is also used as a sum parameter for emissions, where all NMVOC emissions are added up per weight into one figure. In absence of more detailed data, this can be a very coarse parameter for pollution, e.g. for summer smog or indoor air pollution.

H.7. Effect of nitrogen oxide (NOx)

NOx is a generic term for mono-nitrogen oxides (NO and NO_2). These oxides are produced during combustion, especially combustion at high temperatures.

At ambient temperatures, the oxygen and nitrogen gases in air will not react with each other. In an internal combustion engine, combustion of a mixture of air and fuel produces combustion temperatures high enough to drive endothermic reactions between atmospheric nitrogen and oxygen in the flame, yielding various oxides of nitrogen. In areas of high motor vehicle traffic, such as in large cities, the amount of nitrogen oxides emitted into the atmosphere can be quite significant. Traffic, and especially diesel vehicles, is responsible for 50% of total emissions of NOx.

When NOx and volatile organic compounds (VOCs) react in the presence of sunlight, they form photochemical smog, a significant form of air pollution, especially in the summer. Children, people with lung diseases such as asthma, and people who work or exercise outside are susceptible to adverse effects of smog such as damage to lung tissue and reduction in lung function.

H.8. Effect of particulate matter (PM)

Particulates, alternatively referred to as particulate matter (PM) or fine particles, are tiny particles of solid or liquid suspended in a gas. Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer. PM diameters range from less than 10 nanometres to more than 100 micrometers. The biggest human sources of particles are combustion sources, mainly the burning of fuels in internal combustion engines in automobiles and power plants, and wind blown dust from construction sites and other land areas where the water or vegetation has been removed. The effects of inhaling particulate matter has been widely studied in humans and animals and include asthma, lung cancer, cardiovascular issues, and premature death. The size of the particle is a main determinant of where in the respiratory tract the particle will come to rest when inhaled. Larger particles are generally filtered in the nose and throat and do not cause problems, but particulate matter smaller than about 10 micrometers, referred to as PM10, can settle in the bronchi and lungs and cause health problems. The 10 micrometer size does not represent a strict boundary between respirable and non-respirable particles, but has been agreed upon for monitoring of airborne particulate matter by most regulatory agencies. Similarly, particles smaller than 2.5 micrometers, PM2.5, tend to penetrate into the gas-exchange regions of the lung, and very small particles (< 100 nanometres) may pass through the lungs to affect other organs. Particles emitted from modern diesel engines (commonly referred to as Diesel Particulate Matter, or DPM) are typically in the size range of 100 nanometres (0.1 micrometers). In addition, these soot particles also carry carcinogenic components like benzopyrenes adsorbed on their surface.

H.9. Effect of sulphur dioxide (SO_2)

SO_2 is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulphur compounds, their combustion generates sulphur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain. This is one of the causes for concern over the environmental impact of the use of these fuels as power sources. Because of fuel additive catalysts are being used in gasoline and diesel engines in order to lower the emission of sulphur oxide gases into the atmosphere the exhaust emissions of SO_2 are negligible compared to the exhaust of producing fuels. For inland waterways – as there is no strict regulation – the exhaust of SO_2 is relevant.

H.10. Effect of VOC

Volatile organic compounds (VOCs) are organic chemical compounds that have high enough vapour pressures under normal conditions to significantly vaporize and enter the atmosphere. A wide range of carbon-based molecules, such as aldehydes, ketones, and other light hydrocarbons are VOCs. The most common VOC is methane, a greenhouse gas sometimes excluded from analysis of other VOCs using the term non-methane VOCs, or NMVOCs Vapours of VOCs escaping into the air contribute to air pollution.

VOCs are an important outdoor air pollutant. In this field they are often divided into the separate categories of methane (CH_4) and non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases via their role in creating ozone and in prolonging the life of methane in the atmosphere, although the effect varies depending on local air quality. Within the NMVOCs, the aromatic compounds benzene, toluene and xylene are suspected carcinogens and may lead to leukaemia through prolonged exposure.

Some VOCs also react with nitrogen oxides in the air in the presence of sunlight to form ozone. Although ozone is beneficial in the upper atmosphere because it absorbs UV thus protecting humans, plants, and animals from exposure to dangerous solar radiation, it poses a health threat in the lower atmosphere by causing respiratory problems. In addition high concentrations of low level ozone can damage crops and buildings.

Annex I: Comparison of the TRANS-TOOLS results and the Port of Antwerp scenario

This annex, with the exception of section 7 and 8, is a joint text, written by TML/TNO and the Port Authorities of the Port of Antwerp.

I.1. Aim

The objective of this short note is to compare the forecasts of the two sources[89] for the potential of rail transport between the port of Antwerp and the German hinterland. The note presents first briefly the methodology and then the assumptions and the results for the scenario "historical Iron Rhine - 2A".

I.2. Summary of methodologies

<u>TML-TNO</u>

TML-TNO used the TRANSTOOLS model. This consists of the following steps:

1. Use the trade model to translate exogenous assumptions on worldwide regional economic activity into international and national trade flows by type of commodity (NSTR 1 digit classification, with crude oil separately, in total 11 commodity groups) at disaggregate region to region levels for Europe.

2. The associated freight flows are allocated to modes using for each commodity and each pair of regions a share equation that fits the shares to the base years (2005) and takes into account the changes in generalized transport costs.

3. For each mode, the transport flows are allocated over the network of that mode. A specific rail assignment model is used for the Antwerp to Germany rail network

<u>Port of Antwerp</u>

The Port of Antwerp has a two step procedure.

1. Exogenous GDP assumptions for NW Europe and other industrialized countries (based on OECD) are translated into growth of port activity for Antwerp by category of handling (containers, bulk etc.) using historical coefficients that are adjusted using expert advice.

[89] Port of Antwerp EOS 2005 study, and this study.

2. The historical modal shares are applied after checking the available capacity and using exogenous policy assumptions.

I.3. Macro-economic assumptions used

The table below contains the macro-economic assumptions. TML-TNO has growth of activity in Germany lower than average for EU25 presented in the table.

Table 154: Macro-economic assumptions

GDP growth NW Europe	TML-TNO	Port of Antwerp
Growth 2005-2020 in % per year	2.3%	2.08%
Growth 2020-2030 in % per year	2.0%	1.85%
Index 2030 (2005=100)	165	163

I.4. Total transport flows into and out of Antwerp by category

The table below presents the total transport flows into and out of Antwerp by category.

TML-TNO represents total flow Belgium to Germany (see paragraph II.3.2.1 on page 79), this is different from the figures of the Port of Antwerp because:
a) Part of the traffic has other origins or destinations than Germany.
b) Part of the traffic to Germany originates outside the port of Antwerp.

The figures of the Port of Antwerp represent the quantity in and out Port of Antwerp.

Table 155: Total transport flows into and out of Antwerp by category

	TML-TNO	Port of Antwerp
Reference 2005 (million tonne)		
Container		74.6
Other		85.5
Total	106.6	160.1
Index 2020 (2005=100)		
Container		230
Other		110
Total	153	166
Index 2030 (2005=100)		
Container		295
Other		113
Total	175	198

I.5. Assumptions for modal shares

TML-TNO

Makes a difference between with and without Iron Rhine and analyses a scenario with a "dynamic transport policy". In the latter scenario it is assumed that external costs are internalized and rail sector is liberalized. For trucks this means, on top of the Maut in Germany and the Benelux (0.15 €/vehicle-km) an extra 0.075 €/vehicle-km in 2020 and 0.15 €/vehicle-km in 2030. For inland waterways, this means 0.01 €/tonne-km, for rail this also means 0.01 €/tonne-km. The liberalization of the rail sector would mean a reduction of rail travel time of 19% and a reduction in freight costs of 5%.

Port of Antwerp

Increase in modal share is due to structural shifts. Modal share is assumed to increase from 8 to 15% of container traffic from 2015 onwards. This could even become 20%.

I.6. Results for rail transport flows in and out of port of Antwerp

The table below presents the results for rail transport flows in and out of port of Antwerp.

Table 156: Results for rail transport flows in and out of port of Antwerp of maritime origin

	TML-TNO	**Port of Antwerp**
	Transport by rail all routes	**Transport by rail via all routes**
Reference 2005 (million tonne)		
Container	3.6 million tonne	9.8 million tonne
Other	8.6 million tonne	15.2 million tonne
Total	12.3 million tonne	25.0 million tonne
Index 2020 (2005=100)		
Container	179	302.5
Other	131	59.2
Total	144	154.6
Index 2030 (2005=100)		
Container	238	387.2
Total	179	186.7

I.7. Further assessment on the comparison of the flows of the port of Antwerp

In order to explain the difference in volumes, a further assessment[90] has been made on the definitions of the statistics shown. Some differences in definition are clear like some columns show the total for the whole port where others show only the potential for the Iron Rhine and Montzen route. Other differences require some further study.

The paragraphs below discuss the difference in total transport flows and modal sift, and the specific differences in rail transport.

I.7.1. Analysis of total transport

TRANS-TOOLS shows 106 million tonnes of international transhipment of flows in the port of Antwerp; i.e. flows changing mode between an inland mode and maritime transport. Note that in these flows no domestic feeder flows are taken into account; here the port connecting the inland mode is taken into account in relation with the origin/destination on the other end of the maritime link.. Also flows coming in by sea and leaving by sea to another country are not entirely included in these 106 million tonnes.

The port of Antwerp shows 160 million tonnes of maritime transport; i.e. flows coming in by sea plus the tonnes going out by sea. Note that this also includes domestic maritime flows and international feeder flows.

Looking at these definitions it is clear that that the numbers in the table are not comparable. In the following we will analyse the flows of the port of Antwerp in more detail in order to make it better comparable with the TRANS-TOOLS numbers.

From the publication "*Jaaroverzicht Vlaamse havens 2005*" we learn the following:

- Total Maritime transport Antwerp 160 million tonne. This is the total from all incoming and outgoing maritime flows.
- From Rotterdam to Antwerp 28 million tonne crude petrol products are transported into the port area by pipeline in 2005. (Source: Rotterdam-Antwerp Pipeline NV and RAPL).
- In total 29.83 million tonnes is transported by rail in relation with the port (source NMBS). These are flows leaving or entering the port area without any knowledge on whether it is coming from maritime activities or port industry.
- In total 84.3 million tonnes is transported by inland waterways in relation with the port (source: havenbesturen, Promotie Binnenvaart Vlaanderen, NV De Scheepvaart, Admin. Waterwegen en Zeehavens). Also these are flows leaving or entering the port area without any knowledge on whether it is coming from maritime activities or port industry.

[90] This part is done independently from the port of Antwerp at a later stage of the project

From the maritime statistics 2004 (more recent statistics were not available to the consortium at moment of writing), we get the following information for the port of Antwerp (estimate 2005 based on 5.1% evolution in "*Jaaroverzicht Vlaamse havens 2005*"):

- Incoming (excluding exchange with Belgium ports): 75 million tonne (2005 estimate: 79.3 million tonne)
- Outgoing (excluding exchange with Belgium ports): 60 million tonne (2005 estimate: 63.4 million tonne)
- Total (excluding exchange with Belgium ports): 135 million tonne (2005 estimate: 142.7 million tonne)

It should be noted that different modal-split figures are circulating without giving the exact definitions (even on the web-site of the Port of Antwerp). In the table below, some different modal split figures are shown as was reported in a report of ECSA.

Table 157: Current modal-split and future scenarios

Source	Road	Inland water	Rail	Pipeline	Comments
Macharis en Verbeke (2004)	30%	32%	12%	21%	Figures of 2000, Total Freight transport
GHA (2004)	40%	40%	20%	/	Figures of 2004 from annual report, Total freight transport
Strategical Plan (2004)	35%	45%	20%	/	Hypothesis, Total freight transport
Macharis en Verbeke (2004)	59.5%	31.2%	9.3%	/	Figures of 2020, container traffic
GHA (2004)	42%	43%	15%	/	Trend scenario 2015, container traffic
GHA (2004)	50%	37%	13%	/	Pessimistic scenario 2015, container traffic
Strategical Plan (2004)	40%	40%	20%	/	Hypothesis, container traffic
GHA (2004)	36%	32%	32%	/	Scenario 2015, conventional general cargo

Source: ECSA, based on Macharis and Verbeke (2004), GHA (2004) and Strategical Plan (2004)

From the web-site of the Port of Antwerp we get the following statistics:

Table 158: Modal split (in %)

	Maritime	***Industry***	***Total***
Pipeline	3%	48%	21%
Transhipment	7%	-	4%
Road	45%	10%	31%
Barge	27%	39%	32%
Rail	18%	3%	12%
	100%	100%	100%

Source: Port of Antwerp

Applying the maritime modal split figures of the Port of Antwerp on the total maritime flows the tonnes as shown in the table below result. In the last column the same is done but then excluding the domestic flows. Here it is roughly assumed that the same modal split is valid.

Table 159: Modal split in million tonnes, 2005

mode	All maritime	Excl. maritime domestic
Pipeline	4.8	4.08
Transhipment (sea)	11.2	9.52
Road	72	61.2
Barge	43.2	36.72
Rail	28.8	**24.48**
Total	160	136
Total excl. transshipment	**148.8**	**126.48**

Source: Estimates 2005 by TNO based on port of Antwerp 2006

In this table also a total is shown for the maritime flows excluding domestic flows and excluding the transshipment flows. This total is 126.48 million tonnes which already much closer to the TRANS-TOOLS figure of 106 million tonnes but still a difference remains.

This final difference has to do with the way the TRANS-TOOLS database was constructed. It was attempted to preserve as much as possible the economic relation in the transport chain. Important in this definition is that if a commodity changes ownership in the port the commodity can be counted as a maritime flow (for instance USA-Antwerp) and an inland flow (for instance Antwerp-Germany) instead of being one transport chain flow (in this case USA-Antwerp-Germany). This focus on the economical relation is important for a proper forecasting method where transport and economical activity of the origins and destinations are being correlated. A lot of the commodities entering the port are also being processed into industry taking place in the port. In this case a transformation of the commodities takes place into a new commodity and also in these cases the maritime flows also end in the port and are in TRANS-TOOLS not included in the port transshipment figure of 106 million tonnes. It should be noted that also the petrol products transported from Rotterdam to Antwerp by pipeline enter the same production process so when trying to come to the proper totals this should also be taken into account. Furthermore in some cases entrepot takes place in the port which makes it impossible to preserve the total economical relation (for instance USA-Antwerp-Germany) and the transport chain had to be broken down in different flows entering and leaving Antwerp (in the example USA-Antwerp and Antwerp-Germany).

In al the cases where the starting or ending point of the transport flow is considered Antwerp according to the explanation given here, the flow is taken up in the region of Antwerp in the TRANS-TOOLS coding system. The port statistics show information on which part of the maritime flows enters the port industry but this does not include the industry outside the port area in the region of Antwerp. For this reason the information on the port of Antwerp and the region of Antwerp is mixed making it impossible to make the TRANS-TOOLS figures 100% comparable to the statistics of the port of Antwerp. Since the statistics of the port of Antwerp have been used as one of the input data sources for the development of the TRANS-TOOLS database it can be trusted that it is consistent.

I.7.2. Analysis of rail transport (2000-2007)

In the table below, the Port of Antwerp shows that 25 million tonnes are transported by rail, which is more or less in line with the estimate as shown in the table above.

The website of the Port of Antwerp shows the following split in commodities for the rail transport. Please note that this includes all rail flows in relation with the Port of Antwerp including the industry in the port part (so not maritime) of it. Again here the numbers are different so probably again based on different definitions which were not described on the website. In this table however we get an impression of the size of the container flows by rail in relation with the port. This is 9.4 million tonnes according to the (unknown) definition of this table.

Table 160: Port of Antwerp — Cargo traffic by rail in 2006 (in tonnes) all destinations

	Unloaded	*Loaded*	*Total*
Agricultural products and foodstuff	899 048	81 414	980 462
Solid fuels	0	2 458 040	2 458 040
Petroleum and petroleum products	91 287	1 181 288	1 272 575
Ore	5 038	3 395 759	3 446 139
Metal products	3 445 453	823 505	4 268 958
Raw minerals and building materials	79 892	153 691	233 583
Chemicals and fertilisers	601 813	1 382 028	1 983 841
Intermodal transport (= containers)	**3 433 022**	**5 973 371**	**9 406 393**
Machinery vehicles and other goods	548 452	256 042	804 494
Total	**9 149 347**	**15 705 138**	**24 854 485**

To put these rail flows in perspective of the total flows and the developments in the past years the following table has been made from data as can be found on the web site of the port of Antwerp, where the total maritime flows, the total container flows and the total rail flows for the port of Antwerp are shown. For the total rail flows we see that since 1997 the absolute volume transported has remained more or less constant over time. The share of rail transport has declined from 22% in 1997 to 15% in 2006. In the same period the container flows have increased rapidly from 33 million tons (30% of total maritime) in 1997 to 81 million tons in 2006 (48% of total maritime). From this it can be concluded that the increase of container flows is not correlated to the increase of rail transport as such. For this reason also no concrete conclusion can be drawn on the development of rail transport if a further increase of container transport is expected. It could for instance imply an increase of rail transport but it could also imply a prevention of a decline of rail transport. All depends on the composition of the future commodities and the degree in which they will be containerised.

Table 161: Port of Antwerp – History of maritime cargo traffic (in tonnes)
Source: Antwerp Port Authority

Year	Total maritime	Total container	Share container	Total rail	Share rail
1997	111 894 783	33 426 842	29.87%	24 946 028	22.29%
1998	119 788 549	35 376 283	29.53%	26 082 511	21.77%
1999	115 654 020	39 442 240	34.10%	24 274 235	20.99%
2000	130 530 626	44 525 643	34.11%	25 778 059	19.75%
2001	130 050 413	46 409 921	35.69%	22 170 151	17.05%
2002	131 628 816	53 016 582	40.28%	21 627 298	16.43%
2003	142 874 512	61 350 335	42.94%	24 277 052	16.99%
2004	152 326 565	68 280 028	44.82%	23 311 732	15.30%
2005	160 054 365	74 593 112	46.60%	24 037 556	15.02%
2006	167 372 296	80 809 428	48.28%	24 854 485	14.85%

To make a comparison with the TRANS-TOOLS rail transport and the expected future development we have made new data extractions for the region of Antwerp (port and province of Antwerp together) for the common potential of the Iron Rhine and the Montzen route, which is shown in the following table. In this table the figures for the year 2005 and the forecasts for 2020 and 2030 under scenario 2A are taken up. A split is made in container flows and the not-container flows.

Table 162: Rail flows of province Antwerp, all flows (in million tonnes, all destinations)
Source: Trans-Tools

		2005	2A 2020	2A 2030
Maritime	**Containers**	3.625	6.476	8.623
	Other	8.632	11.171	13.333
	Total	12.257	17.648	21.955
Not Maritime	**Containers**	12.205	18.064	20.314
	Other	10.417	14.556	16.747
	Total	22.622	32.620	37.060
All flows Antwerp	**Containers**	15.829	24.541	28.936
	Other	19.049	25.727	30.079
	Total	34.879	50.268	59.015

The figures from the NMBS/SNCB (94% of the Belgian market in 2005) show a total of 29.47 million tonnes loaded or unloaded in the province of Antwerp. This is somewhat smaller than what TRANS-TOOLS indicates (34.88 million tonnes).

Table 163: Loaded and unloaded tonnes by rail in 2005 in province of Antwerp, by province, in tonnes
Source: NMBS/SNCB

A	B	A->B	B->A
02 Antwerp (excl. port)	Other countries	1 128 377	929 481
02 Antwerp (excl. port)	01 Brussel	9 355	9 355
02 Antwerp (excl. port)	02 Antwerp (excl. port)	17 235	
02 Antwerp (excl. port)	03 Limburg	1 711	607
02 Antwerp (excl. port)	04 Luik	2 146	25 149
02 Antwerp (excl. port)	05 Namen	35 776	1 167
02 Antwerp (excl. port)	07 Henegouwen	4 810	6 905
02 Antwerp (excl. port)	08 West Vlaanderen	93 394	86 179
02 Antwerp (excl. port)	09 Oost Vlaanderen	8 749	1 345
02 Antwerp (excl. port)	10 Vlaams Brabant	3 577	1 997
02 Antwerp (excl. port)	11 Waals Brabant	189	13 802
Other countries	12 Port of Antwerp	5 399 408	7 449 189
01 Brussel	12 Port of Antwerp	14 021	5 630
02 Antwerp (excl. port)	12 Port of Antwerp	108 482	419 677
03 Limburg	12 Port of Antwerp	81 487	398 536
04 Luik	12 Port of Antwerp	319 205	212 143
05 Namen	12 Port of Antwerp	3 940	369 132
06 Luxemburg	12 Port of Antwerp	405 001	348 575
07 Henegouwen	12 Port of Antwerp	1 105 168	3 278 114
08 West Vlaanderen	12 Port of Antwerp	1 120 286	2 437 992
09 Oost Vlaanderen	12 Port of Antwerp	36 397	48 988
10 Vlaams Brabant	12 Port of Antwerp	852	2 327
11 Waals Brabant	12 Port of Antwerp	431 750	41 256
12 Port Antwerp	12 Port of Antwerp	3 054 733	
Total loaded/unloaded tonnes in the Port of Antwerp		27 092 289	
Total loaded/unloaded tonnes in the province of Antw. (excl. port)		2 909 353	
Total loaded/unloaded tonnes in the total province of Antwerp		29 473 483	

Additionally, the total transported tonnes in Belgium can be found in the table below. We see that Antwerp takes about half of it.

Table 164: Freight transport by rail, Belgium, 2006, million tonnes
Source: Algemene Directie Statistiek, (bewerking Studiedienst van de Vlaamse Regering) op basis van facturatiesysteem NMBS

National transport	24.867
Import	14.234
Export	20.464
Through traffic	2.624
Total	62.189

Summarising table

Table 165: Summarising table of loaded and unloaded tonnes by rail in 2005/2006 in Antwerp, in million tonnes

		Trans-Tools, 2005	Port of Antwerp, 2006	NMBS, 2005
Maritime (port)	**Containers**	3.625	9.406	
	Other	8.632	15.448	
	Total	12.257	24.854	27.092
Not Maritime (rest of province of Antwerp)	**Containers**	12.205		
	Other	10.417		
	Total	22.622		2.909
All flows (province of Antwerp)	**Containers**	15.829		
	Other	19.049		
	Total	34.879		29.473

To compare first the total rail flows we see that in 2005 TRANS-TOOLS has 12.3 million tonnes maritime flows and 34.9 million tonnes in total for all Antwerp related flows. The 25 million tonnes as indicated by the port of Antwerp is in the middle and also close to what the NMBS/SCNB reports.

It is not unrealistic to assume that more than half of the "Not Maritime" flows in TRANS-TOOLS are in relation with the industry in the port which would make the numbers comparable again. The reason why these numbers are allocated differently in TRANS-TOOLS, is that the basis for this data is the European ETIS database. ETIS cuts every freight flow that changes owner, is bunkered, or changed another way in the port to 2 freight flow: one maritime flow (e.g. China – Antwerp) and one land flow (e.g. Antwerp – Germany). The latter is considered as a non-maritime flow in EITS and thus also in TRANS-TOOLS. The port of Antwerp considers every freight flow in or around the port as "maritime".

Comparing the container flows we see that where the port of Antwerp says 9.4 million tonnes while TRANS-TOOLS shows in 2005 3.6 million tonnes maritime and 12.2 million tonnes not maritime. Also here it has to be assumed that more than half of the not maritime flows are actually related to the port industry/economy (or the commodities change ownership in the port).

A table where the TRANS-TOOLS volumes are allocated to maritime/non-maritime according to the definition of the port of Antwerp can be found below.

Table 166: Summarising table of loaded and unloaded tonnes by rail in 2005/2006 in Antwerp, in million tonnes

		Trans-Tools, 2005	Trans-Tools, 2005, *allocated differently*	Port of Antwerp, 2006	NMBS, 2005
Maritime (port)	Containers	3.625	*9.406*	9.406	
	Other	8.632	*15.448*	15.448	
	Total	12.257	*24.854*	24.854	27.092
Not Maritime (rest of province of Antwerp)	Containers	12.205	*6.423*		
	Other	10.417	*3.601*		
	Total	22.622	*10.025*		2.909
All flows (province of Antwerp)	Containers	15.829	15.829		
	Other	19.049	19.049		
	Total	34.879	34.879		29.473

I.7.2. Analysis of rail transport (Iron Rhine and Montzen potential)

When looking specifically at the potential for the Iron Rhine and the Montzen route we see that the growth is somewhat higher than for the total rail transport in relation with Antwerp. Here we see that for the total maritime flows the growth is 77% up to 2020 and 140% up to 2030. When focusing on the maritime container flows we see that the growth is 81% up to 2020 and 150% up to 2030. In total, 4.2 million tonnes in 2005 comes from the Antwerp area (province and port). In this study, it has been determined that the total flows on the Montzen route in 2005 is 8.2 million tonnes. This means that just about half of the traffic on the Iron Rhine / Montzen corridor is in relation with the region and port of Antwerp. Of the 4.2 million tons there is 1.9 million container traffic.

Table 167: Rail flows of Antwerp, potential Iron Rhine/Montzen (million tonnes)

		2005	2A 2020	2A 2030
Maritime (port)	Containers	0.220	0.399	0.550
	Other	0.239	0.416	0.552
	Total	0.459	0.815	1.102
Not Maritime (rest of province of Antwerp)	Containers	1.652	2.459	2.877
	Other	2.098	2.885	3.301
	Total	3.750	5.345	6.178
All flows (province of Antwerp)	Containers	1.872	2.859	3.427
	Other	2.337	3.301	3.853
	Total	4.209	6.160	7.280

Source: Trans-Tools

I.8. Conclusions concerning the comparison with the scenarios and data of the port of Antwerp

The first conclusion is that the base data of TRANS-TOOLS is comparable with the data of the port of Antwerp. Although at first glance there seemed to be large differences in total tonnage these differences could be explained by making the definitions of the data of the two sources more comparable. It is concluded that the definitions can not be made 100% comparable since in TRANS-TOOLS the focus is on the economic relation, which implies that in cases like change of ownership in the port, commodities being input to the industry in the port or entrepot the flows end or start in he region of Antwerp and are combined in the figures for the rest of the province of Antwerp within the TRANS-TOOLS model. Comparing all information there is no reason to suspect that the base information is differing significantly.

A second conclusion is that the expected growth of the rail flows of the port of Antwerp is in the scenarios of the port of Antwerp slightly higher than the TRANS-TOOLS growth figures. For 2020 TRANS-TOOLS expects a growth of 44% where the port of Antwerp expects a growth of 55%. This can be considered a reasonable difference in modelling/scenario results.

A large difference can be found in the composition of the growth along the container and non-container flows by rail between the scenarios of the port of Antwerp and the TRANS-TOOLS results. The port of Antwerp expects an increase of 203% of container transport where TRANS-TOOLS expects a growth of 79% of the container flows in 2020. Since the total growth of the flows by rail of the port of Antwerp is only 11% higher this means that the non-container flows by rail are showing a decline of 41%. TRANS-TOOLS shows an increase of the non-container flows with 31%. Since the total growth is similar the main difference is in the containerisation rate making that flows that are interpreted in TRANS-TOOLS as non-container are in the scenario of the port of Antwerp container flows. Though our opinion is that the commodities that are transported by rail are not that suitable to be transported by container, thus that the scenario of the port of Antwerp on containers is on the very high end and in our view not realistic.

Annex J: Maintenance and renewal costs

J.1. Assumptions

For this calculation, we started with an assumption that in the Iron Rhine variants, 72 trains[91] will drive on the track. These trains all originate from the Montzen route. After that, the calculation has been adapted with the real number of trains per scenario.

The costs are split into 2 categories according to the frequency of the costs:
- Maintenance costs: maintenance of ramps, new cables, power lines, road crossings, …
- Renewal costs: rebuilding of a bridge or tunnel, replacement of rail tracks, …

The costs are also split into 2 categories whether they are dependent on the number of trains or not:
- Fixed costs: management, rental of buildings, water and power for services, ICT, communication costs, insurance, …
- Variable costs. The variable costs are about 80% of the total maintenance costs.

J.2. Historical Iron Rhine

J.2.1. The Netherlands

J.2.1.1. Maintenance costs

According to ProRail, an additional 3.8 million €/year will be spend on maintenance due to the reactivation of the Iron Rhine. This can be split in:
- € 1.5 million €/year on the part Roermond - Dalheim (excl. tunnel Meinweg)
- € 1.2 million €/year in the Meinweg tunnel.
- € 0.9 million €/year due to a more intensive use of Budel - Roermond

These figures are based on a (hypothetical) train volume of 72 trains per day. ProRail assumes that 1.5 million € of these costs can be considered as fixed costs.

In reality, fewer trains will ride on the Iron Rhine. The table below gives an overview of the maintenance cost for different train volumes.

[91] The renewed Iron Rhine will have a capacity of 72 trains/days both directions (ProRail and Infrabel, 2007). See Annex T: Advice 2007 "Commissie Onafhankelijke Deskundigen IJzeren Rijn" op page 298 for more details.

Table 168: Maintenance costs on the Iron Rhine in The Netherlands, for different assumptions on train volumes, in €$_{2005}$/year
Source: Calculations by ProRail

Year	Reference variant	Extra 72 trains	Extra 50 trains	Extra 20 trains
2015	4 031 488	7 682 319	7 127 422	6 215 770
2016	4 040 564	7 712 466	7 151 766	6 234 603
2017	4 049 648	7 734 747	7 176 144	6 253 461
2018	4 058 741	7 756 787	7 200 556	6 272 343
2019	4 067 841	7 778 829	7 225 003	6 291 250
2020	4 076 950	7 800 873	7 249 483	6 310 180
2021	4 086 067	7 822 918	7 273 998	6 329 135
2022	4 095 192	7 844 965	7 298 547	6 348 115
2023	4 104 325	7 867 013	7 323 130	6 367 118
2024	4 113 467	7 889 063	7 347 747	6 386 146
2025	4 122 616	7 911 115	7 372 399	6 405 199
2026	4 131 774	7 933 169	7 397 084	6 424 275
2027	4 140 940	7 955 224	7 421 804	6 443 376
2028	4 161 589	7 977 281	7 446 558	6 462 502
2029	4 170 795	7 999 339	7 471 346	6 481 651
2030	4 180 009	8 021 399	7 496 168	6 500 825

With the above table, an estimate could be made for the net extra maintenance costs, for the real number of trains. The interpolation between 72, 50 and 30 trains has been made with an exponential function, to capture the non-linearity.

Table 169: Extra maintenance costs on the Iron Rhine in The Netherlands, for scenario "historical Iron Rhine – 2A and – 2B", in €$_{2005}$/year
Source: Own calculations

	Historical Iron Rhine – 2A		Historical Iron Rhine – 2B	
Year	Number of trains	Maintenance costs	Number of trains	Maintenance costs
2015	52.6	3 068 974	23.2	2 288 520
2016	52.6	3 084 888	23.2	2 298 738
2017	52.6	3 097 981	23.2	2 309 487
2018	52.6	3 110 995	23.2	2 320 270
2019	52.6	3 124 022	23.2	2 331 074
2020	52.6	3 137 058	23.2	2 341 897
2021	52.72	3 153 860	22.42	2 334 593
2022	52.84	3 170 695	21.64	2 327 342
2023	47.58	3 022 312	19.32	2 285 053
2024	53.08	3 204 466	20.08	2 312 989
2025	53.2	3 221 404	19.3	2 305 891
2026	53.32	3 238 373	18.52	2 298 842
2027	53.44	3 255 375	17.74	2 291 846
2028	53.56	3 260 713	16.96	2 273 518
2029	53.68	3 277 759	16.18	2 266 618
2030	53.8	3 294 839	15.4	2 259 769

J.2.1.2. Renewal costs

The renewal costs for The Netherlands are calculated in a pragmatic way by ProRail:

- For the track between Budel and Roermond, it is assumed that only replacement costs for tracks will occur. These costs have a yearly basis and amount 138 516 €/year.
- For the track in Roermond (ringway), and the connection between Roermond and Germany (Meinweg tunnel), it is assumed that the new investments due to the reopening of the Iron Rhine, will lead to renewal costs on the long term. To estimate the costs, it is assumed that renewal costs amount 20% of the investment costs: for rail track each year, for bridges and tunnels after 100 year, for other infrastructure after 35 year. The first 35 years, no renewal costs are assumed. The schedule is as follows:
    - 201 347 € per year, each year, first time after 35 years (rail track renewal)
    - 177 million €, after 100 year, each 100 years (bridges and tunnels)
    - 72 million €, after 50 year, each 50 years (other)

The above assumption is based on the full capacity of 72 trains. In reality, fewer trains will ride on the Iron Rhine. The table below gives an overview of the renewal cost for different train volumes.

Table 170: Renewal costs on the Iron Rhine in The Netherlands, for different assumptions on train volumes, in €$_{2007}$/year
Source: Calculations by ProRail

Type	Extra 72 trains	Extra 50 trains	Extra 20 trains
Renewal cost between Budel and Roermond, yearly	138 516	122 142	33 404
Renewal cost between Roermond and the border, every 35 years	35 * 201 347	35 * 201 347	35 * 201 347
Renewal cost between Roermond and the border, every 50 years	177 000 000	177 000 000	177 000 000
Renewal cost between Roermond and the border, every 50 years	72 000 000	72 000 000	72 000 000

With the above table, an estimate could be made for the real number of trains. Only for the first line, the yearly renewal costs for the part Budel-Roermond, the other 3 cost components are assumed to be fixed cost.

Table 171: Yearly renewal costs on the Iron Rhine in The Netherlands, for scenario "historical Iron Rhine – 2A and – 2B", in €$_{2007}$/year, section Budel-Roermond

Source: Own calculations

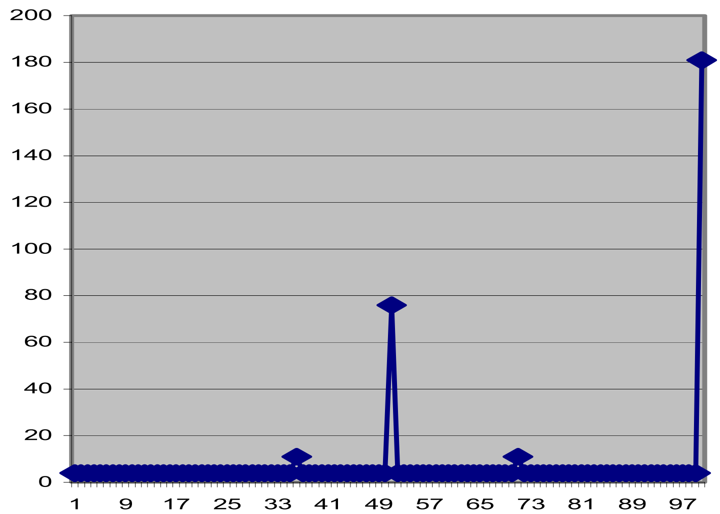
	Historical Iron Rhine – 2A		Historical Iron Rhine – 2B	
Year	**Number of trains**	**Renewal costs**	**Number of trains**	**Renewal costs**
2015	52.6	95 958	23.2	41 778
2016	52.6	95 958	23.2	41 778
2017	52.6	95 958	23.2	41 778
2018	52.6	95 958	23.2	41 778
2019	52.6	95 958	23.2	41 778
2020	52.6	95 958	23.2	41 778
2021	52.72	96 284	22.42	40 867
2022	52.84	96 611	21.64	39 975
2023	47.58	83 256	19.32	37 436
2024	53.08	97 269	20.08	38 249
2025	53.2	97 600	19.3	37 415
2026	53.32	97 932	18.52	36 598
2027	53.44	98 265	17.74	35 800
2028	53.56	98 599	16.96	35 019
2029	53.68	98 934	16.18	34 255
2030	53.8	99 271	15.4	33 507

The net present value of the renewal costs that occur every 50 or 100 years is calculated with a perpetual annuity, with an interval of 50 or 100 years..

J.2.1.3. Total costs

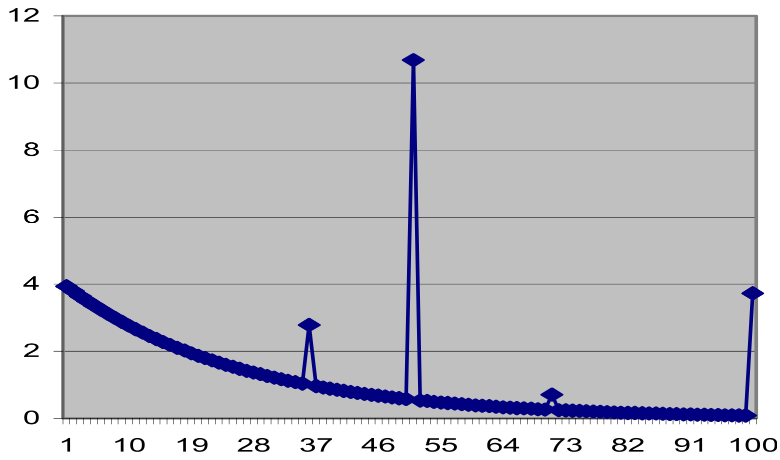
The figures below give an impression of the total costs of maintenance and renewal in The Netherlands.

Figure 27: Total costs (million €) of maintenance and renewal in The Netherlands, historical Iron Rhine, by year (starting year 1 = 2015)



The figure below shows the same, but discounted.

Figure 28: Discounted total costs (million €) of maintenance and renewal in The Netherlands, historical Iron Rhine, by year (starting year 1 = 2015), discount rate: 4%



J.2.2. Belgium

J.2.2.1. Maintenance costs

On average the maintenance costs change as follows (source: ProRail calculations):

- Iron Rhine route (Lier-border): yearly cost of 2.3 million €
- Montzen route (Lier-border): yearly saving of 6.3 million €

The cost reduction of the Montzen route is assumed larger than the cost increase of the Iron Rhine route, because the Montzen route is longer and more complicated (electrified, double track). The result is a cost saving of about 4.0 million € per year. These figures are based on a (hypothetical) train volume of 72 trains per day.

Table 172: Maintenance costs on the Iron Rhine in Belgium, for 72 trains, in €/year
Source: Calculations by ProRail

Year	Reference variant	Extra 72 trains
2015	7 310 066	9 274 316
2016	7 310 066	9 298 253
2017	7 310 066	9 322 213
2018	7 310 066	9 346 194
2019	7 310 066	9 370 198
2020	7 310 066	9 394 224
2021	7 310 066	9 418 271
2022	7 310 066	9 442 341
2023	7 310 066	9 466 433
2024	7 310 066	9 490 546
2025	7 310 066	9 514 682
2026	7 310 066	9 538 840
2027	7 310 066	9 563 020
2028	7 310 066	9 587 222
2029	7 310 066	9 611 446
2030	7 310 066	9 635 691

Table 173: Maintenance costs on the Montzen route in Belgium, for 72 trains, in €/year
Source: Calculations by ProRail

Year	Reference variant	72 trains less
2015	24 712 072	19 427 134
2016	24 782 387	19 427 134
2017	24 852 781	19 427 134
2018	24 923 254	19 427 134
2019	24 993 806	19 427 134
2020	25 064 437	19 427 134
2021	25 135 148	19 427 134
2022	25 205 937	19 427 134
2023	25 276 805	19 427 134
2024	25 347 752	19 427 134
2025	25 416 157	19 427 134
2026	25 478 230	19 427 134
2027	25 531 678	19 427 134
2028	25 585 152	19 427 134
2029	25 638 651	19 427 134
2030	25 692 175	19 427 134

With the above tables, an estimate could be made for the net extra maintenance costs, for the real number of trains. We assumed that the smaller number of trains has the same effect as for the Dutch historical Iron Rhine (i..e. the same balance between fixed and variable costs).

Table 174: Extra maintenance costs on the Iron Rhine in Belgium, for scenario "historical Iron Rhine – 2A and – 2B", in €$_{2005}$/year
Source: Own calculations

	Historical Iron Rhine – 2A		Historical Iron Rhine – 2B	
Year	Number of trains	Maintenance costs	Number of trains	Maintenance costs
2015	52.6	1 651 194	23.2	1 231 288
2016	52.6	1 670 343	23.2	1 244 674
2017	52.6	1 691 567	23.2	1 261 032
2018	52.6	1 712 901	23.2	1 277 530
2019	52.6	1 734 282	23.2	1 294 082
2020	52.6	1 755 709	23.2	1 310 683
2021	52.72	1 779 301	22.42	1 317 099
2022	52.84	1 802 988	21.64	1 323 422
2023	47.58	1 732 063	19.32	1 309 546
2024	53.08	1 850 642	20.08	1 335 796
2025	53.2	1 874 610	19.3	1 341 852
2026	53.32	1 898 672	18.52	1 347 821
2027	53.44	1 922 828	17.74	1 353 707
2028	53.56	1 945 952	16.96	1 356 807
2029	53.68	1 970 297	16.18	1 362 489
2030	53.8	1 994 736	15.4	1 368 092

Table 175: Decrease in maintenance costs on the Montzen route in Belgium, for all scenarios, in €$_{2005}$/year
Source: Own calculations

	Historical Iron Rhine – 2A		Historical Iron Rhine – 2B		Electrified historical Iron Rhine – 2A	
Year	Number of trains	Maintenance costs	Number of trains	Maintenance costs	Number of trains	Maintenance costs
2015	45.6	4 142 846	16.9	3 110 962	48.6	4 268 770
2016	45.6	4 194 804	16.9	3 147 773	48.6	4 322 624
2017	45.6	4 253 132	16.9	3 192 882	48.6	4 382 537
2018	45.6	4 311 806	16.9	3 238 402	48.6	4 442 785
2019	45.6	4 370 635	16.9	3 284 083	48.6	4 503 185
2020	45.6	4 429 614	16.9	3 329 921	48.6	4 563 736
2021	45.67	4 491 871	15.81	3 339 590	49.42	4 662 238
2022	45.74	4 554 355	14.72	3 348 939	50.24	4 762 075
2023	41.18	4 410 314	13.03	3 338 099	45.38	4 597 464
2024	45.88	4 680 008	12.54	3 366 710	51.88	4 965 795
2025	45.95	4 741 104	11.45	3 373 674	52.7	5 067 483
2026	46.02	4 797 339	10.36	3 376 798	53.52	5 165 034
2027	46.09	4 846 872	9.27	3 374 926	54.34	5 256 343
2028	46.16	4 892 323	8.18	3 365 084	55.16	5 345 973
2029	46.23	4 942 139	7.09	3 362 870	55.98	5 439 596
2030	46.3	4 992 101	6	3 360 548	56.8	5 534 319

J.2.2.2. Renewal costs

For Belgium, the renewal of the rail tracks is about 6 million € per year on the Montzen line, according to Infrabel. It is expected that because of the reactivation of the Iron Rhine, the costs for rail track renewal will be 10-15% lower. Other costs of renewal are assumed independent from railway traffic. Hence there is a saving in costs of renewal of 600 000 € per year on the Montzen line (10% of 6 000 000) when the Iron Rhine is activated[92].

In Belgium it is assumed that the costs of renewal on the Iron Rhine will increase with about 15%. The magnitude of these costs is however not known.

We assume that the net renewal cost of the Iron Rhine and the Montzen route is 0.

[92] Source: Infrabel, 3/10/2007

J.3. Iron Rhine via A52

J.3.1. The Netherlands

J.3.1.1. Maintenance costs

In the A52 variant, the section between Roermond and the German border differs from the historical variant. This variant does not have a Meinweg tunnel, which makes it cheaper.

The distance of the new track between Roermond and the border is 7.2 km. Assuming 72 trains, the maintenance costs are about 2 million € lower than for the historical variant.

Table 176: Difference in maintenance costs "Iron Rhine via A52" versus "historical Iron Rhine", in €$_{2005}$/year

	Cost decrease
2015	1 940 169
2020	1 958 725
2030	2 004 895

With the above table, an estimate could be made for the net extra maintenance costs, for the real number of trains. We assumed that the smaller number of trains has the same effect as for the historical Iron Rhine (i.e. the same balance between fixed and variable costs).

Table 177: Extra maintenance costs on the Iron Rhine in The Netherlands, for scenario "Iron Rhine via A52 – 2A", in €$_{2005}$/year
Source: Own calculations

Year	Number of trains	Maintenance costs
2015	64.3	1 616 147
2016	64.3	1 625 969
2017	64.3	1 637 050
2018	64.3	1 648 179
2019	64.3	1 659 319
2020	64.3	1 670 468
2021	64.58	1 682 721
2022	64.86	1 695 020
2023	58.43	1 433 454
2024	65.42	1 719 758
2025	65.7	1 732 195
2026	65.98	1 744 678
2027	66.26	1 757 208
2028	66.54	1 769 645
2029	66.82	1 782 287
2030	67.1	1 794 973

J.3.1.2. Renewal costs

The renewal costs for The Netherlands are calculated in a pragmatic way by ProRail, based on the full capacity of 72 trains. The renewal costs are much lower than for the historical Iron Rhine, because in this scenario, there is no tunnel.

Table 178: Renewal costs on the Iron Rhine in The Netherlands, for 72 trains, in €$_{2007}$/year
Source: Calculations by ProRail

Type	Extra 72 trains
Renewal cost between Budel and Roermond, yearly	138 516
Renewal cost between Roermond and the border, every 35 years	35 * 137 000
Renewal cost between Roermond and the border, every 50 years	16 000 000
Renewal cost between Roermond and the border, every 50 years	20 000 000

Again, an estimate needs to be made for the real number of trains. Only for the first line, the yearly renewal costs for the part Budel-Roermond, the other 3 cost components are assumed to be fixed cost.

J.3.2. Belgium

The costs are equal to the historical Iron Rhine variant. Only the slightly higher number of trains causes a different level of maintenance costs.

J.4. Electrified historical Iron Rhine

J.4.1. The Netherlands

J.4.1.1. Maintenance costs

The extra maintenance costs of electrification (compared to the non-electrified historical Iron Rhine) are 674 000 € for Budel-Weert and Roermond-border. For the section Weert-Roermond no extra costs occur.

Table 179: Extra maintenance costs due to the electrification of the Iron Rhine, The Netherlands, for 72 trains, in €$_{2005}$/year

Year	Extra maintenance costs
2015	632 540
2016	637 044
2017	639 783
2018	642 462
2019	645 135
2020	647 802
2021	650 465
2022	653 121
2023	655 771
2024	658 416
2025	661 056
2026	663 690
2027	666 319
2028	668 941
2029	671 559
2030	674 170

With the above table, an estimate could be made for the net extra maintenance costs, for the real number of trains. We assumed that the smaller number of trains has the same effect as for the historical Iron Rhine (i..e. the same balance between fixed and variable costs).

Table 180: Total extra maintenance costs on the Iron Rhine in The Netherlands, for scenario "Electrified Iron Rhine", in €$_{2005}$/year

Source: Own calculations

Year	Number of trains	Maintenance costs
2015	55.6	3 710 146
2016	55.6	3 730 398
2017	55.6	3 746 455
2018	55.6	3 762 389
2019	55.6	3 778 331
2020	55.6	3 794 279
2021	56.49	3 844 049
2022	57.38	3 894 299
2023	51.82	3 701 115
2024	59.16	3 996 249
2025	60.05	4 047 955
2026	60.94	4 100 148
2027	61.83	4 152 832
2028	62.72	4 194 330
2029	63.61	4 248 020
2030	64.5	4 302 206

J.4.1.2. Renewal costs

The extra renewal costs due to the electrification, based on the full capacity of 72 trains, are 36 million euro, every 50 years. This figure is based on 20% of the extra costs of electrification.

Table 181: Total renewal costs on the Iron Rhine in The Netherlands, for 72 trains, in €$_{2007}$/year, variant "Electrified historical Iron Rhine – 2A"
Source: Calculations by ProRail

Type	Extra 72 trains
Renewal cost between Budel and Roermond, yearly	138 516
Renewal cost between Roermond and the border, every 35 years	35 * 201 347
Renewal cost between Roermond and the border, every 50 years	177 000 000 + 36 000 000
Renewal cost between Roermond and the border, every 50 years	72 000 000

Again, an estimate needs to be made for the real number of trains. Only for the first line, the yearly renewal costs for the part Budel-Roermond, the other 3 cost components are assumed to be fixed cost.

J.4.2. Belgium

For Belgium, no information was available. We assume similar extra costs for electrification as for The Netherlands, pro ratio the number of track kilometres: 48 in The Netherlands, 72 in Belgium.

This leads to the table below:

Table 182: Total extra maintenance costs on the Iron Rhine in Belgium, for scenario "Electrified Iron Rhine", in €$_{2005}$/year
Source: Own calculations

Year	Number of trains	Maintenance costs
2015	55.6	2 523 218
2016	55.6	2 548 505
2017	55.6	2 574 358
2018	55.6	2 600 270
2019	55.6	2 626 225
2020	55.6	2 652 223
2021	56.49	2 702 033
2022	57.38	2 752 483
2023	51.82	2 630 236
2024	59.16	2 855 322
2025	60.05	2 907 723
2026	60.94	2 960 782
2027	61.83	3 014 506
2028	62.72	3 068 207
2029	63.61	3 123 373
2030	64.5	3 179 217

The renewal costs amount 54 million € (72/48 * 36), every 50 years.

J.5. Electrified Iron Rhine via A52

J.5.1. The Netherlands

J.5.1.1. Maintenance costs

The extra maintenance costs of electrification (compared to the non-electrified Iron Rhine via A52) are 550 000 €.

J.5.1.2. Renewal costs

The extra renewal costs due to the electrification, based on the full capacity of 72 trains, are 29.5 million euro, every 50 years. This figure is based on 20% of the extra costs of electrification.

Table 183: Total renewal costs on the Iron Rhine in The Netherlands, for 72 trains, in €$_{2007}$/year, variant "Electrified Iron Rhine via A52 – 2A"
Source: Calculations by ProRail

Type	Extra 72 trains
Renewal cost between Budel and Roermond, yearly	138 516
Renewal cost between Roermond and the border, every 35 years	35 * 201 347
Renewal cost between Roermond and the border, every 50 years	177 000 000 + 29 500 000
Renewal cost between Roermond and the border, every 50 years	72 000 000

Again, an estimate needs to be made for the real number of trains. Only for the first line, the yearly renewal costs for the part Budel-Roermond, the other 3 cost components are assumed to be fixed cost.

J.5.2. Belgium

The costs are equal to the electrified historical Iron Rhine variant. Only the slightly higher number of trains causes a different level of maintenance costs.

J.6. Maintenance costs of the Montzen route in Belgium

In the reference scenario, an investment will be done on the Montzen route, in Aarschot. This new infrastructure will also require maintenance.

Infrabel estimates the maintenance cost to be 2.5 million euro per year, starting in 2020. This maintenance cost can be avoided when the Iron Rhine will be build.

Table 184: Maintenance cost on the Montzen route, in the reference situation, in million €$_{2005}$

	annuity 4%	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Aarschot	-38.02	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50

J.7. Germany

For Germany, no information was available. Therefore, the maintenance and renewal costs are treated as NA (not available).

Annex K: Results of individual modelling steps in Trans-Tools

K.1. Introduction

In this annex results are presented of individual modelling steps performed in the process to determine the potential for the Iron Rhine. The focus of this annex is on those models of which the effects can not directly be seen from the end results of the method applied. In this context we focus on the trade forecasting effects, the modal-shift effect, both part of the TRANS-TOOLS model, and the effect of introducing the additional container flows through the ECORYS-CPB container model.

K.2. Results of the TRANS-TOOLS models

K.2.1. Selection of origin-destinations of interest for the Iron Rhine project

In order to get a picture of the growth in trade and the potential development in rail transport, a selection is made of O-D pairs for which the inter-regional transport could be relevant for the Iron Rhine. The following regions have been selected:

Regions in Belgium (West Belgium)
- Antwerp
- Oost-Vlaanderen
- West-Vlaanderen
- Vlaams-Brabant
- Waals-Brabant
- Brussel/Bruxelles

Regions in Nord-Rhein-Westfalen in Germany (NRWF):
- Düsseldorf
- Cologne
- Munster
- Detmold
- Arnsberg

Regions in other hinterlands:
- Germany (general)
- Poland
- Czech Republic
- Slovakia

- Hungary
- Switzerland
- Austria

In the tables, the transport between West Belgium and NRWF and the other hinterlands is given so that a difference is made between NRWF and the general hinterland.

The tables with total transport flows are meant to give insight into the development of transport flows. Little can be concluded from these tables on the amount to be transported on the Iron Rhine. It is only after the assignment step (allocation of rail flows on the network) that we know what will be the effect on the use of the Iron Rhine.

K.2.2. Total transport flows and modal split

This paragraph gives the total transport and modal split on the selection of the O-D pairs that are possibly relevant to the Iron Rhine

K.2.2.1. TRANS-TOOLS Trade model

By using the trade model from TRANS-TOOLS, the growth of the transport between regions can be determined by type of good (for all modes of transport at the same time). In the tables below, this growth is shown for the socio-economic scenarios 2A/2B up to the year 2020 and 2030. Also the respective indexes (base 2005) are shown.

The table shows that the total trade increase varies on these relations until the year 2020 from an increase of 46% (Belgium - NRWF) to an increase of 57% (Belgium - remaining hinterland). For the period until 2030 the increase of the trade on these relations varies from an increase of 69% (Belgium - NRWF) to an increase of 87% (Belgium - remaining hinterland). The total increase of the transport flows between West-Belgium and NRWF plus the remaining hinterland is 53% for the year 2020 and 80% for the year 2030.

The results in this table are not directly comparable with the Port of Antwerp trade flows as
a) all trade from Belgium to NRWF and beyond is considered (also non-port flows)
b) flows from the Port of Antwerp with destination in Belgium are not considered in this table. This is of course considered in the total analysis.

There is a strong difference in the growth rates by type of goods. In the period until 2030 the trade on the relation West-Belgium and NRWF plus the remaining hinterland grows for ores and scrap with only 17%, whereas the increase for machines and remaining end products amounts to 122%.

Table 185: Growth transport flows in the period 2005 to 2020 and 2030, scenario2 (all modes of transport)

tonnage * 1000	2005	2020	index 2020	2030	index 2030
Belgium <-> NRWF + other catchment area					
Agriculture	7 052	9 258	131	10 065	143
Food	7 575	10 756	142	11 926	157
Solid mineral fuels	2 061	2 561	124	2 783	135
Crude oil	25	25	100	25	100
Ores	2 251	2 526	112	2 642	117
Metal	11 467	18 587	162	22 528	196
building material	11 486	12 666	110	13 916	121
Fertilisers	2 624	3 326	127	3 588	137
Chemicals	21 757	38 716	178	47 882	220
final products	22 260	40 262	181	49 351	222
petrol products	18 103	24 406	135	27 323	151
Total	106 661	163 089	153	192 029	180
Belgium <-> NRWF					
Agriculture	898	1 161	129	1 257	140
Food	2 372	3 327	140	3 674	155
solid mineral fuels	542	624	115	664	123
Ores	1 314	1 474	112	1 540	117
Metal	4 685	7 656	163	9 379	200
building material	7 066	7 575	107	8 262	117
Fertilisers	1 080	1 325	123	1 413	131
Chemicals	9 392	16 202	173	19 761	210
final products	6 166	10 434	169	12 356	200
petrol products	7 420	9 856	133	10 930	147
Total	**40 935**	**59 634**	**146**	**69 236**	**169**
Belgium <-> other catchment area					
Agriculture	6 154	8 097	132	8 808	143
Food	5 203	7 428	143	8 252	159
solid mineral fuels	1 519	1 938	128	2 119	139
crude oil	25	25	100	25	100
Ores	937	1 052	112	1 102	118
Metal	6 781	10 932	161	13 149	194
building material	4 420	5 092	115	5 654	128
Fertilisers	1 544	2 001	130	2 175	141
Chemicals	12 365	22 514	182	28 121	227
final products	16 094	29 828	185	36 994	230
petrol products	10 684	14 550	136	16 394	153
Total	**65 726**	**103 457**	**157**	**122 793**	**187**

Warning: This table shows results of a representative corridor which is NOT by definition the same as the potential for the Iron Rhine.

K.2.2.2. TRANS-TOOLS Modal-split

In tables below we present results for the 2A scenario (medium economic growth and normal transport policy) and for the 2B scenario (medium economic growth and dynamic transport policy including internalisation of externalities and liberalisation of rail giving lower rail costs). The results presented do not yet include the correction for modal share and port shifts for containers generated by the ECORYS-CPB model that could result from the reactivation of the Iron Rhine.

For each of these scenarios four results are presented:

- Base year **2005**: observed modal split
- Future year after running the trade model (“**tm**”): this means that the modal split per category of goods and transport relation is the one of 2005.
- Future year after running the modal-split model, without Iron Rhine (“**ms**”): this means that for each category of goods and for each transport relation the change in the level of service (due to infrastructure, pricing, speed etc.) can affect the modal shares – in the **ms** scenario there is no Iron Rhine available
- Future year after running the modal-split model, with Iron Rhine (“**ms IR**”): this is scenario “ms” to which the Iron Rhine has been added.

By presenting these steps separately it becomes clear what the impact of the different steps of the modal-split is. The results have been incorporated in two tables below for the A respectively B policy scenario. In interpreting these tables, remember that these are modal shares of a total freight volume that is growing (almost doubling). A small decrease in the market share of rail can hide a strong increase in the absolute volume transported by rail.

Table 186: Development of the modal-split in the scenario “Historical Iron Rhine - 2A” for 2020 and 2030 (before ECORYS-CPB model run)

Western-Belgium <-> NRWF + other hinterland														
tonnes	2005		2020 tm		2A 2020 ms		2A 2020 ms IR		2030 tm		2A 2030 ms		2A 2030 ms IR	
** 1000*	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
Road	57558	61.59	92796	64.54	92631	64.39	92599	64.36	110789	65.44	110624	65.30	110584	65.27
Rail	7243	7.75	11672	8.12	11657	8.10	11697	8.13	13765	8.13	13739	8.11	13788	8.14
Iww	28653	30.66	39317	27.34	39580	27.51	39574	27.51	44750	26.43	45052	26.59	45045	26.59
Total	93454	100.00	143784	100.00	143868	100.00	143870	100.00	169303	100.00	169415	100.00	169417	100.00
Western-Belgium <-> NRWF														
tonnes	2005		2020 tm		2A 2020 ms		2A 2020 ms IR		2030 tm		2A 2030 ms		2A 2030 ms IR	
** 1000*	tonnage	%	tonnage	%	tonnage	%	tonnage	%	tonnage	%	tonnage	%	tonnage	%
Road	21224	55.38	33197	58.87	33113	58.67	33105	58.65	39196	59.75	39110	59.55	39101	59.54
Rail	1439	3.76	2231	3.96	2244	3.98	2255	4.00	2587	3.94	2602	3.96	2615	3.98
Iww	15660	40.86	20961	37.17	21084	37.36	21082	37.35	23822	36.31	23963	36.49	23960	36.48
Total	38323	100.00	56389	100.00	56441	100.00	56441	100.00	65605	100.00	65676	100.00	65676	100.00
Western-Belgium <-> other hinterland														
tonnes	2005		2020 tm		2A 2020 ms		2A 2020 ms IR		2030 tm		2A 2030 ms		2A 2030 ms IR	
** 1000*	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
Road	36334	65.90	59599	68.19	59518	68.08	59494	68.05	71593	69.04	71514	68.94	71483	68.91
Rail	5804	10.53	9441	10.80	9413	10.77	9442	10.80	11177	10.78	11137	10.74	11173	10.77
Iww	12993	23.57	18355	21.00	18496	21.16	18493	21.15	20928	20.18	21089	20.33	21085	20.32
Total	55131	100.00	87395	100.00	87427	100.00	87429	100.00	103698	100.00	103739	100.00	103741	100.00

Warning: This table shows results of a representative corridor which is NOT by definition the same as the potential for the Iron Rhine.

Table 187: Development of the modal-split in the scenario "Historical Iron Rhine – 2B" for 2020 and 2030

Western-Belgium <-> NRWF + other hinterland												
tonnes	2005		2020 tm		2B 2020 ms		2B 2020 ms IR		2030 tm		2B 2030 ms		2B 2030 ms IR	
** 1000*	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
Road	57558	61.59	92796	64.54	91318	63.37	91283	63.34	110789	65.44	107273	63.07	107222	63.04
Rail	7243	7.75	11672	8.12	12258	8.51	12302	8.54	13765	8.13	15278	8.98	15342	9.02
Iww	28653	30.66	39317	27.34	40530	28.13	40523	28.12	44750	26.43	47528	27.94	47518	27.94
Total	93454	100.00	143784	100.00	144105	100.00	144107	100.00	169303	100.00	170079	100.00	170082	100.00
Western-Belgium <-> NRWF														
tonnes	2005		2020 tm		2B 2020 ms		2B 2020 ms IR		2030 tm		2B 2030 ms		2B 2030 ms IR	
** 1000*	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
Road	21224	55.38	33197	58.87	32803	57.94	32795	57.93	39196	59.75	38322	57.95	38311	57.93
Rail	1439	3.76	2231	3.96	2328	4.11	2340	4.13	2587	3.94	2812	4.25	2828	4.28
Iww	15660	40.86	20961	37.17	21481	37.94	21478	37.94	23822	36.31	24994	37.80	24990	37.79
Total	38323	100.00	56389	100.00	56613	100.00	56613	100.00	65605	100.00	66128	100.00	66128	100.00
Western-Belgium <-> other hinterland														
tonnes	2005		2020 tm		2B 2020 ms		2B 2020 ms IR		2030 tm		2B 2030 ms		2B 2030 ms IR	
** 1000*	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%
Road	36334	65.90	59599	68.19	58514	66.88	58488	66.85	71593	69.04	68951	66.33	68911	66.29
Rail	5804	10.53	9441	10.80	9930	11.35	9962	11.39	11177	10.78	12466	11.99	12514	12.04
Iww	12993	23.57	18355	21.00	19049	21.77	19045	21.77	20928	20.18	22534	21.68	22529	21.67
Total	55131	100.00	87395	100.00	87493	100.00	87495	100.00	103698	100.00	103951	100.00	103954	100.00

Warning: This table shows results of a representative corridor which is NOT by definition the same as the potential for the Iron Rhine.

For the correct interpretation of the tables, lets take an example. In the Table 186, looking at the total on the corridor Western Belgium in relation with NRWF and the other hinterland we see the following development of the modal-split. The road transport has in the base year 2005 a share of 61.59%. In 2020, after the calculation with the trade model (column "tm") in which each commodity shows its own growth by OD we see that the share of road has grown to 64.54%. After calculation of the effect of the level-of-service (prices, speed etc. but without Iron Rhine) we see that the share of road transport drops to 64.39%. Finally we see that the reactivation of the Iron Rhine only leads to a reduction of 0.03% of the road transport on this corridor.

For rail transport we see in the same process a shift of 7.8% in the base year 2005 to 8.12% as a result of the relative shares of the commodities transported and the independent growth rates to 8.10% (column "ms" as a result of the level-of-service and to 8.13% if one adds the Iron Rhine (column "ms IR"). For inland navigation we see a shift from 30.7% in 2005 to 27.3% after running the trade model to 27.5% as a result of the level-of-service changes.

We see the following trends in the scenario 2A:

- The main part of the absolute increase of the rail transport is explained by the increase of the transport flows as a result of socio-economic developments (increase of the trade), this is illustrated in the left column of each scenario concerning the results directly after the application of the trade model;
- As a result of the increase of the trade of the different goods types, the proportion of road transport increases with some percents, the share of rail transport increases slightly and the proportion of inland shipping decreases with some percents. This change in the modal-split is caused because different goods types have different growth factors. By road transport more high-quality goods are transported

(that have a high growth factor), by inland shipping relatively more low-quality goods are transported (that have a lower growth factor). The modal-split will change as a result of the increase of the trade, because different shares of goods types with different growth factors;

- A smaller part of the increase is caused by modal-split impact as a result of developments in level-of-service of the transport modes (such as toll levy and users fee) without opening of the Iron Rhine. This difference is illustrated in the left column and the middle column for each scenario;
- The reactivation of the Iron Rhine has a limited influence on modal-split on the corridor. This difference is illustrated in the tables above by the difference between the middle column (after modal split without Iron Rhine) and the right column (after modal split with Iron Rhine) for each scenario

In the background scenario without strong transport policy (Historical Iron Rhine - 2A), the main shifts in the modal-split take place as a result of the computations in the trade model where the relative shares of the commodities traded are changed. The effects of the level-of-service changes as calculated in the modal-split model are very small. The addition of the Iron Rhine infrastructure does almost not increase the share of rail.

When we consider the scenario with strong transport policy (Historical Iron Rhine - 2B), we can see the effects of the policy comparing the results of both tables for the columns “ms” and “ms IR”. We see, again for NRWF and the other hinterland, that in 2020, the share of road is decreased by 1% point, from 64.39% in 2A to 63.37% in 2B due to the dynamic transport policy. Of the 1% percentage point decrease of road, rail takes 0.4 percentage point (increasing from 8.10% in 2A to 8.51% in 2B) and inland waterways takes the rest. Even under a dynamic transport policy will the Iron Rhine not increase the market share of rail significantly: in 2020 in scenario B, the share of rail will increase from 8.51% in column “ms” to 8.54% in column “ms IR”.

In the background scenario with strong transport policy (2B), there is only a small shift in the modal shares and the addition of the Iron Rhine infrastructure does almost not increase the share of rail.

K.3. ECORYS-CPB container model

Annex E: Container model on page 203 gives all details on the results of the container model. The table below shows the effects of the additional container flows on the potential for the Iron Rhine.

Table 188: Effect container model on potential Iron Rhine, by scenario and variant (million tonne)

	Historic Iron Rhine – 2A		Historic Iron Rhine – 2B		Iron Rhine via A52 – 2A		Electrified historic Iron Rhine – 2A		Electrified Iron Rhine via A52 – 2A	
	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
Without container model	8.76	9.05	3.97	2.45	10.56	11.13	9.30	10.68	11.20	12.40
Container model	0.28	0.27	0.05	0.01	0.33	0.28	0.30	0.34	0.36	0.35
Total	9.04	9.32	4.02	2.46	10.89	11.41	9.60	11.02	11.56	12.75

As can be send depending on the scenario and variant the effect larger or smaller. For reference one should note that one fully loaded container train contains 0.26 million tonne. Depending on the balance on the route this container train generates at maximum one empty train. So depending on the scenario and variant shown the additional container flows generate at maximum a bit more than 2 additional trains.

Annex L: Investment costs

L.1. Belgium

L.1.1. Reference scenario

In the reference situation, Belgium plans to autonomously, in both cases: with and without the Iron Rhine:
- Build noise screens on the section Lier-Hamont (see III.3.2 on page 119)
- Remove a road-rail crossing in Neerpelt (see III.4.3 on page 140)
- Maintenance costs of the track, as it is in use for domestic passenger transport, and for 2 freight trains per day in 2008, and including the maintenance costs needed to deal with the future autonomous growth of this traffic.

The costs above are not included in the investment costs in the table below.

In the scenario without Iron Rhine, an investment of 87.88 million € is needed in Aarschot (Montzen route). This is the building of a free crossing (2 fly-overs) in 2020 near Aarschot, which allows to cope with the transport demand on the Montzen route in combination with increasing passenger traffic. This investment will not be needed when the Iron Rhine is build, at least not before 2040. In the case when the Iron Rhine is build, this investment can thus been saved. Details can be found in "Annex R: Capacity in Aarschot (Montzen route)" on page 288. The investment of 87.88 million € is spread over the years as follows: 5% (2018) - 15% (2019) - 40% (2020) - 30% (2021) - 10 % (2022).

The net present value of this can be found in the table below.

Table 189: Net present value of the Aarschot investment, million €

total	NPV discount rate 4%	2018	2019	2020	2021	2022
-87.88	-32.19	-4.39	-13.18	-35.15	-26.36	-8.80

We assumed no other significant investments (e.g. electrification) are foreseen.

L.1.2. Investment costs historical Iron Rhine and Iron Rhine via A52

The investment costs in both scenarios are equal for Belgium, as the A52 and historical variants only differ in The Netherlands and Germany. They are estimated by Infrabel (11-09-2008) to be 42 million $euro_{2005}$ including planning and administration costs, excluding VAT. The accuracy of the cost estimation is +/- 25 %.

The breakdown of the costs can be found in the table below.

Table 190: Breakdown of the Belgian investment costs on the Iron Rhine, million €, excluding VAT

Gradual investments: a. Double track Balen-Werkplaatsen-Neerpelt b. New passing track in Hamont	17.97
Changes at the railway station Neerpelt + passenger tunnel	7.89
ETCS at the section Lier-Hamont	5.68
Noise screens (both sides) on the section Lier-Hamont	9.84
Total	**41.40**

Infrabel states that, with these investment, the capacity on the Iron Rhine section Lier-Hamont will be large enough to cope with the predicted number of trains by 2030.

The total already spend costs by Infrabel (and before by the NMBS) are up to date 6.684 million € (situation March 2008). These costs are not included in the investment costs in the table below, because they are considered as "sunk costs".

L.1.3. Electrification

The electrification costs in Belgium take following into account:

- Electrification in the current system 3 kV DC of the 1-track-line from Mol (exclusive because this station is already electrified) up to Balen-Werkplaatsen (10 km), the 2-track line from Balen-Werkplaatsen to Neerpelt (13 km) and the 1-track-line from Neerpelt to the Dutch border (10 km).
- New traction station in Balen and Neerpelt
- New separating post in Geel and Lommel
- In the neighbourhood of the border arrangements (a neutral zone) are necessary to handle with the tension differences between countries (BE/NL): a neutral zone 3 kV/ 1.5 kV is foreseen (situated over the border in Budel)

For the electrification, the costs are (rounded) 40 million $€_{2005}$, with an accuracy of +/-40%.

An overview of this is given in the figure and table below.

Table 191: Electrification of the Iron Rhine in Belgium

Description	Quantity	Unit price (million €)	Total price (million €)
Traction sub-station	2	4	8
Section post	2	0.8	1.6
Double Track Compound 3 kV	33	0.5	16.5
Single track Compound 3 kV	20	0.3	6
			32.1
Subtotal			
Study costs (17%)			5.46
Infrabel general overhead (9.2%)			2.95
Total			40.51

Figure 29: Electrification of the Iron Rhine in Belgium

In total the electrified Iron Rhine would cost 82 million €.

L.1.4. Distribution of the investment costs of the years

For Belgium, the distribution of the investment costs of the years was not given. As suggested by the steering committee, we used the following division:

- year -4: 10%
- year -3: 20%
- year -2: 30%
- year -1: 30%
- year 0: 10%

L.1.5. Summary of costs per scenario

Table 192: Investment costs additional to the reference scenario in Belgium – Iron Rhine operational in 2015, in million euro$_{2005}$ for 2 discount rates

	2011	2012	2013	2014	2015	2018	2019	2020	2021	2022	Total	NPV in 2007 (4%)	NPV in 2007 (2.5%)
Historical Iron Rhine	4.20	8.40	12.60	12.60	4.20	-4.39	-13.18	-35.15	-26.36	-8.80	-45.88	0.90	-2.50
Electrified historical Iron Rhine	8.20	16.40	24.60	24.60	8.20	-4.39	-13.18	-35.15	-26.36	-8.80	-5.88	32.42	31.92
Iron Rhine via A52	4.20	8.40	12.60	12.60	4.20	-4.39	-13.18	-35.15	-26.36	-8.80	-45.88	0.90	-2.50
Electrified Iron Rhine via A52	8.20	16.40	24.60	24.60	8.20	-4.39	-13.18	-35.15	-26.36	-8.80	-5.88	32.42	31.92

Table 193: Investment costs additional to the reference scenario in Belgium – Iron Rhine operational in 2020, in million euro$_{2005}$ for 2 discount rates

	2016	2017	2018	2019	2020	2021	2022	Total	NPV in 2007 (4%)	NPV in 2007 (2.5%)
Historical Iron Rhine	4.20	8.40	8.21	-0.58	-30.95	-26.36	-8.80	-45.88	-4.99	-6.70
Electrified historical Iron Rhine	8.20	16.40	20.21	11.42	-26.95	-26.36	-8.80	-5.88	20.92	23.72
Iron Rhine via A52	4.20	8.40	8.21	-0.58	-30.95	-26.36	-8.80	-45.88	-4.99	-6.70
Electrified Iron Rhine via A52	8.20	16.40	20.21	11.42	-26.95	-26.36	-8.80	-5.88	20.92	23.72

VI.2. Netherlands

L.2.1. Reference scenario

The expenditure (13 million euro) for the autonomous development has been subtracted from the investment cost for the Iron Rhine in The Netherlands.

L.2.2. Investment costs historical Iron Rhine

The investment costs of the project consist of all the costs needed to realise the project. They include the study costs, which are part of the engineering costs. Other engineering costs are: preparation, monitoring, and overhead costs. Other investment costs are the largest part and contain the costs for tracks, bridges, tunnels, concrete, signalling, noise abatement etc.

Table 194: Investment costs in The Netherlands, million euro$_{2007}$ VAT exclusive, historical Iron Rhine
Source: ProRail (15/07/2008), later adapted by TML

Year	Starting date 2015	Starting date 2020
2009	3	3
2010	7	7
2011	7	7
2012	50	10
2013	130	10
2014	130	10
2015	99	15
2016	61	37
2017	27	73
2018		88
2019		87
2020		79
2021		61
2022		27
TOTAL	514	514

The total investment costs are 514 million €. The accuracy of the cost estimation is +/-15 %. Total investment cost spend before 2008 are to be considered as "sunken costs", they are already spend and cannot influence a decision anymore. Therefore, they are excluded in the SCBA.

L.2.3. Electrified historical Iron Rhine

The electrification costs in The Netherlands take following into account:

- Electrification in the current system 1.5 kV DC of the 1-track-line from Budel up to Weert (exclusive because this station is already electrified), from Roermond (exclusive because this station is already electrified) up to the German border and some deviation tracks. In total 37.4 km
- 4 new traction stations.
- In the neighbourhood of the border arrangements (neutral zones) are foreseen to handle with the tension differences between countries (BE/NL and NL/DE). The neutral zone between BE and NL is - incorporated in the investment costs in Belgium; the neutral zone between NL and DE is - in this study - assumed to be situated on Dutch territory, and incorporated in de costs on Dutch territory.

The total costs are estimated at 49.3 million €.. The cost calculation is added in the table below. The accuracy of the cost estimation for electrification is +/-40 %.

It is assumed that these costs have the same spread over time as the costs for the historical Iron Rhine.

Table 195: Costs for electrification of the Iron Rhine, in €, VAT exclusive.
Source: ProRail, 2-7-2008

Construction costs		Number	Unit	Price/unit (€)	Price (€)
Overhead line	on main and waiting tracks, single track	37.4	km	392 863	14 691 100
Tension lock	1500 V dc <-> 15 kV ac	1	piece	3 400 000	3 400 000
Traction sub-stations	complete	4	pieces	3 000 000	12 000 000
TOTAL construction costs					**30 091 100**
Engineering, indirect costs, unforeseen costs, …					19 220 690
TOTAL investment costs					**49 311 790**

L.2.4. Iron Rhine via A52

The investment costs of the Iron Rhine via A52 variant are 253 million € (source: ProRail, 02-10-2008), though the years up to 2008 should not be taken into account for the SCBA, as these 4 million € are sunken costs. Thus, the total investment costs are 249 million €. The accuracy of the cost estimation for the Iron Rhine via A52 variant is +/-20 %.

In the SCBA calculation, the difference of the project and reference variant (13 million euro) will to be made.

It is assumed that these costs have the same spread over time as the costs for the historical Iron Rhine.

L.2.5. Electrified Iron Rhine via A52

The total costs of the electrification of the Iron Rhine via A52 are estimated at 37 million €.. The accuracy of the cost estimation for electrification is +/-40 %. It is assumed that these costs have the same spread over time as the costs for the historical Iron Rhine.

L.2.6. Summary of net costs per scenario

Table 196: Investments costs additional to the reference scenario in The Netherlands – Iron Rhine operational in 2015, in million euro$_{2007}$ for 2 discount rates

	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	NPV in 2007 (4%)	NPV in 2007 (2.5%)
Historical Iron Rhine	3	7	7	50	130	130	99	61	27	514	391.04	432.54
Electrified historical Iron Rhine	3.3	7.7	7.7	54.8	142.4	142.4	108.5	66.9	29.6	563.3	428.55	474.03
Iron Rhine via A52	1.4	3.3	3.3	23.3	60.7	60.7	46.2	28.5	12.6	240	182.59	201.97
Electrified Iron Rhine via A52	1.6	3.8	3.8	26.9	70	70	53.4	32.9	14.6	277	210.73	233.10

Table 197: Investments costs additional to the reference scenario in The Netherlands – Iron Rhine operational in 2020, in million euro$_{2007}$ for 2 discount rates

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total	NPV in 2007 (4%)	NPV in 2007 (2.5%)
Historical Iron Rhine	3	7	7	10	10	10	15	37	73	88	87	79	61	27	514	283.92	329.60
Electrified historical Iron Rhine	3.3	7.7	7.7	11	11	11	16.4	40.5	80	96.3	95.3	86.6	66.9	29.6	563.3	311.14	361.19
Iron Rhine via A52	1.4	3.3	3.3	4.6	4.6	4.7	7	17.3	34.1	41.1	40.6	36.9	28.5	12.6	240	132.56	153.89
Electrified Iron Rhine via A52	1.6	3.8	3.8	5.4	5.4	5.4	8	19.9	39.3	47.4	46.9	42.6	32.9	14.6	277	152.96	177.57

L.3. Germany

L.3.1. Reference scenario

We assume for Germany the following:

- All investments needed to foresee the needed the capacity on existing capacity (now and in the future) is autonomous. For a non-exhaustive list, see "B.4.3. Capacity in Germany" on page 196.
- There will be no additional investments on the Iron Rhine track between the Dutch border and Rheydt in the reference scenario (i.e. the track will stay in use for existing passenger service).
- None of the A52 variant will be build in the reference scenario.

The costs above are not included in the investment costs in the table below.

L.3.2. Investment costs historical Iron Rhine

The cost estimate for non-electrified alternatives in Germany are only included for comparison reasons in the SCBA, as DB Netz states that the German Federal Government will not order to build a non-electrified line.

These costs include for the "Historical Iron Rhine":

- upgrading to a two-track line of high capacity = about 100 million €
- electrification of the two-track line = about 30 million €
- planning and administration costs = about 20 million €

For the historical Iron Rhine, the costs are (rounded) 150 million €.

The source for these figures is "*Gemeinsame Kostenschätzung und Risikobeschreibung von IVV und DB Netz AG für die „A52-Variante" und die „Historische Trasse" des „Eisernen Rheins" auf deutschem Territorium vom 05.08.2008*", made in agreement between DB Netz and the Transport Ministry of Nord-Rhein-Westfalen at August 5th, 2008.

DB Netz has informed us that no costs have been spend up to now.

L.3.3. Investment costs electrified historical Iron Rhine

Additional to the costs above, the costs for electrification of the historical line in Germany takes following into account:

- Electrification in the current system 15 kV 16.7 Hz AC of the 2-track-line from Rheydt Gbf (exclusive because this station is already electrified) to Dalheim in the final situation.
- Electrification of the 1-track-line from Dalheim to the Dutch-German border.
- Additional sub station for the electric supply is not necessary as the next existing sub station is situated in Wickrath at about 3 km south of Rheydt Gbf. An electric supply in the current system 15 kV 16.7 Hz AC is not necessary as the next existing sub station is situated in Wickrath at about 3 km south of Rheydt Gbf.
- In the neighbourhood of the border an arrangement (neutral zone)is foreseen to handle with the tension differences between countries (NL/DE); the investment costs for this neutral zone are (in this study) incorporated in the costs on Dutch territory..

The costs are estimated at 30 million €.

L.3.4. Investment costs Iron Rhine via A52

These costs include for the "A52-variant of Iron Rhine" (according to the estimations of IVV):

- A new two-track line of high capacity = about 380 million € (without a level-free connection to the line Mönchengladbach-Viersen).
- Electrification of the two-track-line = about 25 million € (without a high tension supply of the substation; this is one of the risks).
- Planning and administration costs = about 75 million €.

For the electrified Iron Rhine via A52, the costs are (rounded) 480 million € with great uncertainty. According to DB Netz, the investments could go up to 900 million €. The non-electrified version would cost around 455 million €. According to DB Netz, there is a high risk for further investments according to a new high voltage feeder line for the power supply of the substation needed at the new line (costs > 10 million €).

L.3.5. Distribution of the investment costs of the years

For Germany, the distribution of the investment costs of the years was not given. As suggested by the steering committee, we used the following division:

- year -4: 10%
- year -3: 20%
- year -2: 30%
- year -1: 30%
- year 0: 10%

L.3.6. Summary of costs per scenario

The table below gives an overview of the investment costs in Germany. The accuracy of the cost estimation is unknown.

Table 198: Investments costs additional to the reference scenario in Germany – Iron Rhine operational in 2015, in million euro$_{2005}$ for 2 discount rates

	2011	2012	2013	2014	2015	Total	NPV in 2007 (4%)	NPV in 2007 (2.5%)
Historical Iron Rhine	12.00	24.00	36.00	36.00	12.00	120.00	94.56	103.26
Electrified historical Iron Rhine	15.00	30.00	45.00	45.00	15.00	150.00	118.20	129.08
Iron Rhine via A52	45.50	91.00	136.50	136.50	45.50	455.00	358.54	391.53
Electrified Iron Rhine via A52	48.00	96.00	144.00	144.00	48.00	480.00	378.24	413.04

Table 199: Investments costs additional to the reference scenario in Germany – Iron Rhine operational in 2020. in million euro$_{2005}$ for 2 discount rates

	2016	2017	2018	2019	2020	Total	NPV in 2007 (4%)	NPV in 2007 (2.5%)
Historical Iron Rhine	12.00	24.00	36.00	36.00	12.00	120.00	77.72	91.27
Electrified historical Iron Rhine	15.00	30.00	45.00	45.00	15.00	150.00	97.15	114.08
Iron Rhine via A52	45.50	91.00	136.50	136.50	45.50	455.00	294.70	346.06
Electrified Iron Rhine via A52	48.00	96.00	144.00	144.00	48.00	480.00	310.89	365.07

Annex M: Calculation of rail-road crossing time losses

M.1. General

M.1.1. The Netherlands

The reason for this approach is, that for the Netherlands, for 72 trains, detailed information was available from SO I[93]. For the other situations, we have made our own calculation, following a similar approach, but for different train numbers.

The table below shows the calculation for 72 trains on the historical variant in The Netherlands. Input on number of cars, trains and type of crossing was available from SO I. The activity figures (road and rail passings) are allocated to different periods of day: daytime (12h), evening (4h) and night (8h). This further desaggregation is needed to take into account the relatively high rail activity at night compared to a low road activity, thus avoiding most car-train passings and consequent time loss (and accidents).

Below a calculation example for "Fabriekstraat" (on tracé A), "daytime" is given:

1. *Road traffic intensity: 98 passings per hour (= 1.63 passings/minute)*
2. *Waiting time per train passing: 1 min/passing*
3. *Trains passings: reference scenario: average of 1.6, historical Iron Rhine – 2A: 42.2 trains per daytime period.*
4. *The additional closing time due to increased rail activity is consequently: (42.2-1.6) * 1 = 40.5 min/daytime*
5. *This additional closing time affects more road users, namely: 1.63 * 40.5 = 66.15 minutes additional time loss per 12h daytime period (or 402.6 hours per year) due to increased rail activity due to the project.*

A calculation example for "Roermondseweg" (on tracé B), "daytime" (a mitigated spot):

1. *Road traffic intensity: 21052 passings per day (= 23.39 passings/minute)*
2. *Waiting time per train passing: 1.3 min/passing*
3. *Trains passings: reference scenario: average of 116.0 trains per daytime period.*
4. *The spared closing time due to the mitigation is consequently: 1.3 * 116.0 = 155.4 min/daytime*
5. *This spared closing time due to the mitigation affects road users, namely: 23.39 * 155.4 = 3634.81 minutes spared time loss per 12h daytime period (or 21454.9 hours per year) due to increased rail activity due to the project.*

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[93] SO I stands for "Studie Opdracht I" and discusses the effects of the reactivation of the Iron Rhine following the trajectory for the Dutch part of the line. B.C.J. Weijers et. al. (2008): "IJzeren Rijn: Actualisering 2007 Eindrapportage studieopdracht I Actualisatie ontwerp tracévariant A3 BIJLAGE H: Trillingsonderzoek" (reference: TCE5-27-I-L11-043r).

Table 200: Calculation of time losses at road-rail crossings

Road	Number of cars per day in 2030	Closing time per train passage (min)	Passengers trains per day	Freight trains per day (ref.)	Freight trains per day (project)	Crossing type (reference scenario)	Crossing type (project)	Train passings/day DAY (difference)	Train passings/day EVE (difference)	Train passings/day NIGHT (difference)	Car passings/min DAY	Car passings/day EVE	Car passings/day NIGHT	Time losses for cars (hours/year) DAY	Time losses for cars (hours/year) EVE	Time losses for cars (hours/year) NIGHT
Tracé part A																
Stationsweg	7148	1	0	3	77	HAVIO	AHOB	40.52	14.81	18.67	7.94	4.47	0.74	1957.6	402.5	84.6
Weg Budel - Groot	0	0	0	3	77	closed	closed	0	0	0	0	0	0	0	0	0
1e heuvelweg	286	1	0	3	77	St. An-drew's cross	St. An-drew's cross	40.52	14.81	18.67	0.32	0.18	0.03	78.3	16.1	3.4
Fabriekstraat	1470	1	0	3	77	AHOB	AHOB	40.52	14.81	18.67	1.63	0.92	0.15	402.6	82.8	17.4
Landweg	113	1	0	3	77	St. An-drew's cross	St. An-drew's cross	40.52	14.81	18.67	0.13	0.07	0.01	31.0	6.4	1.3
Trancheeweg	1211	1	0	3	77	AHOB	AHOB	40.52	14.81	18.67	1.35	0.76	0.13	331.7	68.2	14.3
Singelvenweg	0	0	0	3	77	closed	closed	0	0	0	0	0	0	0	0	0
Tracé part B																
Koekoeksweg	0	0	144	39	111	closed	closed	0	0	0	0	0	0	0	0	0
Breybaan	1127	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	1.25	0.70	0.12	390.4	80.3	16.9
Koekoeksweg	0	0	144	39	111	closed	closed	0	0	0	0	0	0	0	0	0
Roermond-seweg	21052	1.3	144	39	111	AHOB	Separated	-115.98	-40.72	-26.30	23.39	13.16	2.19	-21454.9	-4237.1	-456.1
Schoordijk	282	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	0.31	0.18	0.03	97.7	20.1	4.2
Kelperweg	3632	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	4.04	2.27	0.38	1258.1	258.7	54.4
Oudenhofweg	127	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	0.14	0.08	0.01	44.0	9.1	1.9
Beemder-hoekweg	116	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	0.13	0.07	0.01	40.2	8.3	1.7
Weyerveld-seweg	0	0	144	39	111	closed	closed	0	0	0	0	0	0	0	0	0
Stapperstraat	3632	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	4.04	2.27	0.38	1258.1	258.7	54.4
Schoorstraat	1127	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	1.25	0.70	0.12	390.4	80.3	16.9
Stationstraat	8044	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	8.94	5.03	0.84	2786.5	572.9	120.4
Stekstr. Duykstr.	124	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	0.14	0.08	0.01	43.0	8.8	1.9
Heyhuyserweg	14441	1.3	144	39	111	AHOB	Separated	-115.98	-40.72	-26.30	16.05	9.03	1.50	-14717.4	-2906.5	-312.9
Houterweg	0	0	144	39	111	Sepa-rated	Separated	0	0	0	0	0	0	0	0	0
Spiekerweg	0	0	144	39	111	closed	closed	0	0	0	0	0	0	0	0	0
Napoleonsweg	8116	1.3	144	39	111	AHOB	AHOB	39.42	14.41	18.17	9.02	5.07	0.85	2811.4	578.1	121.5
Hornerweg	0	0	144	39	111	closed	closed	0	0	0	0	0	0	0	0	0
Roermond-seweg	7264	1.3	144	39	111	AHOB	Separated	-115.98	-40.72	-26.30	8.07	4.54	0.76	-7403.0	-1462.0	-157.4
Berikstraat	0	0	144	39	111	closed	closed	0	0	0	0	0	0	0	0	0
Tracé part C																
Loijweg	1500	1	0	0	72	None	AHOB	39.42	14.41	18.17	1.67	0.94	0.16	399.70	82.18	17.27
Raaijstraat	1500	1	0	0	72	None	AHOB	39.42	14.41	18.17	1.67	0.94	0.16	399.70	82.18	17.27
Beekweg	1500	1	0	0	72	None	AHOB	39.42	14.41	18.17	1.67	0.94	0.16	399.70	82.18	17.27
melicker-bosweg	1500	1	0	0	72	None	AHOB	39.42	14.41	18.17	1.67	0.94	0.16	399.70	82.18	17.27

Road	Number of cars per day in 2030	Closing time per train passage (min)	Passengers trains per day	Freight trains per day (ref.)	Freight trains per day (project)	Crossing type (reference scenario)	Crossing type (project)	Train passings/day DAY (difference)	Train passings/day EVE (difference)	Train passings/day NIGHT (difference)	Car passings/min DAY	Car passings/day EVE	Car passings/day NIGHT	Time losses for cars (hours/year) DAY	Time losses for cars (hours/year) EVE	Time losses for cars (hours/year) NIGHT
Tracé part D																
Asenrayerweg	357	1	0	0	72	None	Separated	0	0	0	0	0	0	0	0	0
Melickerven-weg	56	1	0	0	72	None	Separated	0	0	0	0	0	0	0	0	0
Meinweg	182	1	0	0	72	None	Separated	0	0	0	0	0	0	0	0	0
onbev. over-weg	56	1	0	0	72	None	Separated	0	0	0	0	0	0	0	0	0
onbev. over-weg	56	1	0	0	72	None	Separated	0	0	0	0	0	0	0	0	0
Stationsweg	357	1	0	0	72	None	Separated	0	0	0	0	0	0	0	0	0
Total car hours lost														26073	1787	751
Total passenger hours lost														37103	2543	1069
Value of time (€/hour)														4.265	6.398	2.133
Total cost per year (€)														-230687		

As shown in the table above, the Netherlands have a benefit of 230 687 euro per year. The fact that there is a benefit, is due to the mitigation measures (change into separated infrastructure). Without mitigation measures, there would be a loss of 176 812 euro per year, thus the mitigation value is 407 499 euro per year.

From this table (and a similar one for the case without mitigation), the marginal cost of time losses per rail tonne-km in The Netherlands are calculated, taking into account 15 rail-road crossings for 44.7 km of rail track with 580 million tonne-km. The result was 0.000397 €/million tonne-km (benefit) for a mitigated case, and -0.000304 (cost) for a non-mitigated case.

The same calculation has been made for every variant, with different train numbers in each variant.

M.1.2. Belgium and Germany

For the Belgium and Germany, the tonne-km multiplied with the marginal cost of time losses per rail tonne-km gave the monetary effect on the time losses at road-rail crossings, taking into account the real number of crossings per km of rail track.

Table 201: Calculation scheme for time losses at road-rail crossings

			Number of crossings / km rail track	Valuation
Historical Iron Rhine	Iron Rhine	BE	0.7614	Without mitigation
		NL	0.3350	With mitigation
		DE	0.3350	Without mitigation
	Montzen route	BE	0.8987	Without mitigation
		DE	0.3350	Without mitigation
Iron Rhine via A52	Iron Rhine	BE	0.7614	Without mitigation
		NL	0.3350	With mitigation
		DE	0	Not relevant
	Montzen route	BE	0.8987	Without mitigation
		DE	0.3350	Without mitigation

M.2. Overview per section

The table below gives and overview per section. The benefits in section A2 and B are larger, as this is the place where the mitigation measures are taken.

Table 202: Time losses at road-rail crossings, per section, €/year

Section	**additional time loss cars (h/year) DAY**	**additional time loss cars (h/year) EVE**	**additional time loss cars (h/year) NIGHT**	**Total**	**Ratio (A2 + B)/Total**
A	12 774	3 940	276	16 989	
A2	-124 813	-36 946	-1302	-163 061	**110,41%**
B	-91 924	-26 755	-549	-119 227	
C	7 230	2 230	156	9 617	
D	0	0	0	0	
TOTAL	-196 732	-57 531	-1 419	-255 682	

Note: for accidents, the same proportion can be used, as the calculation is similar

Annex N: Estimating road travel times with speed flow functions

The effects on congestion are calculated by estimating the effect of a reduction of the truck volumes on the average speeds on the motorways in the study area.

For this, speed-flow functions have been used for each of the relevant motorways. The parameters of these speed-flow functions have been estimated based on data of the Belgian motorways in the study area.

All measurements are gathered by single-loop inductive detectors embedded in the concrete of the Belgian motorway road network and sent to a central database called START/SITTER. Each minute, these detectors measure the number of passenger cars and trucks, as well as the average speed of all these vehicles. Note that the employed detectors are known for the fact that they may have a relatively large measurement error. This should be taken into account when considering and using this data.

For our study, we aggregated the measurements into hourly intervals, this for all the sections in the road network at hand:

- E313 between ringway Antwerp and interchange in Ranst.
- E313 between interchange Ranst and interchange Lummen.
- E34 between interchange Ranst and Dutch border.
- E314 between interchange Lummen and Dutch border.

The measurements are reported as vehicles per hour. We then multiplied them with the lengths of the sections, so that we obtained vehicle-kilometres. These results were then furthermore aggregated into daily volumes.

In order to estimate the travel times, we consider the hourly average speed of all vehicles on a section, in function of the number of vehicles driving[94] there. Inverting the average speed and multiplying it with the length of the section, gives us the average travel time over that section. We then fit a curve to the collected measurements, giving a functional relation between the total daily transport volume and the average travel time on the motorway:

$$T = T_{\text{ff}} \left(1 + \alpha \left(\frac{q}{q_{\max}} \right)^{\beta} \right)$$

In this relation, T_{ff} corresponds to the travel time under free-flow conditions, $q_{\max}$ to the maximum observed daily volume, and α and β are parameters that influence the shape of the function.

For the fitting of the curves, we used the following methodology:

[94] As is common in this literature we assume that one truck-km equals 2 vehicle km.

- T_{ff} is derived by taking the median of all the travel times under free-flow conditions. The latter are all traffic volumes that fall within 15% of the maximum observed daily traffic volume. This provides a good enough estimation of the free-flow travel time.

- $q_{\max}$ is always taken to be the maximum observed daily volume.

- α and β are jointly estimated by means of a non-linear optimisation in MATLAB.

Note that the travel time T corresponds to the travel time on a complete motorway for both driving directions.

For 4 motorways, we give the BPR[95] curves depicting the relation between the total daily volume and the average travel time. The curves itself can be found in the pictures below.

Table 203: Parameters for speed-flow functions

Road segment	Tff (minutes)	qMax (vehicle-km)	alpha	beta
E313 between ringway Antwerp and interchange in Ranst	12.5146	1812800	0.154350	2.4730
E313 between interchange Ranst and interchange Lummen	56.6199	4169500	0.088675	3.9366
E34 between interchange Ranst and Dutch border	58.2865	3363700	0.084305	2.0630
E314 between interchange Lummen and Dutch border	47.6315	1932000	0.062701	2.2695

For other motorways we have estimated the parameters as follows:

- (q/qMax) = 90% in the year 2005, assuming that on average, 90% of the capacity is taken in 2005.
- alpha = 0.2 (on the high side, to avoid underestimation) .
- beta = 4 (on the high side, to avoid underestimation) .

[95] BPR stands for the Bureau of Public Roads, that proposed the functional relationship that is used here.

Figure 30: E314 between interchange Lummen and Dutch border

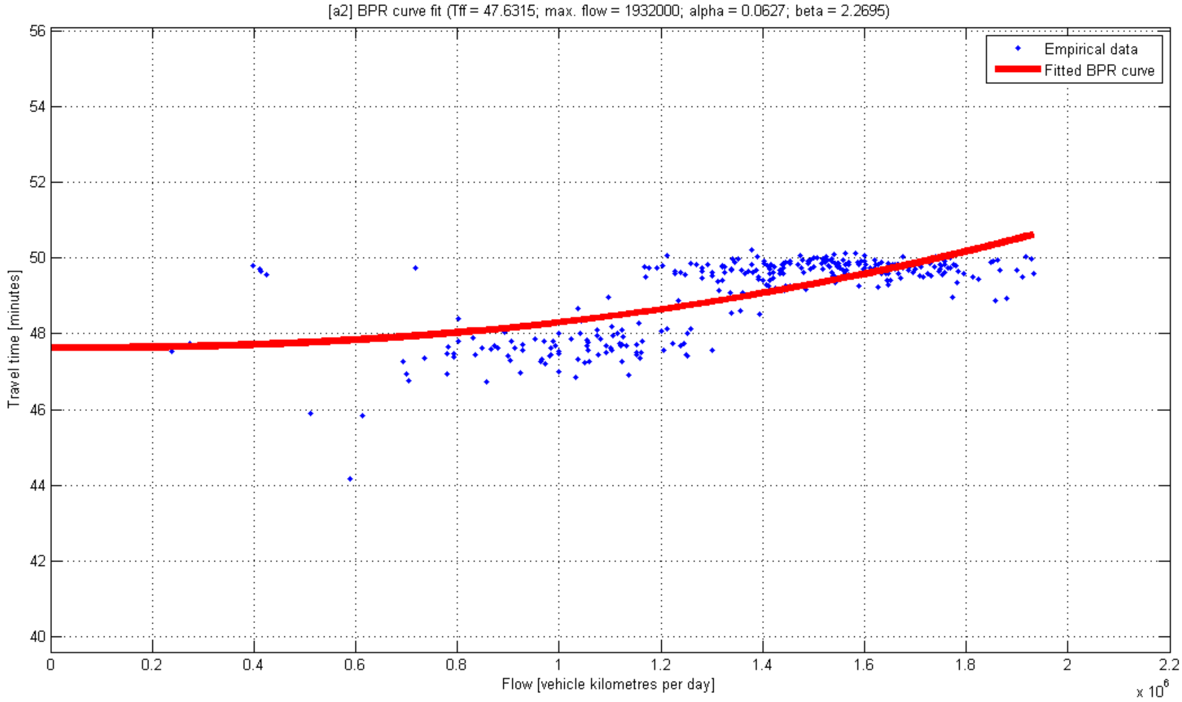


Figure 31: E313 between interchange Ranst and interchange Lummen

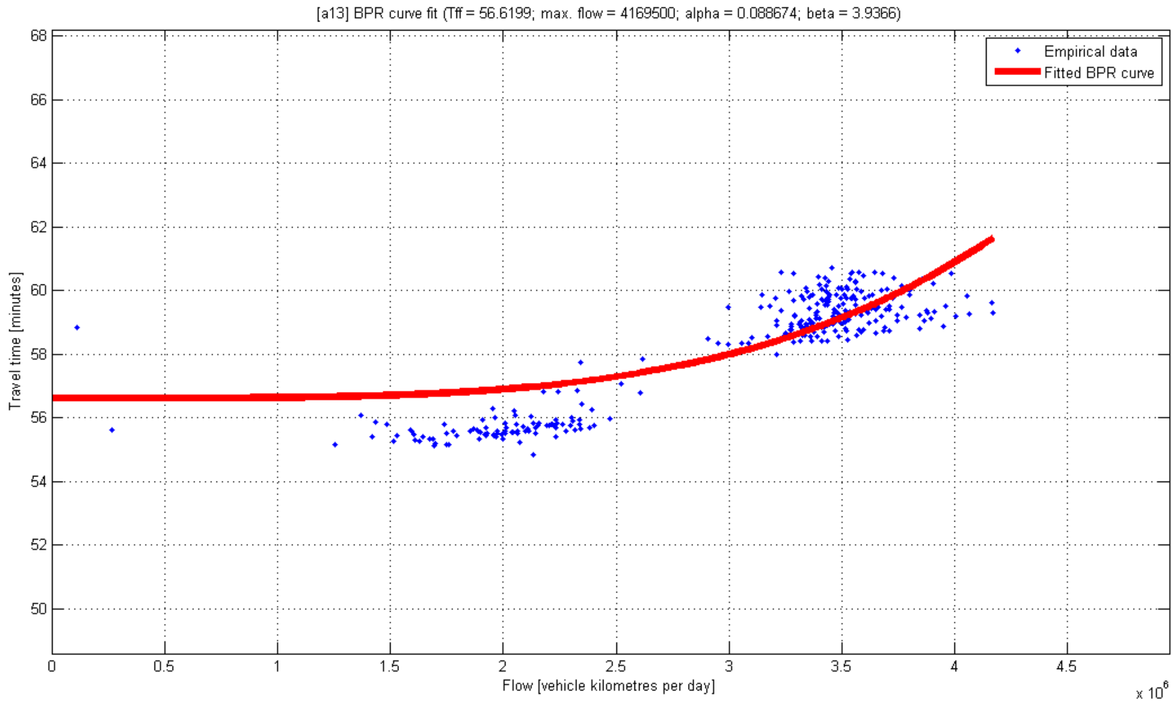


Figure 32: E313 between ringway Antwerp and interchange in Ranst

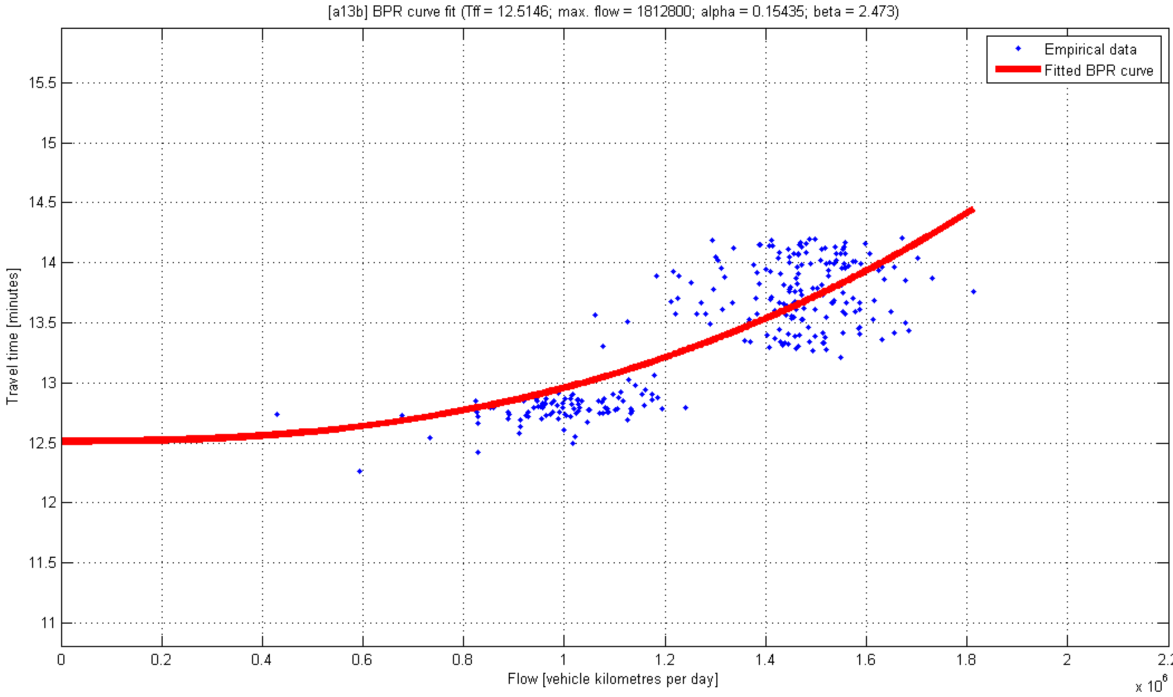
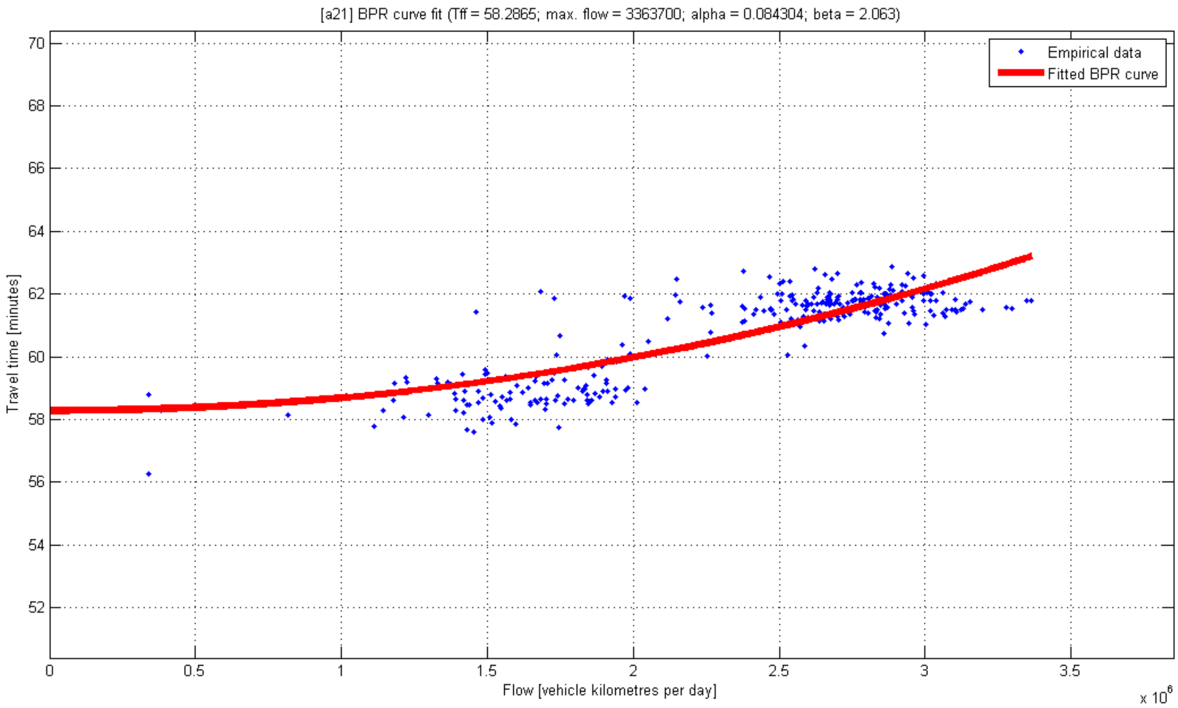


Figure 33: E34 between interchange Ranst and Dutch border



Annex O: Marginal cost of public funds

This annex describes why and how to use a marginal cost of public funds for government transport investments[96].

O.1. What is the marginal cost of public funds and why does it matter?

When a project is funded with public money this implies that ceteris paribus taxes need to be increased (or other public expenses decreased). Almost all taxes are distortive: they create a wedge between the social marginal cost and the price. Increasing a distortion has an efficiency cost. The reason is that this prevents even more market transactions that are beneficial for society as a whole. The "marginal cost of public funds" ("MCPF") takes this into account by multiplying the net call on public funds by a factor that is in general larger than one.

When an investment project requires public money, the implication is that the cost of the project is increased and this makes this project less likely too succeed. On the other hand if the project increases public revenues the project receives a bonus.

The MCPF will depend on the type of taxes that is increased to finance the project. In principle one can use many different taxes to fund a project and each type of tax will have its own MCPF attached to it. As taxes on labour (income, social security contributions and indirect taxes on labour income owners) constitute the bulk of the tax revenues and are therefore in general the type of taxes that need to be increased we will work under the assumption that the project is financed by labour taxes. We will more specifically assume it is financed by a change in the proportional labour tax. It is clear that the value of the MCPF is also an important element in the pricing of transport projects and in the use of the revenues of transport projects[97].

The MCPF is easily confused with the discount rate for public investments. The discount rate specifies the future benefits to be earned by a public investment in order to compensate the use of resources for investments now. The trade off that is made is between resources used in the current year and resources in future years. An important factor in the determination of the public discount rate is therefore the interest rate on the capital market as this is the opportunity cost used by private agents to choose between resources now and in the future. The MCPF is an opportunity cost that exists in every year that taxes need to be levied for a public project. So when the project if funded by loans the tax increase can be deferred

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[96] We thank G. Blauwens & T. van Hoek for clarifying discussions. They do not necessarily agree with the approach suggested here.

[97] See De Palma A., Lindsey R., Proost S. (Eds.), Investment and the use of tax and toll revenues in the transport sector, Elsevier Science, 2007 – where the MCPF approach is used to assess the net benefits and optimal pricing of investment projects in several EU countries.

but sooner or later a tax increase will be required. In this note we concentrate therefore on the MCPF in one given year.

In this note we discuss first briefly what guidance the OEI and RAILPAG give us in the determination of the MCPF. Next we give a simple graphical illustration for the concept of MCPF. We conclude with a suggestion for the MCPF to be used in this study.

O.2. How do the OEI and RAILPAG deal with this problem?

The OEI guidelines[98] ask to check the type of taxes used to finance the project and to analyse whether these taxes lead to additional efficiency effects. It is considered as a complex matter but CPB and SEO have in the past already integrated efficiency effects of labour taxes into Cost Benefit Analysis. The MCPF value used was 1.25.

RAILPAG mentions the problem as important but too complex for their general guide. They recommend continuing to study it and to harmonize the use of the MCPF within the European Union.

So they see the problem as important, ask to integrate it, but do not suggest a specific value.

O.3. A simple graphical illustration

In this section we use a simple graphical illustration. Many simplifying assumptions are needed to explain the issue in a simple way. A more elaborate algebraic model that is more complete and uses much les assumptions and relates this issues to the academic literature on this topic can be found in Kleven and Kreiner (2006)[99], Proost (2007) and in Calthrop, De Borger, Proost (2008)[100].

1. We use the following assumptions:

A.1 only one type of labour (a standard hour by a standard employee)

A.2 supply of labour reacts positively to the after tax wage

A. 3 the only tax available is a proportional labour tax

A.4 well functioning labour market in equilibrium

[98] Ministerie van Verkeer en Waterstaat en Ministerie van Economische Zaken Nederland (2004),"Indirecte effecten infrastructuurprojecten – aanvullingen op de Leidraad OEI", p33 en 34

[99] Kleven H., C. Kreiner (2006), The marginal cost of public funds: hours of work versus labour force participation, *Journal of Public Economics*, 90, p 1955-1973

[100] Proost, S. (2007). L'analyse des projets d'infrastructure de transport dans un cadre d'équilibre général. In: Maurice J., Crozet Y. (Eds.), *Le calcul économique dans le processus de choix collectif des investissements de transport* (pp. 340-360). Paris: Economica.

A.5 domestic producers that have no market power on the international market (small open economy assumption)

A.6 domestic producers use only one input: home labour that has a fixed productivity

A.7 the transport investment does not affect the production process at home, nor does it deliver any services to the households

A.8 we use a one period model where the cost of the investment has to be paid in the period that it is used

2. We can now turn to Figure 34 to analyze the effects on the labour market of this investment. Initially a quantity *Wo* of labour is used. This is the result of the demand for labour from home producers that are faced with a perfectly elastic demand for their products, they have constant returns to scale and their cost is the gross wage. The supply of labour by households also reacts to prices but much less. There is an initial labour tax *t* that creates a wedge between the gross wage paid by employers and the net wage received by households.

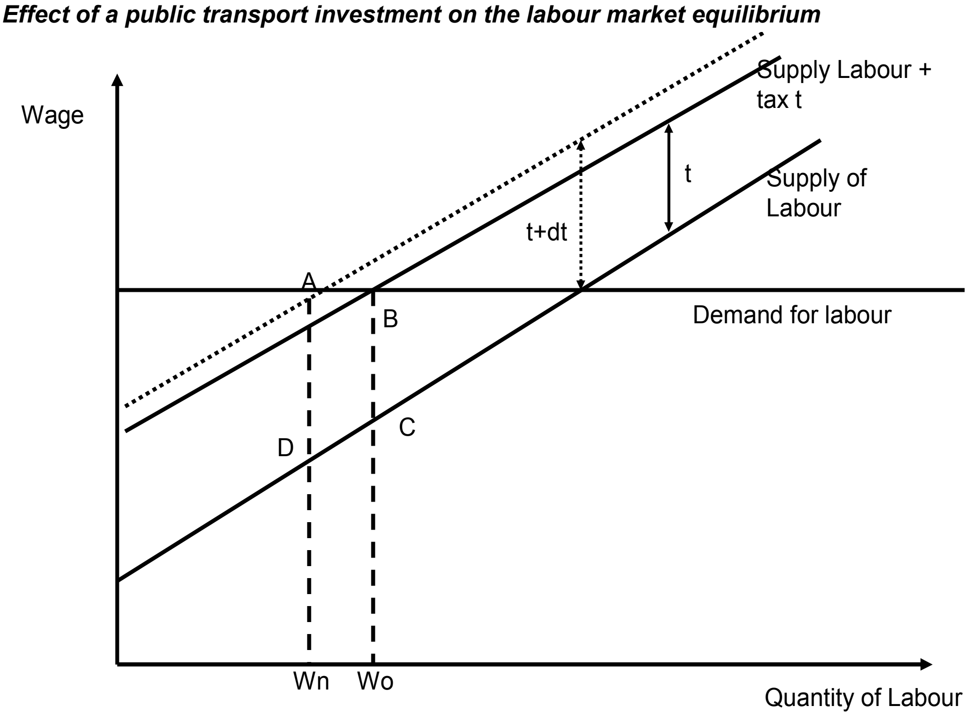
3. The next step is to introduce the transport investment paid by public funds. This requires two changes in the initial equilibrium. First there is the extra demand for labour to produce the transport investment. Second there is the need to increase the tax on labour in order to pay for the investment.

We examine the effects in two steps. Let us first introduce the effect on the demand for labour. Given our assumptions there is no effect on the demand function for labour. The extra labour demanded raises the gross wage but an increase in the gross wage is impossible because this would make home producers lose their markets. The only possible equilibrium is that the extra labour needed is taken away from the initial home production. The result of the first step is that the supply and demand of labour does not change.

The second step is to introduce an increase in the tax on labour that is necessary to pay for the transport investment. This means that the supply of labour curve shifts upwards by *dt*. The total effect is a reduction in labour supply equal to *Wn-Wo*.

The full cost of this public investment is then equal to the nominal cost I plus the extra deadweight loss created by the tax increase needed to pay for the investment. This equals area *ABCD*. If the ratio *ABCD/ I* can be taken as constant, one can work with a marginal cost of public funds parameter (>1) that gives the full efficiency cost per € of public subsidies needed.

Figure 34: Effect of a public transport investment on the labour market equilibrium



The conclusion in this very simple case is that the public investment decreases employment and this can be counted in welfare terms as an extra cost of public funds.

4. To use the simple graphical model many assumptions have been used. Some of them are worth discussing.

An important assumption we can relax is that there are no benefits of the transport investment (A7). Benefits are in principle measured on the benefit side in a cost benefit analysis but in our model we have to consider the interactions with the labour markets. How does this investment affect the labour and product market side?

First consider a direct transport benefit for the consumers. If these are leisure trips that become more attractive, then the labour supply curve shifts to the left as there is less interest to supply labour and this makes the transport investment even more expensive in welfare terms.

If it are commuting trips that become more attractive (time gains), this can be seen as a decrease in the wedge between the gross product of labour and the net wage because the commuting cost is part of that wedge. Now the labour supply curve shifts to the right and it could be that there is even an increase in the labour supply: if the reduction in commuting costs is larger than the extra tax on labour.

To model these two types of benefits correctly one needs to distinguish two categories of households: those that are directly affected by the transport investment (one particular region) and those that pay the extra labour tax (the whole country). As effects are not proportional, this may clearly matter.

Second consider an increase in productivity at home due to lower freight costs. This means that the production costs decrease and that the purchasing power of the net wage increases so that the net wage increases. In Figure 34 this could be represented by a smaller net tax increase and a lower downward effect on labour supply.
If the decrease in transport costs benefits mostly foreign producers or gives rise to higher rents for some shippers, this beneficial effect on labour supply disappears.

As regards the other assumptions, A1 can be relaxed easily, A2 is an empirical question to which we return later, A3 can be adapted and the same framework can be applied to any other tax (see algebraic models supra), A4 is a basic assumption used in almost all cost benefit frameworks, A5 is an empirical matter, A6 can be relaxed but it would need an algebraic model to work it out, A8 can be relaxed, this amounts to applying the same reasoning in each of the periods[101].

O.4. How to determine the marginal cost of public funds?

We need in fact values for 3 countries: Belgium, The Netherlands and Germany.

We rely mainly on results by Kleven & Kreiner (2006) who studied the MCPF for different types of labour taxes for 15 European countries using a model with disaggregate labour supply (hours worked and participation decisions). The MCPF they computed is for a public investment that has no effect at all on the economy (our assumption A7 above) so it is rather an upper bound. In the Iron Rhine project, the effect on commuting costs and on product prices is probably a second order effect so the correction downwards will be small.

We report in the table below the results for a proportional change in the labour tax[102].

We find in Kleven &Kreiner[103] (Table II, scenarios S5 and S6[104] - the full table has been added at the end of this annex) the following values for the MCPF:

[101] See Liu L., (2003), "A marginal cost of funds approach to multi-period public project evaluation: implications for the social discount rate", Journal of Public Economics, 87, p 1707-1718

[102] One can also consider a regressive labour tax change in which the tax rate for the poor are increased more. In that case, the MCPF tends to be somewhat lower. Another option is to increase the tax rates for the upper income deciles, then the MCPF tends to be higher. This illustrates that the way the project is financed matters.

[103] Kleven H., C.Kreiner (2006), The marginal cost of public funds: hours of work versus labour force participation, CEPR disc paper 5594 – a shorter version is published in Journal of Public Economics (supra) but the latter version does not show results for Belgium and the Netherlands.

[104] These scenarios have been selected because they combine the two types of labour supply responses: the number of hours of work per day ("intensive margin") and the participation decision in the labour force ("extensive margin"). Neglecting one of these would be incorrect.

Table 204: MCPF values for a proportional change in the labour tax

MCPF values	Scenario S5	Scenario S6
“hours of work” labour supply elasticity	0.0	0.1
“participation” in labour force elasticity	0.2	0.2
Belgium	**1.41**	**2.14**
Germany	**1.38**	**1.85**
Netherlands	**1.24**	**1.52**

The values of labour supply elasticities used in scenario S5 and S6 are plausible for Belgium and The Netherlands[105].

There are two reasons why these values are to be considered rather as an upper bound. First the direct beneficial effects of the transport investment on labour supply[106] are not taken into account. Second, the labour taxes have been decreased somewhat over the last years.

It is difficult to determine one precise value for the MCPF, the literature suggests it is clearly higher than 1.

Considering these elements we suggest to use, as a prudent working value for the cost benefit analysis, a value of 1.2 for the MCPF. This is a value for a proportional change in the labour tax. Sensitivity analysis is clearly needed, values of 1 (regressive labour tax reform[107]) and 1.4 (more progressive labour tax reform) are suggested.

[105] Orsini, K., (2006), “Is Belgium making work pay?” working Paper CES-K.U.Leuven, March 22 2006.

[106] On commuting time and price of consumer goods cfr. discussion of assumption A7 supra.

[107] One can check values for a more regressive labour tax reform or a more progressive labour tax reform using values per decile in lower half of Table III of Kleven and Kreiner (2006).

Table 205: Table II of Kleven and Kreiner for the MCPF value of a proportional change in the labour tax value (of which only scenarios S5 to S9 report complete results and of which we selected S5 and S6)

TABLE II
The marginal cost of public funds for proportional tax changes under different elasticity scenarios

	Standard Model				Intensive-Extensive Model				
Country	S1	S2	S3	S4	S5	S6	S7	S8	S9
Austria	1.00	0.90	1.18	1.04	1.25	1.56	1.37	1.27	1.88
Belgium	1.00	0.83	1.32	1.04	1.41	2.14	1.74	1.50	3.23
Denmark	1.00	0.85	1.29	1.05	1.48	2.22	1.94	1.55	3.59
Finland	1.00	0.86	1.31	1.08	1.46	2.23	1.94	1.56	3.55
France	1.00	0.88	1.21	1.04	1.32	1.72	1.57	1.37	2.20
Germany	1.00	0.90	1.23	1.08	1.38	1.85	1.55	1.37	2.55
Greece	1.00	0.92	1.11	1.01	1.12	1.26	1.19	1.15	1.36
Ireland	1.00	0.89	1.16	1.01	1.21	1.45	1.32	1.23	1.68
Italy	1.00	0.89	1.19	1.04	1.22	1.52	1.40	1.29	1.79
Luxembourg	1.00	0.89	1.14	1.00	1.14	1.32	1.24	1.19	1.46
Netherlands	1.00	0.90	1.18	1.04	1.24	1.52	1.37	1.27	1.81
Portugal	1.00	0.88	1.15	0.99	1.15	1.36	1.29	1.21	1.50
Spain	1.00	0.94	1.07	1.00	1.10	1.19	1.14	1.11	1.27
Sweden	1.00	0.86	1.28	1.06	1.43	2.08	1.92	1.53	3.11
United Kingdom	1.00	0.93	1.10	1.02	1.13	1.26	1.18	1.14	1.36

Note: Table I displays the labor supply elasticities used in each scenario. These elasticities combined with the wage shares and tax rates in Table A1 are inserted into eq. (16) in order to calculate the marginal cost of public funds.

Table 206: Table III of Kleven and Kreiner (2006) for the MCPF value of a proportional change in the labour tax value for each of the deciles

TABLE III
The marginal cost of public funds for an increase in the marginal tax rate in bracket k

Country	Bracket/decile where the marginal tax is increased (k)									
	1	2	3	4	5	6	7	8	9	10
					Standard Model (S3)					
Austria	0.87	0.92	1.00	1.23	1.60	1.68	1.92	7.33	13.87	L
Belgium	0.82	0.89	1.01	1.24	1.84	2.13	5.80	L	L	L
Denmark	0.84	0.96	1.19	2.08	2.24	4.00	L	L	L	L
Finland	0.84	1.17	1.50	2.03	6.18	4.03	7.58	L	L	L
France	0.86	1.05	1.19	1.36	1.51	1.69	1.98	1.99	2.36	14.69
Germany	0.85	0.93	1.04	1.32	2.27	2.52	8.98	14.82	L	14.94
Greece	0.92	0.94	1.04	1.16	1.23	1.43	1.51	2.11	2.29	1.59
Ireland	0.89	0.92	0.99	1.15	1.27	1.24	1.80	1.70	3.11	5.65
Italy	0.88	0.94	1.14	1.39	1.87	2.09	2.69	4.15	4.77	L
Luxembourg	0.91	1.00	1.04	1.08	1.17	1.13	1.61	1.66	1.94	3.28
Netherlands	0.88	0.92	1.00	1.12	1.43	1.77	3.51	3.95	7.09	24.65
Portugal	0.91	0.95	1.17	1.18	1.26	1.26	1.40	1.50	1.38	2.46
Spain	0.95	0.98	1.01	1.08	1.11	1.12	1.16	1.23	1.32	1.99
Sweden	0.85	1.33	1.72	2.15	2.55	L	L	L	L	L
United Kingdom	0.92	0.95	1.00	1.09	1.14	1.21	1.28	1.47	1.52	2.68
					Intensive-Extensive Model (S6)					
Austria	1.16	1.22	1.31	1.61	2.13	2.07	2.24	9.52	13.87	L
Belgium	1.27	1.35	1.50	1.86	2.99	3.19	13.68	L	L	L
Denmark	1.34	1.51	1.92	4.50	4.10	9.91	L	L	L	L
Finland	1.29	2.00	2.82	4.31	L	10.29	28.68	L	L	L
France	1.29	1.59	1.71	1.89	2.01	2.12	2.34	2.14	2.36	14.69
Germany	1.26	1.37	1.51	1.98	4.13	3.97	59.07	37.30	L	14.94
Greece	1.08	1.10	1.20	1.34	1.38	1.59	1.63	2.22	2.29	1.59
Ireland	1.18	1.18	1.25	1.43	1.53	1.42	2.04	1.79	3.11	5.65
Italy	1.13	1.19	1.46	1.80	2.48	2.62	3.27	4.65	4.77	L
Luxembourg	1.10	1.21	1.23	1.26	1.33	1.24	1.76	1.72	1.94	3.28
Netherlands	1.17	1.20	1.28	1.40	1.79	2.15	4.59	4.49	7.09	24.65
Portugal	1.14	1.18	1.46	1.41	1.46	1.40	1.51	1.55	1.38	2.46
Spain	1.10	1.12	1.14	1.20	1.22	1.19	1.21	1.25	1.32	1.99
Sweden	1.28	2.32	3.24	4.19	4.88	L	L	L	L	L
United Kingdom	1.10	1.13	1.17	1.24	1.26	1.31	1.34	1.51	1.52	2.68

Note: The numbers are computed from eq. (17) using the wage shares and tax rates in Table A1 as well as labor supply elasticities. We use elasticity scenario S3 for the standard model and scenario S6 for the intensive-extensive model. In these two scenarios, the uncompensated hours-of-work elasticity equals 0.1. The calculations also depend on the compensated hours-of-work elasticity which is set equal to 0.2. An "L" indicates that the tax rate is above the Laffer curve maximum.

Annex P: Dangerous goods

P.1. Methodology

In the analysis for dangerous goods on rail, we make use of the "*Basisbestanden goederenvervoer 2004*"[108]. Transporting dangerous goods usually means transporting chemical products. But from the "*Basisbestanden goederenvervoer 2004*" it is concluded that 51% of the chemical products do not contain dangerous goods. That's why it is not possible to split the chemical products up further into different categories given the "*Basisbestanden goederenvervoer 2004*". To do so, the vehicle fleet in The Netherlands is analyzed. The division of the trucks in The Netherlands for the year 2005 is shown in the table below. Another estimation (vehicle kilometres and forecast VGS – actualization of 2003[109]) gives a similar picture.

Table 207: Number of train wagons in 2005, by category of dangerous goods

Category of dangerous good	Type	Goods	Wagon
A	inflammable gasses	LPG, LNG, propylene, butadiene, ethylene oxide, etc.	37%
B2	toxic gasses	Ammonia, etc.	13%
B3	very toxic gasses	Chlorine (only)	2%
C3	very inflammable fluids	Petrol, fuel, natural gas condensate, etc.	38%
D3	toxic fluids	Acrylic resin nitrile (only)	5%
D4	very toxic fluids	Fluorine hydrogen, bromide, etc.	4%
TOTAL			**100%**

P.2. Results

For the links on the Iron Rhine the total number of trains is divided into dangerous good categories. The results are shown in the following tables. Again all results in these tables for the Iron Rhine are measured on the section between Budel and Weert and for the Montzen route the results are measured between Montzen and the German border.

[108] From Infrabel, information has been received on the current transport of dangerous goods via the Montzen route. These numbers seemed to be very high and furthermore, it was not possible to make a translation from the assignment of dangerous goods into different type categories as they are used in this Iron Rhine study. Therefore, it was decided not to use the Infrabel data on dangerous goods.
[109] Forecast of the transport of dangerous goods by rail, ProRail, December 2003

Table 208: Results section Neerpelt – Weert (number of trains), 2020

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
A – inflammable gasses	1.14	0.28	1.20	0.29	1.13	0.27	0.59	0.01	1.23	0.30	1.32	0.32	1.36	0.33
B2 – toxic gasses	0.40	0.10	0.42	0.10	0.40	0.10	0.21	0.00	0.43	0.11	0.46	0.11	0.48	0.12
B3 – very toxic gasses	0.06	0.02	0.06	0.02	0.06	0.01	0.03	0.00	0.07	0.02	0.07	0.02	0.07	0.02
C3 – very inflammable fluids	1.17	0.29	1.23	0.30	1.16	0.28	0.60	0.01	1.27	0.31	1.36	0.33	1.40	0.34
D3 – toxic fluids	0.15	0.04	0.16	0.04	0.15	0.04	0.08	0.00	0.17	0.04	0.18	0.04	0.18	0.04
D4 – very toxic fluids	0.12	0.03	0.13	0.03	0.12	0.03	0.06	0.00	0.13	0.03	0.14	0.03	0.15	0.04
Total dangerous goods	**3.05**	**0.74**	**3.21**	**0.77**	3.03	0.73	1.57	0.02	3.30	0.81	3.53	0.86	3.65	0.89

Table 209: Results section Neerpelt – Weert (number of trains), 2030

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
A – inflammable gasses	1.39	0.33	1.53	0.36	1.19	0.28	0.59	0.02	B-D	D-B	1.46	0.32	1.57	0.36
B2 – toxic gasses	0.49	0.12	0.54	0.13	0.42	0.10	0.21	0.01	1.57	0.36	0.51	0.11	0.55	0.13
B3 – very toxic gasses	0.08	0.02	0.08	0.02	0.06	0.02	0.03	0.00	0.55	0.13	0.08	0.02	0.08	0.02
C3 – very inflammable fluids	1.43	0.34	1.57	0.37	1.23	0.29	0.60	0.02	0.08	0.02	1.50	0.33	1.61	0.37
D3 – toxic fluids	0.19	0.04	0.21	0.05	0.16	0.04	0.08	0.00	1.61	0.37	0.20	0.04	0.21	0.05
D4 – very toxic fluids	0.15	0.04	0.16	0.04	0.13	0.03	0.06	0.00	0.21	0.05	0.16	0.03	0.17	0.04
Total dangerous goods	**3.72**	**0.89**	**4.08**	**0.96**	**3.19**	**0.75**	**1.57**	**0.06**	0.17	0.04	**3.90**	**0.86**	**4.20**	**0.95**

Table 210: Results section in Weert – Roermond (number of trains), 2020

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
A – inflammable gasses	0	0	0	0	1.13	0.51	0.58	0.25	1.23	0.54	1.35	0.80	1.39	0.81
B2 – toxic gasses	0	0	0	0	0.40	0.18	0.20	0.09	0.43	0.19	0.47	0.28	0.49	0.28
B3 – very toxic gasses	0	0	0	0	0.06	0.03	0.03	0.01	0.07	0.03	0.07	0.04	0.08	0.04
C3 – very inflammable fluids	0	0	0	0	1.16	0.53	0.60	0.26	1.26	0.56	1.38	0.82	1.43	0.83
D3 – toxic fluids	0	0	0	0	0.15	0.07	0.08	0.03	0.17	0.07	0.18	0.11	0.19	0.11
D4 – very toxic fluids	0	0	0	0	0.12	0.06	0.06	0.03	0.13	0.06	0.15	0.09	0.15	0.09
Total dangerous goods	0	0	0	0	**3.02**	**1.37**	**1.56**	**0.67**	**3.29**	**1.46**	**3.60**	**2.13**	**3.72**	**2.16**

Table 211: Results section in Weert – Roermond (number of trains), 2030

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
A – inflammable gasses	0	0	0	0	1.19	0.57	0.59	0.33	1.56	0.66	1.49	0.91	1.60	0.95
B2 – toxic gasses	0	0	0	0	0.42	0.20	0.21	0.11	0.55	0.23	0.52	0.32	0.56	0.33
B3 – very toxic gasses	0	0	0	0	0.06	0.03	0.03	0.02	0.08	0.04	0.08	0.05	0.09	0.05
C3 – very inflammable fluids	0	0	0	0	1.22	0.59	0.60	0.33	1.60	0.68	1.53	0.94	1.65	0.97
D3 – toxic fluids	0	0	0	0	0.16	0.08	0.08	0.04	0.21	0.09	0.20	0.12	0.22	0.13
D4 – very toxic fluids	0	0	0	0	0.13	0.06	0.06	0.04	0.17	0.07	0.16	0.10	0.17	0.10
Total dangerous goods	0	0	0	0	**3.18**	**1.53**	**1.57**	**0.87**	**4.18**	**1.77**	**3.98**	**2.44**	**4.29**	**2.53**

Table 212: Results section in Germany (number of trains), 2020

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
A – inflammable gasses	0	0	0	0	1.13	0.32	0.66	0.11	1.23	0.36	1.34	0.63	1.39	0.64
B2 – toxic gasses	0	0	0	0	0.40	0.11	0.23	0.04	0.43	0.12	0.47	0.22	0.49	0.22
B3 – very toxic gasses	0	0	0	0	0.06	0.02	0.04	0.01	0.07	0.02	0.07	0.03	0.07	0.03
C3 – very inflammable fluids	0	0	0	0	1.16	0.33	0.68	0.11	1.26	0.36	1.38	0.64	1.42	0.65
D3 – toxic fluids	0	0	0	0	0.15	0.04	0.09	0.02	0.17	0.05	0.18	0.08	0.19	0.09
D4 – very toxic fluids	0	0	0	0	0.12	0.03	0.07	0.01	0.13	0.04	0.15	0.07	0.15	0.07
Total dangerous goods	0	0	0	0	**3.01**	**0.86**	**1.77**	**0.30**	**3.28**	**0.95**	**3.59**	**1.68**	**3.71**	**1.70**

Table 213: Results section in Germany (number of trains), 2030

	No IR 2A		No IR 2B		Historical IR 2A		Historical IR 2B		Electrified historical IR 2A		IR via A52 2A		Electrified IR via A52 2A	
	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B	B-D	D-B
A – inflammable gasses	0	0	0	0	1.19	0.34	0.58	0.09	1.56	0.43	1.49	0.70	1.60	0.74
B2 – toxic gasses	0	0	0	0	0.42	0.12	0.20	0.03	0.55	0.15	0.52	0.25	0.56	0.26
B3 – very toxic gasses	0	0	0	0	0.06	0.02	0.03	0.01	0.08	0.02	0.08	0.04	0.09	0.04
C3 – very inflammable fluids	0	0	0	0	1.22	0.35	0.59	0.10	1.60	0.44	1.53	0.72	1.64	0.76
D3 – toxic fluids	0	0	0	0	0.16	0.05	0.08	0.01	0.21	0.06	0.20	0.10	0.22	0.10
D4 – very toxic fluids	0	0	0	0	0.13	0.04	0.06	0.01	0.17	0.05	0.16	0.08	0.17	0.08
Total dangerous goods	0	0	0	0	**3.17**	**0.91**	**1.55**	**0.25**	**4.17**	**1.15**	**3.97**	**1.88**	**4.28**	**1.97**

As an example, we take a look at scenario "Historical Iron Rhine - 2A" for the year 2020. To start with we look at the direction from Belgium to Germany. On the section Neerpelt-Weert there will be 3.05 trains per day and on the section Weert-Roermond there will be 3.03 trains per day. On the section at the German border this will be 3.01 trains per day.

In the opposite direction, from Germany to Belgium, we see at the German border 0.86 trains per day. On the section Roermond-Weert this is 1.37 trains per day and between Weert and Neerpelt 0.73 trains per day.

Annex Q: Calculation of noise and recreation per section

Q.1. Noise

See also chapter III.3.2 on page 119.

Table 214: Noise damage in million $€_{2005}$/year, "Historical Iron Rhine – 2A", 2030, The Netherlands

Area		Noise level	Costs Reference	Costs Iron Rhine (no measures)	Costs Iron Rhine (measures)	Delta
A1	CR	<56	0	0	0	0
		56-58	261	493	493	232
		59-63	0	2 233	154	154
		64-68	0	3 250	250	250
		69-71	0	3 744	208	208
		>71	0	0	0	0
A2	WT	<56	0	0	0	0
		56-58	10 440	24 969	2 146	-8 294
		59-63	28 875	57 134	5 082	-23 793
		64-68	21 000	49 375	250	-20 750
		69-71	1 456	7 280	624	-832
		>71	1 408	2 816	1 408	0
B	NW	<56	0	0	0	0
		56-58	116	29	58	-58
		59-63	308	385	385	77
		64-68	250	625	0	-250
		69-71	624	0	0	-624
		>71	0	1 408	352	352
	LD	<56	0	0	0	0
		56-58	2 320	4 495	2 146	-174
		59-63	5 005	11 704	3 927	-1 078
		64-68	4 750	5 250	1 625	-3 125
		69-71	2 704	5 408	1 248	-1 456
		>71	2 816	8 448	2 464	-352
C	RM	<56	0	0	0	0
		56-58	928	1 334	870	-58
		59-63	2 387	2 772	2 387	0
		64-68	2 875	3 875	2 875	0
		69-71	1 248	1 248	1 248	0
		>71	0	0	0	0
D	RD	<56	0	0	0	0
		56-58	0	29	29	29
		59-63	0	231	77	77
		64-68	0	125	125	125
		69-71	0	0	0	0
		>71	0	0	0	0

The ration (A2 + B)/Total is 1.017139.

Q.2. Recreation – disturbance by noise

See also chapter III.3.4.1.c on page 126.

Table 215: Recreation disturbance, Netherlands, number of trips per ha per year

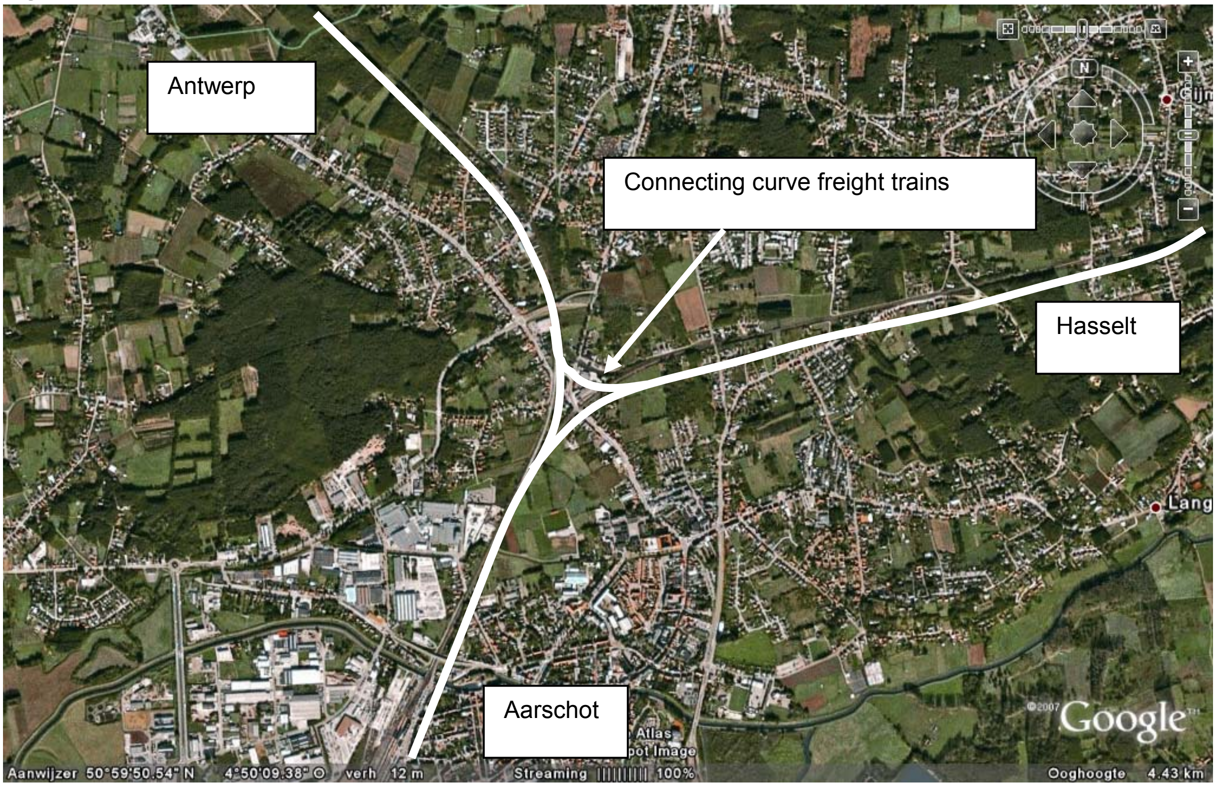
Community		Area	hiking				biking				TOTAL
			Agrarian country-side	Wet nature	Dry nature	Forests, parks	Agrarian country-side	Wet nature	Dry nature, forests	Parks	
Bergen	Weert	Boshoven buitengebied	11	93	187	280	23	19	38	58	
	Weert	Industrieterrein Boshoverheide	14	113	227	340	23	19	38	57	
	Cranendock	Verspreide huizen in het Oosten	9	78	157	235	24	19	38	58	
	Cranendock	Industrieterrein Dorplein	13	103	206	308	22	18	35	53	
Melicker-heide	Roermond		19	131	263	394	38	28	56	84	
	Roermond	Kitkensberg en omgeving	18	123	247	370	41	31	62	92	
Meinweg + Roerdal	Roerdalen	Verspreide huizen Herken-bosch	21	138	276	414	43	31	63	94	
	Roerdalen	Vlodrop	18	120	240	361	46	34	68	102	
A2-B			**25**	**207**	**413**	**620**	**46**	**38**	**77**	**115**	**1 541**
Total			**124**	**901**	**1802**	**2703**	**260**	**200**	**399**	**599**	**6 987**
Ratio (A2 + B)/Total											**0.22062**

Annex R: Capacity in Aarschot (Montzen route)

The analysis and calculations in this annex are provided by Infrabel.

R.1. Location of the Aarschot bottleneck

Figure 35: Aerial view of the situation of the Aarschot bottleneck



The aerial photograph above shows the situation of the Aarschot bottleneck. The table below gives, illustratively, the numbers of trains in Aarschot.

Table 216: The numbers of trains on 15th June 2008

	passenger trains	freight trains	light engines
From / to direction Antwerp	79	54	3
From / to direction Aarschot	166	35	7
From / to direction Hasselt	124	82	6

All passenger trains run via the station of Aarschot. The passenger trains between Antwerp and Hasselt are counted double on the fork towards Aarschot because they enter Aarschot via the Hasselt-Aarschot section and leave via the Aarschot-Antwerpen section.

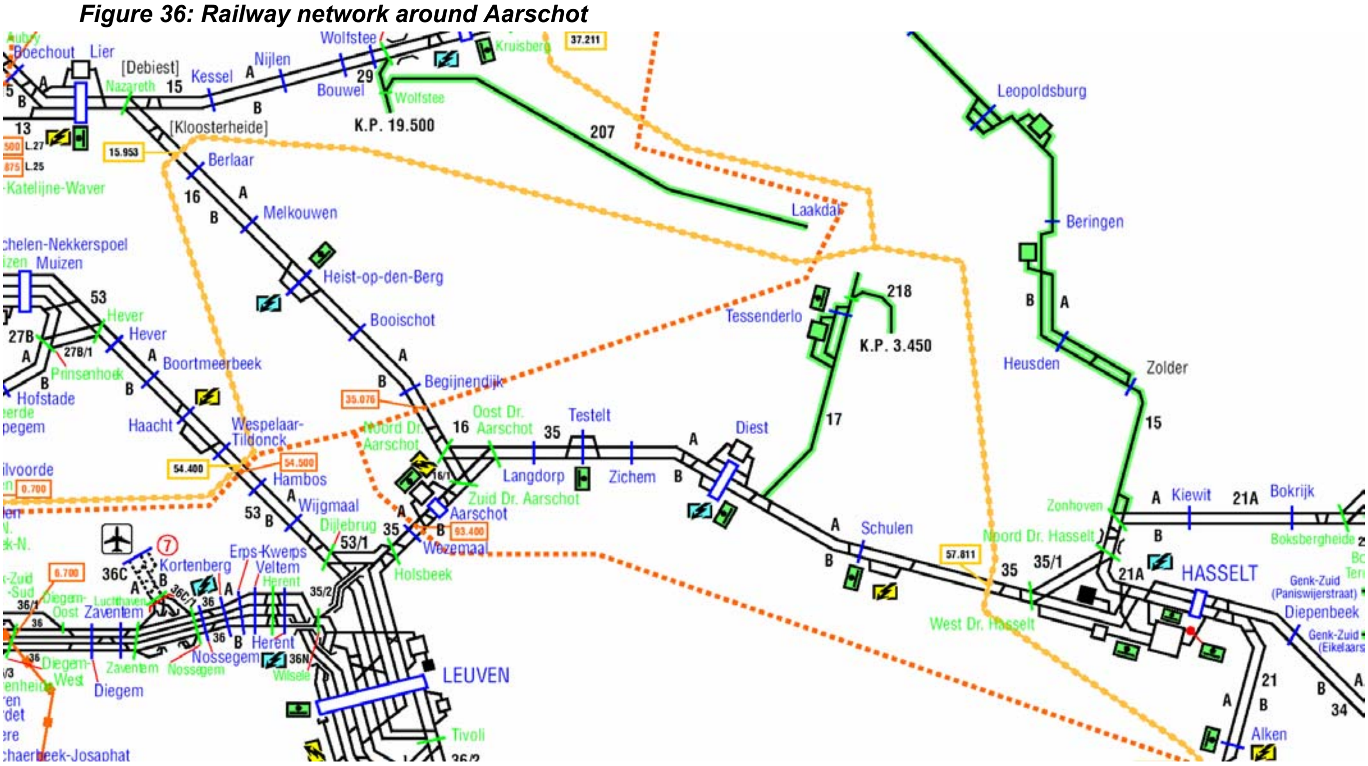
The connecting curve is being used exclusively by freight trains running between Antwerp and Hasselt and beyond towards Liège. The freight trains from Zeebrugge and Ghent come from direction Aarschot and run in the direction of Hasselt. These figures show that most freight trains run between Antwerp and Hasselt and between Aarschot and Hasselt.

In the recent past (2005-2006), there was one peak-hour passenger train (morning and evening peak) that also made use of this curve. But due to the dense occupation by freight trains, it was impossible to guarantee the regularity of those peak-hour trains, which resulted in their declining popularity and eventually the cancellation of those trains.

Infrabel wishes to establish, in the short term, a new fast train service between Antwerp and Hasselt, via this connecting curve.

The picture below gives an overview of the railway stations mentioned in this annex.

Figure 36: Railway network around Aarschot



R.2. Train numbers

R.2.1 Train paths versus actual trains

The analysis of future train numbers has been based on the current number of train paths rather than the actual trains. The reason why we use train paths instead of actual train runs, is that this information is more easily available.

Infrabel states that using the number of train paths is an adequate representation of the actual number of train runs. Based on the timetable of 15/06/2008, 88 freight trains (incl. light engines) pass through the station of Langdorp (located on the section towards Hasselt). Based on the effective freight train runs on 19/06/2008, the number is 79: But one can also find examples of days during which more trains have run than scheduled in the timetable.

R.2.2 Determining the future number of trains

R.2.2.1. Current number of trains

First, we examine the current use of the route sections on the Montzen route. That approach has been based on the data of the database "Work170" for the train service on Thursday 15/06/2008. The table below gives a survey of the number of train paths on the Montzen route.

Table 217: Number of trains per day per station on the Montzen route, based on the train service of 15/06/2008

Rail station	Number of trains/day (both directions)	Peak hour	Maximum number of trains/hour	Maximum number of trains/hour per direction
Boechout (near Lier and Antwerp)	245	20-21	15	9
Heist-op-den-Berg	139	21-22	9	5
Langdorp (near Aarschot)	212	21-22	15	10
Diepenbeek	176	19-20	11	6
Montzen (near German border)	110	1-2	10	8

Based on the table above, the number of train paths is broken down into train paths for respectively freight and passenger trains. At the same time, the busiest direction of traffic is taken into account because it is a determining factor in the capacity assessment. The results are as follows:

Table 218: Number of freight trains per day per station on the Montzen route, based on the train service of 15/06/2008

Rail station	Number of freight trains/day (both directions) (light engines separately)	Maximum number of freight trains/hour	Maximum number of freight trains/hour per direction
Boechout (near Lier and Antwerp)	62+2	5	3
Heist-op-den-Berg	56+2	5	3
Langdorp (near Aarschot)	85+3	9	5
Diepenbeek	85+2	7	4
Montzen (near German border)	95+15	10	8

The number of trains in the section Langdorp-Diepenbeek-Montzen is larger than on the sections near Antwerp, as the traffic from Zeebrugge is joins the Montzen route in Aarschot.

Furthermore we also see that the maximum number of freight trains on mixed railway lines (passengers & freight) remains limited to 5 trains/hour, which occurs between Boechout to Y Glons (Tongeren). Between Tongeren and the German border, the line is a dedicated freight line, so that the maximum number of freight trains can go up. In this case, this is up to 8 trains per hour in the busiest direction.

R.2.2.2. Future number of freight trains

To determine the number of freight trains on the Montzen route in 2030, without reactivation of the Iron Rhine, the transport forecasts from the table below have been used.

Table 219: Number of freight trains per day per station on the Montzen route, in 2020 and 2030

Rail section	No IR – 2A 2020	No IR – 2A 2030	No IR – 2B 2020	No IR – 2B 2030	Historical IR – 2A 2020	Historical IR – 2B 2020	Historical IR – 2A 2030	Historical IR – 2B 2020
Antwerp – Aarschot	88.6	102.9	92.2	111.7				
Aarschot – Hasselt	92.3	104.9	95.4	112.8				
Hasselt – Tongeren	79.4	91.4	82.6	99.5				
Tongeren – Montzen	77.5	89.4	80.8	97.7				
Montzen – German border	71.8	83.1	75.6	93.0	26.2	58.7	36.8	87.0

Note: see also Table 23 and Table 24 on page 88, where the same figures are shown.

R.2.2.3. Future number of passenger trains

We hereinafter assume that the number of trains in 2030 will be the same as in 2020. That is probably incorrect, but at this point in time there is no information available that would allow for reasonable assumptions about the evolution of the train service between 2020 and 2030. That is why the passenger service level by 2030 has been maintained at the same level as the train service for the year 2020.

It is reasonable to assume that the train service in the year 2020 will largely be the same as the current train service. The only difference between the two will probably lie in the fact that a number of the current peak hour trains will become regular trains and that a number of new peak hour trains will be added. The assumption is that 2 * 14 = 28 regular trains and 2 * 2 new peak hour trains will be added per day. We thereby assume that the number of passenger trains during peak hours and the maximum number of trains per direction will proportionately remain the same as today. That gives us the following figures for passenger traffic in 2020-2030:

Table 220: Number of passenger trains per day per station on the Montzen route, 2020-2030, scenario “No Iron Rhine – 2A”

Rail station	Number of passenger trains/day (both directions)	Maximum number of passenger trains/hour	Maximum number of passenger trains/hour per direction
Boechout	213.0	11.77	7.06
Heist-op-den-Berg	113.0	5.58	2.79
Langdorp	156.0	7.55	6.29
Diepenbeek	121.0	5.44	2.72
Montzen	0.0	0	0

To actually meet the forecasted passenger growth figures, as laid down in the management contract between Infrabel and the Belgian government, it is reasonable to expect that longer trains and trains with more seating capacity (cf. double deck trains) will be operated instead of introducing additional passenger trains.

R.2.2.4. Future number of trains (passengers & freight)

The tables below give the total number of trains in 2020 and 2030.

Table 221: Forecasted number of trains per day in the railway stations on the Montzen route, 2020, scenario "No Iron Rhine – 2A"

Rail station	Total number of trains/day (both directions)	Maximum number of trains/hour	Maximum number of trains/hour per direction
Boechout	213.0	11.77	7.06
Heist-op-den-Berg	201.6	13.05	7.25
Langdorp	248.3	17.57	11.71
Diepenbeek	200.4	12.53	6.83
Montzen	77.5	7.05	5.64

Table 222: Forecasted number of trains per day in the railway stations on the Montzen route, 2030, scenario "No Iron Rhine – 2A"

Rail station	Total number of trains/day (both directions)	Maximum number of trains/hour	Maximum number of trains/hour per direction
Boechout	213.0	11.77	7.06
Heist-op-den-Berg	215.9	13.98	7.77
Langdorp	260.9	18.46	12.31
Diepenbeek	212.4	13.28	7.24
Montzen	89.4	8.00	6.40

Table 223: Forecasted number of trains per day in the railway stations on the Montzen route, 2020, scenario "Historical Iron Rhine – 2A"

Rail station	Total number of trains/day (both directions)	Maximum number of trains/hour	Maximum number of trains/hour per direction
Boechout	213.0	11.77	7.06
Heist-op-den-Berg	139.0	9.00	5.00
Langdorp	182.0	12.88	8.58
Diepenbeek	147.0	9.19	5.01
Montzen	43.0	3.91	3.13

Table 224: Forecasted number of trains per day in the railway stations on the Montzen route, 2030, scenario "Historical – 2A"

Rail station	Total number of trains/day (both directions)	Maximum number of trains/hour	Maximum number of trains/hour per direction
Boechout	213.0	11.77	7.06
Heist-op-den-Berg	150.0	9.71	5.40
Langdorp	193.0	13.66	9.10
Diepenbeek	158.0	9.88	5.39
Montzen	37.0	3.36	2.69

This total number was obtained by adding up the forecasted numbers of passenger and freight trains per route section, for scenario "No Iron Rhine – 2A", which is the lowest scenario for the Montzen route. We thereby assumed that the number of passenger trains during peak hours and the maximum number of trains per direction proportionally remains the same as today.

Please note that the number of freight trains in Boechout will decrease by 2030. That is due to the fact that the freight trains for Montzen from/to the Port of Antwerp will use the then newly build Second Port Access and will therefore no longer run via Boechout.

The table below gives a survey of train numbers per segment, per measuring point (station) and per scenario (with and without the Iron Rhine).

The station of Langdorp is to be situated along the railway line "from/to Hasselt" and the station of Begijnendijk along the line "from/to Antwerp".

Table 225: Forecasted number of trains per day per section and scenario on the Montzen route, scenario "No Iron Rhine – 2A"

Scenario	Measuring point	Freight trains	Passenger trains	TOTAL
2008	Langdorp	88	124	212
	Begijnendijk	57	79	136
Historical Iron Rhine – 2A 2020	Langdorp	26	156	182
	Begijnendijk	26	113	139
No Iron Rhine – 2A 2020	Langdorp	92	156	248
	Begijnendijk	88	113	201
Historical Iron Rhine – 2A 2030	Langdorp	37	156	193
	Begijnendijk	37	113	150
No Iron Rhine – 2A 2030	Langdorp	105	156	261
	Begijnendijk	103	113	216

R.3. Capacity analysis without Iron Rhine

In Belgium, it is assumed that on a given section, for more than 12 trains per hour and per direction, the possibility of capacity problems becomes fairly likely (12 trains/hour is similar to an average train sequence of 5 minutes). This is a general rule of thumb for the possible capacity problems along a route, taking into account the intersections in stations, level track intersections, level crossings, timetable with limited margins, …

For Aarschot, this rule of thumb needs to be adapted a little. Two major freight traffic flows come together in Aarschot: one from Antwerp and one from Zeebrugge. Table 222 shows that the criterion described above (12.31 > 12) is exceeded near Langdorp station.

If we consider the Aarschot triangle and take account of the fact that trains run on the left side in Belgium, it is easy to see that train traffic coming from Hasselt and running toward Antwerp is hindering the traffic coming from Aarschot and running toward Hasselt. The same applies to traffic coming from Antwerp to Aarschot and traffic coming from Hasselt to Antwerp. It may be assumed that such crossing takes at least 6 minutes: path actuation / passage of train 1/ clearing route / new path actuation / passage of train 2 / clearing route.

The introduction of ETCS/ERTMS will not allow reducing the crossing time because it has no effect on it. The crossing time for 2 trains is determined by path actuation, train crossing clearance, and a given margin to guarantee regularity. Therefore we may consider a 6 minutes crossing time as reasonable (but tight). We deduct from this that in the specific Aarschot case, maximum 10 crossings per hour are acceptable.

The length of the connecting curve is 846 m between the 2 level track forks. Considering the position of the signals, the usable length of the connecting curve is only 484 m. In other words, trains of maximum 484 m would keep the crossings at Y North (respectively Y East) clear for other train traffic. In reality the average length of a freight train is 600 m and the maximum length amounts to 750 m. This effect is even reinforced by the level crossing located on the connecting curve. That implies that a freight train cannot stop in the curve. The crossing on the Hasselt side and the crossing on the Antwerp side can therefore not be considered individually. The combination of both crossings does not allow for any margin.

If we analyse the Y East Aarschot Triangle as described above, we obtain the following results:

	Trains from Hasselt to Antwerp	Trains from Aarschot to Hasselt	Total
Current situation	10 trains in peak hour / 2 directions (Aarschot and Antwerp) = 5	4	9 crossings (< 10) *just acceptable*
Based on the number of trains by 2020	11.71 / 2 = 5.86	5 (1 passenger train added)	10.86 crossings (>10) *unacceptable*
Based on the number of trains by 2030	12.31 / 2 = 6.16	5 (1 passenger train added)	11.16 crossings (>10) *unacceptable*.

Considering that other infrastructural measures (e.g. building passing tracks) would not be effective on this busy route section, a flyover is the only right solution.

If we analyse the Y North Aarschot Triangle in the same way, we obtain the following result:

	Trains from Hasselt to Antwerp	Trains from Aarschot to Hasselt	Total
Current situation	10 trains in peak hour / 2 directions (Aarschot and Antwerp) = 5	3	8 crossings (< 10) *acceptable*
Based on the number of trains by 2020	11.71 / 2 = 5.86	4 (1 passenger train added)	9.86 crossings *only just acceptable* However, considering the interaction with the Y East Aarschot triangle, which cannot be maintained on the ground level in 2020, we can conclude that measures need to be taken by 2020 in order to solve this bottleneck.
Based on the number of trains by 2030	12.31 / 2 = 6.16	4 (1 passenger train added)	10.16 crossings (>10) *unacceptable*

Considering that other infrastructural measures (e.g. building passing tracks) would not be effective on this busy route section, a flyover is the only right solution.

In view of the above, we should conclude that both level track forks need to be replaced, as from 2020, by flyover constructions.

The current timetable graphs show that even today it is extremely hard to introduce additional trains on the Aarschot triangle.

The major disadvantage of level track intersections is the interference between traffic flows that need to cross each other because of the fact that trains run on the left side. When traffic is dense, this takes away any flexibility from the timetable and has a negative effect on regularity (cf. knock-on effect of delays).

A flyover neutralizes the disadvantages mentioned above and moreover has a positive effect on the capacity. It may be assumed that a flyover has a capacity increasing effect of + 30 %.

Partly due to the level crossing situated on the connecting curve, the most obvious solution to solve the capacity problem would be to place the entire route section between Y North Aarschot Triangle and Y East Aarschot triangle on a viaduct structure as of 2020.

R.4. Capacity analysis with Iron Rhine

If we analyse the Y East Aarschot Triangle as described above, we obtain the following results:

	Trains from Hasselt to Antwerp	Trains from Aarschot to Hasselt	Total
Current situation	10 trains in peak hour / 2 directions (Aarschot and Antwerp) = 5	4	9 crossings (< 10) *just acceptable*
Based on the number of trains by 2020	8.58 / 2 = 4.29	5 (1 passenger train added)	9.29 crossings (< 10) *just acceptable*
Based on the number of trains by 2030	9.10 / 2 = 4.55	5 (1 passenger train added)	9.55 crossings (< 10) *just acceptable*

The infrastructure is suitable in both cases and does not need adaptations before 2030.

If we analyse the Y North Aarschot Triangle in the same way, we obtain the following result:

	Trains from Hasselt to Antwerp	Trains from Aarschot to Hasselt	Total
Current situation	10 trains in peak hour / 2 directions (Aarschot and Antwerp) = 5	3	8 crossings (< 10) *acceptable*
Based on the number of trains by 2020	8.58 / 2 = 4.29	4 (1 passenger train added)	8.29 crossings (< 10) *acceptable*
Based on the number of trains by 2030	9.10 / 2 = 4.55	4 (1 passenger train added)	8.55 crossings (< 10) *acceptable*

The infrastructure is suitable in both cases and does not need adaptations before 2030.

R.5. Investment cost

The investment cost of the new infrastructure in Aarschot has been estimated on the basis of indicator values. These unit sums include the following work: R&D cost, phasing, project management and a coefficient for unforeseen items.

The completed project "connecting curve L35/2 in Leuven" is used as a basis for the calculation. The actual cost of that project amounted to 38.7 million €. The L35/2 Leuven project has cost 26.7 million €.

The investment cost for the additional infrastructure at Aarschot breaks down as explained in the table below.

Additional infrastructure	Calculation	Costs
Connecting curve similar to the L35/2 project	Aarschot: 846 m plus 250 m run-up slope at every flyover at the 2 forks, in total 1346 m. The viaduct length will be about 550 m. The L35/2 Leuven project was 1333 m with 561 m viaduct. We assume the costs are the same: 26.7 million €. However, the transformation (tracks, catenary, signalling) of 2 rather complex forks are included in the total cost of 38.7 mio € in the Leuven project. Also, the costs for the track bed (slope + viaduct), electrified single track and signalling for the Aarschot need to be added. In total, Aarschot would cost 12 million euro less than Leuven.	26.70 million €
Double track	In order include double tracks the track bed (incl. slopes and viaduct) has to be widened and railway infrastructure and technical equipment (catenary and signalling) need to be added: • all-in track: 1250 €/m • all-in civil engineering: 1750 €/m • all-in technical equipment: 800 €/m This results in an additional cost of 3800 €/m * 1346 m	5.12 million €
Two flyover forks	The civil engineering part for 1 "average" flyover fork is estimated at 25 mio €.	50 million €
Adaptations of sidings at flyover forks	Before a flyover fork, as set of sidings (trapezium) has to be placed so that switching over is possible before the fork. The switches must be passable at a sufficiently high speed (90 km/h). Also the "level track branch" and the existing railway infrastructure in this zone need upgrading. The all-in price (signalling, catenary, switches) of 1 such a complex is estimated at 1.25 million €.	2.5 million €
Preparing the zone for construction work	Dismantling of the existing tracks and making the site ready for building.	1 million €
SUBTOTAL		**85.32 million €**
Expropriations	It is common for this type of projects to reserve 3 % of the basic estimate for expropriations.	2.56 million €
TOTAL		**87.88 million €**

Thus the investment cost of the additional infrastructure at Aarschot is estimated at **87.88 million €**.

R.6. Conclusion

Nowadays, the level track forks of the Aarschot triangle are heavily used. The capacity limit has not been reached yet, but the margin is very thin. Growing traffic (freight and/or passengers) would require measures to ensure the smooth operation of railway traffic.

Considering the assumptions made for future passenger traffic and the forecast for freight traffic (see above), infrastructural measures will be required as of 2020. The solution consists of lifting the entire route section between Y North Aarschot triangle and Y East Aarschot triangle onto a viaduct and to replace the level track forks by flyovers.

This adaptation of the infrastructure represents an investment cost of 87.88 million € in the reference case, when the Iron Rhine will not be in use.

In case the Iron Rhine will be in use, no investments are needed before 2030.

Annex T: Advice 2007 "Commissie Onafhankelijke Deskundigen IJzeren Rijn"

The next 14 pages contain the advice of the Commission of Independent Experts (*Commissie van Onafhankelijke Deskundigen - COD*) of 8 June 2007, in Dutch. A German version is also added (also 14 pages).

In the 2007 advice, the COD discussed different traffic studies that were made for the Iron Rhine, and gave an advice to the Belgium and Dutch ministers on which number of trains to use in the design of the rail modernisation (both freight and passenger trains).