INTRAPLAN
Consult GmbH

BVU

Fehmarnbelt Forecast 2014
- Update of the FTC-Study of 2002

for

Femern A/S

2014

Intraplan
Consult GmbH
Orleansplatz 5a
81667 München
Tel: +49 (0) 89 45911-0
Email: info@intraplan.de

BVU Beratergruppe
Verkehr + Umwelt GmbH
Wentzingerstr. 19
79106 Freiburg
Tel: +49 (0) 761 47930-0
Email: post@bvu.de

Figures

Tables

0 MANAGEMENT SUMMARY

0.1 Introduction

The decision to build the Femerbelt Fixed Link (FBFL) was founded among other on detailed traffic forecasts which were carried out by the Fehmarn Belt Traffic Consortium (FTC) in two phases: 1996/1998 (final report 1999) and 2002 (final report 2003).

These forecasts were based on specific traffic models both for freight and passenger traffic, which included large scale surveys of passengers, shippers and forwarders, traffic counts and statistics, and the knowledge in traffic modeling which was available both in Denmark and Germany at those days.

Forecast horizon in the second study phase was 2015. For this year several scenarios were analyzed in a detailed way giving results for the traffic development between Northern Europe and the continent as a whole, the traffic of the FBFL due to market development, modal split-development and route choice including the relationship between ferry traffic and the FBFL. Based on the detailed results for the base year 2001 and the forecast year 2015 additionally a 'trend forecast” for 2025 was prepared with a limited level of detail.

Given the more than 10 years since the preparation of the FTC 2002 forecast with a lot of changes in traffic, economy and transport policy and given the delays of the FBFL-project, which was then to be expected in service in 2015, it is sensible to update the FTC-forecast fundamentally.

For the planning approval process in Germany an extrapolation of the FTC-forecasts of 2002 has been pre-pared in 2012. However, this update was only a projection, analyzing recent traffic statistics and the factors influencing the traffic development on aggregate level. This study did not include an update of the forecasting methodology and not even new model calculations.

However Femern A/S needed for business and for technical planning purposes a more detailed and more sophisticated approach, permitting even scenario calculations, calculations for different forecast horizons and describing the competition with other modes and routes. This is only possible with the re-activation and substantial update of the FTC-model itself. This is feasible due to the fact, that the FTC-methodology and software of 1992/2002 were basically developed and operated by the FTC-consortium members BVU (freight) and ITP (passenger traffic). Therefore these two companies are able to re-activate and update the FTC model.

0.2 Study Approach

The new forecast FTC 2014 for the FBFL has to consider both passenger and freight traffic. There are two main questions which had to be answered by the study based on model calculations:

(1) The **relevant traffic and its development** in the study area, that means the traffic between Scandinavia on the one side and Germany and the Continent on the other side.

(2) What is the **share** of this traffic, which the FBFL can gain compared to alternative modes and routes?

Considered in the study is the total traffic between

° Denmark, east of Great Belt, Sweden, Norway, Finland on the one side and
° Germany, other continent (excl. CIS, Baltic States, Eastern Poland) on the other side.

The FTC-model of 2002 has been updated in the sense, that the scope and level of detail concerning

° the study area
° the zonal system
° the relevant traffic
° the differentiation into modes (road, rail, ferry, air)
° the sectoral structure of traffic

are comparable to the FTC 2002 study.

As in the FTC-model of 2002 **all relevant factors for the traffic development** of the FBFL are considered

° the autonomous growth (due to economy, population, car ownership etc.)
° the modal-split development (apart from the Fixed Link also dependent on user costs and hinterland infrastructure) for passenger traffic additionally 'induced traffic'
° the route choice (including competition with the ferry-lines).

As in the FTC 2002 study the results are presented both for the study area (total market) as well as for the FBFL itself (share of traffic). The results are calculated both in terms of traffic units (passengers, tons) as well as in vehicle units (cars, buses, lorries, trains/wagons).

The model is feeded with the most recent data on

° demand/OD-matrices
° supply/network models incl. hinterland network and ferries
° prices/user costs incl. for ferries,

all for the base year (2011) and for the forecast horizons.

With regard to model sensitivities the model has been re-estimated due to recent surveys and statistical data, which are available in Denmark, Germany and Sweden. The same is valid for the calibration, which is mainly carried out on the basis of ferry statistics (passengers, cars, busses, lorries), Great Belt traffic counts and railway count data (Jylland/Flensburg).

Different from the FTC 2002 study, which basically focused on one forecast year (2015), the updated FTC-model of 2014 is designed as a model for **medium and long term forecasts for different forecast years**. Here a two-step-process has been applied:

(1) several main forecast years (pillar years), for which full scale model runs including all inputs and outputs are calculated
(2) qualified inter- and extrapolation on aggregate level resp. for the key results, to get the complete forecast time series.

As pillar years have been fixed
° 2022 with case (first full year of operation of the FBFL) in two variants: full FBFL effect and including a ramp-up effect
° 2022 without case (in comparison with the '2022 with case' with full FBFL effect) to see the effect of FBFL
° 2025 (with FBFL) as year, when the ramp-up phase is finished = main medium forecast year
° 2035 (with FBFL) as long term forecast year.

As the planning approval process in Schleswig-Holstein is concentrating on the horizon 2030, and for better comparability with the current BVWP process, all results have been calculated for 2030 as well.

For financial calculations the forecasts are extrapolated from 2035 to 2047 (25 years from 2022, the assumed first year of operation of the FBFL).

As in the FTC-study of 2002 two scenarios have been calculated. The first scenario is the **Case A,** using the set of assumptions as fixed for the planned German Bundesverkehrs-wegeplan (**BVWP)** 2015, that is for the user costs and transport prices, the socio-economic key figures and key assumptions with regard to the infrastructure. The second scenario based on the assumptions of the **Danish Ministry of Transport**, Ministry of Finance and OECD is the **Case B. As in the FTC-study of 2002 the scenario B, based on the assumptions of the Danish Ministry of Transport ect., is the relevant scenario for the further planning process and considered the main scenario. Case A is considered a sensitivity scenario.**

0.3 Scenario Assumptions

With regard to the **socio-economic development** (see Table 0-1) the scenario assumptions differ mainly in premises of GDP development with a generally more pessimistic view in the Case A and a more optimistic medium term development in Denmark in Case B.

Item	CASE A	CASE B
Population Denmark	DK 2030: 6,14 million	STATBANK FORECAST; 2013 (2030: 5,92 million)
Population Germany	BBSR BVWP (2030: 79,7 million)	BBSR Raumordnungsprognose 2012, population by region. (2030: 78,1 million)
Population Rest	S: 10,80 million. N: 5,78 million. FIN: 5,85 million	S,N,F - national forecasts, rest from EUROSTAT (2030: S: 10,73 N: 6,04 FIN: 5,85)
GDP	average 2011 – 2030 in % p.a. DK 1,3 D 1,14 S 1,3 N 1,7 FIN 1,3 All other based on OECD 11/2012 Forecasts	average 2012 – 2030 in % p.a. DK 1,3 % p.a. (up to 2022 1,6 % p.a.) D 1,2 S 2,3 N 2,9 FIN 2,2 All based on OECD 11/2012 Forecasts except for DK where the forecast of the Ministry of Finance is applied.

Table 0-1: Scenario assumptions: socio-economic data

	Case A	Case B
Road Access FBFL in Germany	Federal Highway B207 Heiligenhafen Ost – Puttgarden, upgrading from 2 to 4 lanes in **2022** without Fehmarnsund Bridge)	Federal Highway B207 Heiligenhafen Ost – Puttgarden, upgrading from 2 to 4 lanes in **2022** without Fehmarnsund Bridge)
Feeder Roads in Germany	2030: Lübeck – Glückstadt – Tunnel Elbe - Bremerhaven	A 20 - (Lübeck -) Weede – Bad Segeberg (A21) – Wittenborn **2028** Wittenborn – Glückstadt **2025** Tunnel Elbe **2025** Elbe- Bremerhaven (A22) **2030**
Competing Roads Germany	2030: Berlin – Warsaw complete motorway (no assumptions in Baltic countries)	E30/E67 Berlin – Warsaw – Via Baltica Berlin – Warsaw motorway complete **2012/13** Warsaw – Kaunas express road complete **2030** Kaunas – Riga express road com-

	Case A	Case B
		plete **2030** Riga – Tallin express road complete **2030**
Rail Access FBFL Germany	Upgrading railway line Lübeck - Puttgarden, electrification in **2022,** two tracks, speed up to 160 km/h	Upgrading railway line Lübeck - Puttgarden, electrification in **2022,** two tracks, speed up to 160 km/h
Rail Feeder Lines	<u>Denmark:</u> ° HSL Ringsted – Copenhagen (250 km/h, parallel to E20) **2018** <u>Germany:</u> ° HSL Hamburg/Bremen – Hannover (300 km/h) **2030** ° electrification/upgrading Lübeck – Bad Kleinen – Schwerin **2030** ° double track Uelzen – Stendal (- Berlin) **2030**	<u>Denmark:</u> ° HSL Ringsted – Copenhagen (250 km/h, parallel to E20) **2018** <u>Germany:</u> ° HSL Hamburg/Bremen – Hannover (300 km/h) **2030** ° electrification/upgrading Lübeck – Bad Kleinen – Schwerin **2030** ° double track Uelzen – Stendal (- Berlin) **2030**
Nr. of passenger trains on FBFL	**2022: 32** **(8 train-pairs HSR:** **HH - CPH;** **8 train-pairs regional[1])** **2025: 34** **(9 train-pairs HSR:** **HH - CPH;** **8 train-pairs regional)** **2030/35:38** **(11 train-pairs HSR:** **HH - CPH;** **8 train-pairs regional[1])**	**2022: 32** **(8 train-pairs HSR:** **4 HH - CPH,** **2 HB - CPH,** **2 HH - Stockholm;** **8 train-pairs regional[1])** **2025: 36** **(10 train-pairs HSR:** **6 HH - CPH,** **2 HB - CPH,** **2 HH - Stockholm;** **8 train-pairs regional[1])** **2035: 40** **(12 train-pairs HSR:** **6 HH - CPH,** **2 HB - CPH,** **2 HH - Göteborg,** **2 HH - Stockholm;** **8 train-pairs regional[1])**
Maximum Freight Train Lengths	till 2012: 740 m between Padborg-Maschen since 2013: Padborg - Maschen: 835 m	till 2012: 740 m between Padborg-Maschen since 2013: Padborg - Maschen: 835 m

1 Mainly connecting the existing regional trains Kobenhavn - Nyköbing - Maribo (Bus) - Rødby with Lübeck - Puttgarden => line Kobenhavn - Nyköping - Rødby - Burg (Fehmarn)

	Case A	Case B
	from 2022: Puttgarden - Maschen: 835 m[2] Other corridors: unchanged to 2011: 740 m	from 2022: Puttgarden - Maschen: 835 m Other corridors: unchanged to 2011: 740 m
Fehmarn Belt	FBFL from 2022, no parallel service due to detailed analyses[3]	FBFL from 2022, no parallel service due to detailed analyses[3]
Other Ferries	Unchanged	Unchanged

Table 0-2: Scenario assumptions: differences in the infrastructure/supply assumptions between the scenarios

With regard to the **user costs** (see Table 0-3 for passenger traffic and Table 0-4 for freight traffic) the scenarios differ mainly in the assumptions for the car user costs.

2 FBFL infrastructure is designed to handle 1000 meter trains in the long term. Due to the infrastructure on the feeder lines however we assume the train lengths as described in the table.

3 see chapter 8

	Case A	Case B
FBFL (car)	Rødby - Puttgarden 60 € (price level 2010)	Rødby-Puttgarden 65 € (price level 2013) List price for the ferry in 2007
User Costs Ferries	price level 2010	price level 2013
User costs other:		
Variable car user costs (without toll):	+0.5 % p.a.	Values from TØ1): - 2,0 % p.a. 2011 - 2035
Road toll costs:	price level 2010	price level 2013
Bus toll costs:	price level 2010	price level 2013
Rail user costs:	+0.5 % p.a.	price level 2013
Air user costs:	price level 2010	price level 2013

1) Transportøkonomiske Enhedspriser til brug for samfundsøkonomiske analyser, Udarbejdet af DTU Transport og COWI for Transportministeriet, Version 1.4, November 2013. Here a considerable reduction in car user costs is assumed, taking an excessive technological improvement of car engines regarding consumption for granted, which results in a substantially lower user cost forecast than assumed in the other scenarios (38 % until 2035 2011 - 2022: - 3,32 % p.a., 2011 - 2025 (- 2,90 % p.a., 2011 - 2035: - 1,99 % p.a.).

Table 0-3: Assumptions with regard to user costs passenger traffic

	Case A	Case B
FBFL (for Lorry)	Rødby-Puttgarden 300 € (price level 2010)	Rødby-Puttgarden 267 € list price (price level 2014)
Ferries (for Lorry)	price level 2010	price level 2014
Lorry	price level 2010	variable costs constant, fixed costs: +0,6 % p.a.
Road Toll	price level 2010	price level 2014, no road toll in Northern Europe
Rail Conventional	price level 2010	price level 2014
Rail Combined	- 0,5 % p.a.	price level 2014

Table 0-4: Freight Transport Cost Assumptions

0.4 Main Results for Passenger Traffic

In Table 0-5 an overview is given of the total passenger traffic development in the study corridor according to the Case A forecast.

In total passenger traffic will almost double between 2011 and 2035, resulting in an average growth rate of 2,7 % per annum. However, the biggest growth is assigned to **air traffic** (growth rate of 3,5 % p.a.). In this mode there is a big share of traffic with 1.500 km trip length or more which is only to a minor extent a relevant market for the FBFL or the competing ferries. Land based traffic would grow at a lower rate (in total incl. 'ferry walk-on' by 25 %, that is 0,9 % per annum in the average).

With regard to the different modes there will be an increase of **car traffic** (1,5 % p.a. in the average) which is stimulated to a considerable extent even by the FBFL (induced traffic, shift from other destinations) due to the travel time savings of more than one hour in the average compared to the Rødby - Puttgarden ferry.[4] The biggest relative growth of traffic would occur for **rail** for which the number of travelers would triple between 2011 and 2035, however, starting from a rather poor modal split today. The decisive boost for the rail traffic growth is the FBFL which allows a travel time between Hamburg and Copenhagen of less than three hours. **Bus traffic** would grow at a slower rate. **Ferry walk-on** would decrease due to the closing of the ferry when the FBFL is opening.

4 If taking waiting time and embarking/debarking time into consideration

Mode	1000 passengers/year						average growth	
	2011	2022 (without Fixed Link	2022 (with Fixed Link)	2025	2030	2035	2011 - 2035[2)] (in % p.a.)	2025 - 2035 (in % p.a.)
Rail	460	659	1.298	1.338	1.433	1,510	5,1	1,2
Car	8.970	10.492	10.788	11.235	12.148	12.895	1,5	1,4
Air	17.226	26.011	25.714	28.510	34.446	39.303	3,5	3,3
thereof core study area[1)]	1.657	2.132	1.952	1.974	2.223	2.427	1,6	2,1
Bus	2.320	2.474	2.447	2.518	2.601	2.668	0,6	0,6
Ferry Walk On	1.512	1.424	982	965	957	950	- 1,9	-0,2
Total	**30.488**	**41.060**	**41.229**	**44.566**	**51.584**	**57.326**	**2,7**	**2,5**

1) Core study area: Eastern Denmark/Sweden with Germany
2) Traffic growth includes traffic jump due to the FBFL

Table 0-5: Forecast results for passenger traffic between Scandinavia and Europe - Case A [5]

In the **Case B** traffic growth in the study area is slightly higher than in the FTC Case A (see Table 0-6).

5 Here: traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side

Mode	1000 passengers/year						average growth	
	2011	2022 (without Fixed Link	2022 (with Fixed Link)	2025	2030	2035	2011 - 2035[2] (in % p.a.)	2025 - 2035 (in % p.a.)
Rail	460	629	1.149	1.155	1.091	1.038	3,4	-1,1
Car	8.970	10.769	11.087	11.582	12.528	13.302	1,7	1,4
Air	17.226	27.996	27.733	31.299	38.496	44.384	4,0	3,6
thereof core study area[1]	1.657	2.244	2.081	2.234	2.488	2.696	2,0	1,9
Bus	2.320	2.392	2.361	2.442	2.526	2.594	0,5	0,6
Ferry Walk On	1.512	1.413	974	958	949	941	- 2,0	-0,2
Total	**30.488**	43.199	43.304	47.436	55.589	62.259	**3,0**	**2,8**

1) Core study area: Eastern Denmark/Sweden with Germany
2) Traffic growth includes traffic jump due to the FBFL

Table 0-6: Forecast results for passenger traffic between Scandinavia and Europe - Case B [6]

The main reasons for the difference are the assumptions regarding the user costs for car traffic. There is a considerable decrease in the user costs assumed: a decrease in variable costs of 38 % compared to 2011. Compared to the Case A user costs would decrease to nearly the half until 2035. Therefore even rail traffic would be considerable lower in this scenario and even decrease slightly after 2025.

Fehmarn Belt traffic

In **Case A** passenger traffic on FBFL would grow considerably, from about 1,95 million vehicles (passenger car and bus) before opening of the FBFL, a figure which almost was reached ahead in 2007, to nearly 3,4 million after opening and ramp-up of the project (see Figure 0-1). After that steady growth to 4,0 million vehicles in 2035 is expected. The extrapolation to 2047 would give 4,6 million vehicles, 25 years after opening. **Case B** would result in similar growth patterns,

6 Here: traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side

growing from above 2,0 million to 3,5 million between the opening of the FBFL and 2025. 4,1 million passengers would use the FBFL in 2035 resulting in an extrapolated traffic car and bus traffic growth to 4,7 million in 2047. The main reason for the traffic jump are route **choice effects**, from other ferries (for example Rostock – Gedser) and from the Great Belt Bridge (route Hamburg – Flensburg – Odense – Copenhagen) to the FBFL due to travel time savings. But there are also new ('induced') traffic and modal-split-effects (mainly from short haul air traffic to rail).

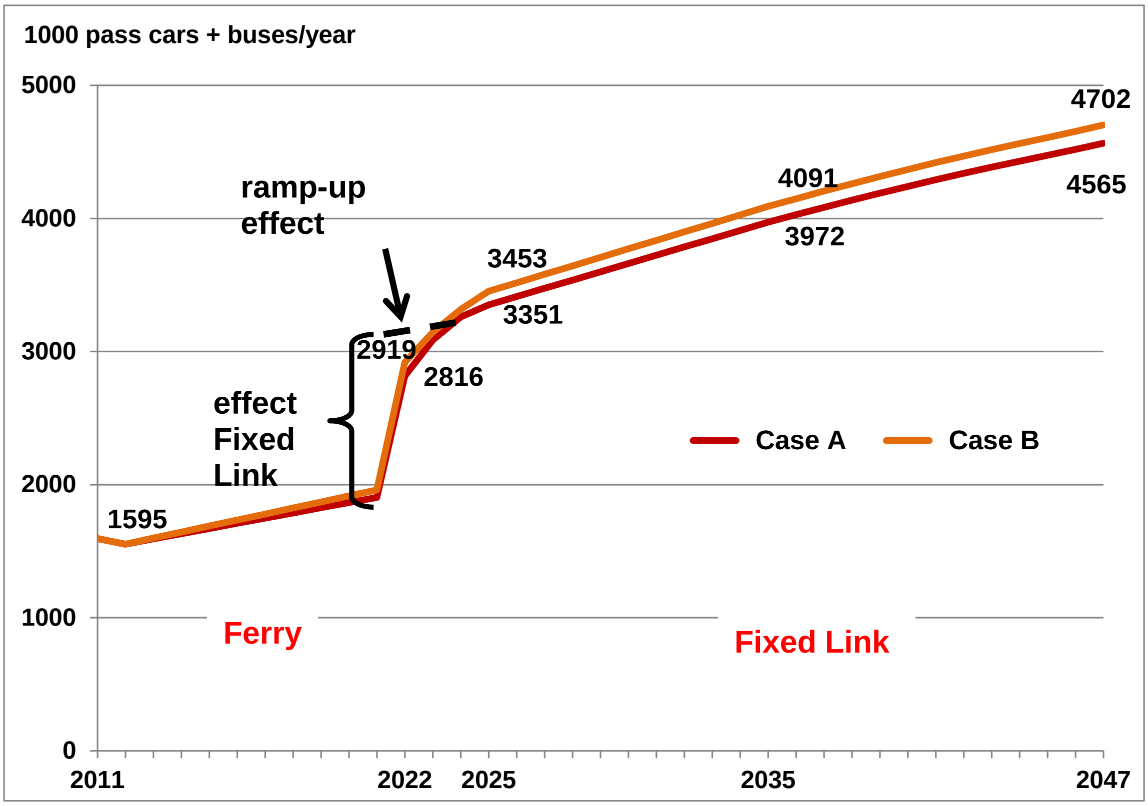


Figure 0-1: Forecast time series for passenger vehicle traffic over Fehmarn Belt

0.5 Main Results for Freight Traffic

A total freight traffic volume between Scandinavia and Continental Europe in the range of 37,2 million to 40,2 million tons is projected for 2022. This corresponds to a growth by 29 % to 40 % in the period from 2011 to 2022. Until 2035, total freight traffic volumes between 43,9 million t and 49,1 million t and thus a growth corridor of 1,8 % to 2,3 % p.a. as of 2011 are expected.

	2011	2022 after opening		2025		2030[7]		2035		annual growth 2011-2035		annual growth 2025-2035	
	base year	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B
Road freight	22.610	29.345	31.298	30.587	32.979	32.745	35.634	34.902	38.288	1,8%	2,2%	1,3%	1,5%
Rail freight	6.164	7.902	8.909	8.108	9.408	8.543	10.132	8.978	10.856	1,6%	2,4%	1,0%	1,4%
Total	**28.774**	**37.247**	**40.207**	**38.695**	**42.387**	**41.288**	**45.766**	**43.880**	**49.144**	**1,8%**	**2,3%**	**1,3%**	**1,5%**

Table 0-7: Total freight transport volume between Scandinavia and Continental Europe in 1.000 t per year

After the opening of the Fehmarn Belt Fixed Link in 2022, a freight transport volume of 13,6 million t to 14,8 million t is projected across the Fehmarn Belt. Due to the expected route shifts as response to the new built link, the traffic volume increase over the Fehmarn Belt will be 37 % to 49 % between 2011 and 2022. In the long term, a growth of 1,1 % to 1,4 % p.a. from 2025 on will lead to transport volumes between 15,9 million t to 18,0 million t across the Fehmarn Belt in 2035.

	2011	2022 after opening		2025		2030		2035		annual growth 2011-2035		annual growth 2025-2035	
	base year	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B
Road freight	4.282	6.212	6.444	6.622	6.870	7.041	7.337	7.460	7.804	2,3%	2,5%	1,2%	1,3%
Rail freight	5.617*	7.390	8.320	7.584	8.788	7.993	9.464	8.402	10.140	1,7%	2,5%	1,0%	1,4%
Total	**9.899**	**13.602**	**14.764**	**14.206**	**15.658**	**15.034**	**16.801**	**15.862**	**17.944**	**2,0%**	**2,5%**	**1,1%**	**1,4%**

* Traffic over Great Belt

Table 0-8: Freight transport volume across the Fehmarn Belt in 1.000 t per year

As depicted in Figure 0-2, the number of lorries using the Fehmarn Belt Fixed Link in 2035 is estimated to range from 644.000 to 673.000 vehicles. Thus, road transportation across the Fehmarn Belt is projected to increase by 76 % to 84 % from 2011 to 2035 including the route shifts amounting to 10 % to 13 % after the opening of the FBFL. Rail transportation however, is

[7] 2030 figures are linearly interpolated values between the forecast horizons 2025 and 2035.

expected to develop less dynamically by 50 % to 81 % to an amount of 8,4 to 10,1 million t in 2035 as shown in Figure 0-3.

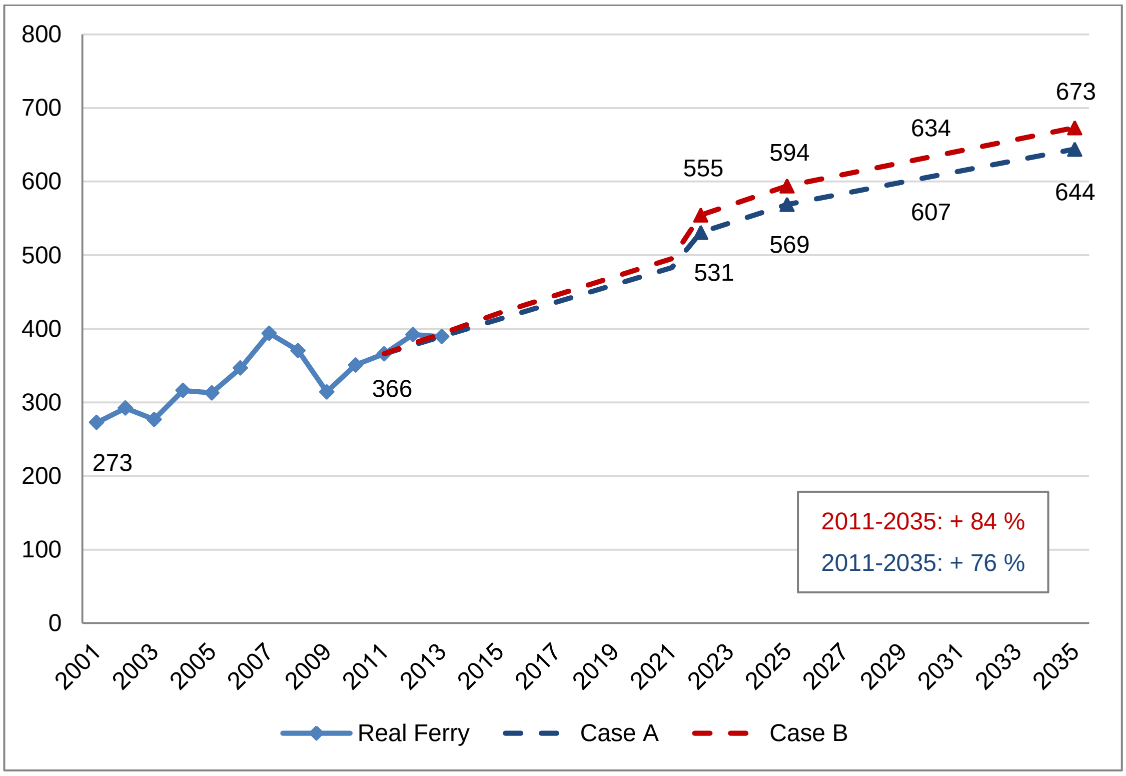


Figure 0-2: Number of lorries across Fehmarn Belt in 1.000 vehicles

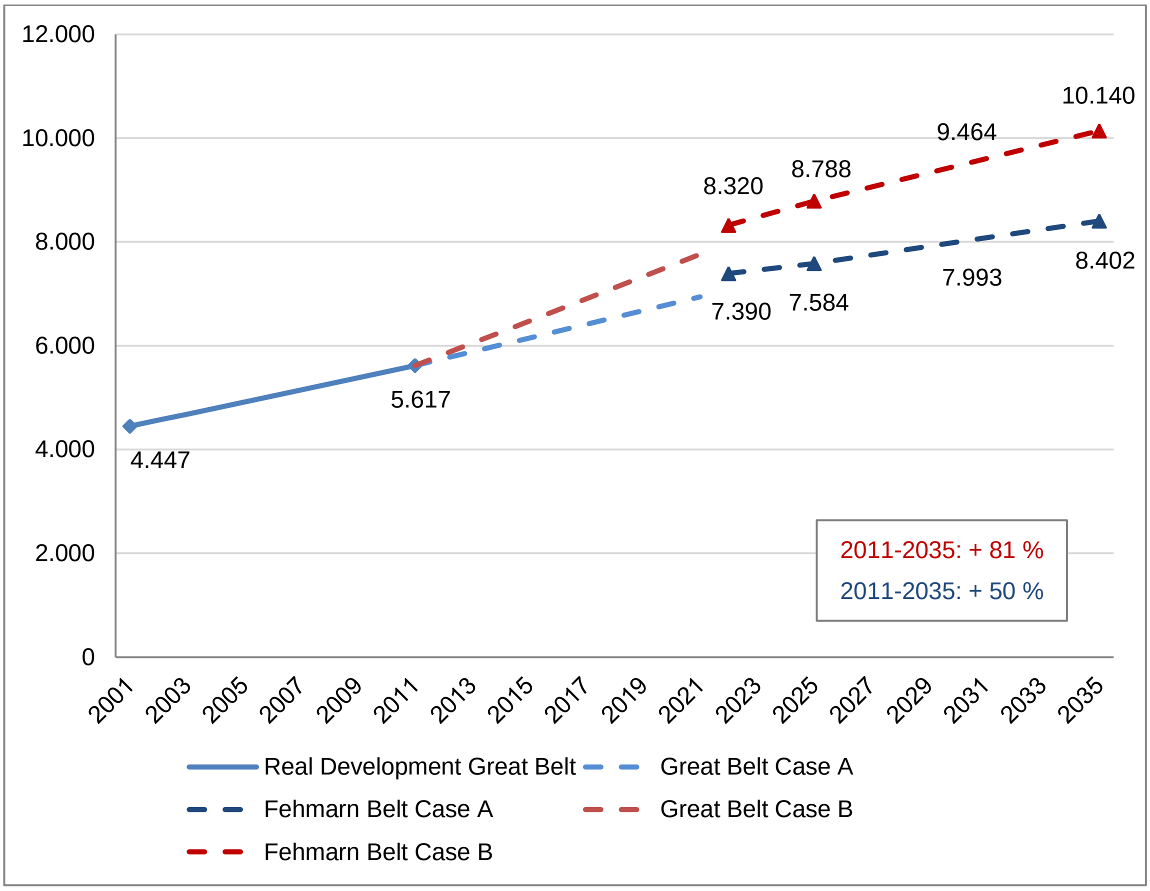


Figure 0-3: Rail transport volume in 1.000 tons across Great Belt (until 2022) and Fehmarn Belt (as of 2022)

0.6 Vehicle traffic and trains including a comparison to the FTC 2002 study

In **Case A** (see Table 0-9) the average daily traffic (ADT) on Fehmarn Belt would grow from nearly 5,4 thousand vehicles in 2011 to nearly 6,8 thousand in 2022 (without FBFL). After opening of the FBFL the numbers would grow to more than 10,7 thousand vehicles until 2025. In 2035 the figure would be at 12,65 thousand vehicles, of which 85 % would be passenger cars.

	vehicles per day (ADT)					
	2011	2022 with-out FBFL	2022 with FBFL	2025	2030	2035
pass. cars[1)]	4.285	5.236	7.619	9.079	10.014	10.778
buses	84	77	96	101	103	104
lorries	1.003	1.455	1.356	1.559	1.663	1.764
total mot. vehicles	**5.372**	**6.768**	**9.071**	**10.739**	**11.780**	**12.646**

1) incl. motorcycles

Table 0-9: Average Daily Traffic (ADT) on Fehmarnbelt, **Case A**

In **Case B** (see Table 0-10) the average daily traffic would be slightly higher than in Case A. Here the number is rising to more than 13 thousand vehicles in 2035.

	vehicles per day (ADT)					
	2011	2022 without FBFL	2022 with FBFL	2025	2030	2035
pass. cars[1)]	4.285	5.395	7.904	9.362	10.321	11.107
buses	84	74	93	99	100	101
lorries	1.003	1.392	1.521	1.627	1.737	1.844
total mot. vehicles	**5.372**	**6.861**	**9.518**	**11.088**	**12.158**	**13.052**

1) incl. motorcycles

Table 0-10: Average Daily Traffic (ADT) on Fehmarnbelt, **Case B**

The direct effect of the FBFL (**'traffic jump'**) is shown in Table 0-11 (Case A) and Table 0-12 (Case B).

	Before opening of FBFL in 2022	After opening of FBFL in 2022[1)]	Increase in %
Cars	5.236	8.627	65 %
Busses	77	96	25 %
Lorries	1.356	1.455	7 %
Total	**6.668**	**10.178**	**53 %**

1) excluding ramp-up-effect which are included in Table 0-9.

Table 0-11: Traffic jump caused by the FBFL (ADT) - **Case A**

	Before opening of FBFL in 2022	After opening of FBFL in 2022 1)	Increase in %
Cars	5.395	8.951	66 %
Busses	74	93	26 %
Lorries	1.392	1.534	10 %
Total	**6.860**	**10.578**	**54 %**

1) excluding ramp-up-effect which are included in Table 0-10.

Table 0-12: Traffic jump caused by the FBFL (ADT) - **Case B**

By the FBFL vehicle traffic on Fehmarn Belt would increase by 53 % in Case A and 54 % in Case B, related to the year 2022. The effects for passenger car traffic are at 65 % (Case A) resp. 66 % (Case B). For lorries the effects are smaller (7 % in Case A and 10 % in Case B).

The reason for the traffic jump is mainly traffic pulled from other routes, ferries-routes as well as the Great Belt fixed link connection. The latter provides today for passenger car drivers a cheaper and more flexible and even, in spite of the detour of nearly 140 km, an equally fast connection on most relations, compared to the Rødby - Puttgarden ferry, when taking waiting time and time to embark and disembark the ships into consideration. The competition of the existing ferry line Rødby - Puttgarden with the Great Belt bridge is also the reason, that the traffic jump for passenger cars in the FTC 2014 study is higher (65/66 %) than the traffic jump expected in the FTC 2002 study (49 %): Since the FTC 2002 study the fares of the Rødby - Puttgarden ferry increased considerably whereas the Great Belt bridge toll was reduced in 2005 and is widely stable since then, if taking inflation into consideration. By that the attractivity of the Great Belt connection increased considerably which means that, if a FBFL is realized, a lot more traffic can be 'pulled back' from the Great Belt than expected in the FTC 2002 study. Due to a low average speed of lorries ((the 140 km detour via Great Belt is for lorries about half an hour more time consuming than for passenger cars[8]) and due to the mandatory rest periods for lorry drivers, the Great Belt alternative to Fehmarn Belt is much less attractive for lorries than for passenger cars. Therefore for freight traffic the 'pull back' effect from Great Belt in the case with the FBFL is much lower than for passenger traffic.

8 80 km/h compared to 110 km/h

Apart from route choice effects another reason for the traffic jump is new traffic due to the increased accessibility in consequence of a travel time reduction of around one hour (ferry cruising time 45 minutes, average waiting time 15 minutes, time for embarking and disembarking about 15 minutes, minus driving time through the tunnel).

Apart from the 'traffic jump' the results with regard to ADT vehicle traffic on FBFL are rather similar to the FTC 2002 study (see Table 0-13)., when comparing the figures of the FTC 2014 study for 2022 with the FTC 2002 study results for 2015: About the same numbers for cars and slightly higher for lorries.

Vehicle Type	**2022**		**2025**		**2030**		**2035**		**for comparison FTC 2002 Case B (2015)**
	Case A	**Case B**	**Case A**	**Case B**	**Case A**	**Case B**	**Case A**	**Case B**	
passenger cars (ADT)	7.619	7.904	9.079	9.362	10.014	10.321	10.778	11.107	7.786
buses (ADT)	96	93	101	99	103	100	104	101	129
lorries (ADT)	1.356	1.521	1.559	1.627	1.663	1.737	1.764	1.844	1.238
total road vehicles (ADT)	**9.071**	**9.518**	**10.739**	**11.088**	**11.780**	**12.158**	**12.646**	**13.052**	**9.153**

Table 0-13: Vehicles on FBFL in the FTC 2014 study (for comparison FTC 2002)

Also the number of trains (see Table 0-14) is similar, at least for Case B comparing the new 2025 figures with the FTC 2002 results for 2015: 101 trains, of which 65 trains are freight trains in the FTC 2014 study, FTC 2002: 99 trains, of which 59 are freight trains.

Vehicle Type	2022		2025		2030		2035		for comparison FTC 2002 Case B (2015)
	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	
passenger trains/day	32	32	34	36	36	38	38	40	40
freight trains/day*	**54**	**61**	**56**	**65**	**59**	**70**	**62**	**74**	**59**
total trains/ day*	**86**	**93**	**90**	**101**	**95**	**108**	**100**	**114**	**99**

* For the purpose of comparison, the methodology for the calculation of the daily freight train numbers is based on a decision between the Danish Ministry of Transport and German Ministry of Transport (06 December 2012,(further details: see chapter 6.2.3). Thus, the FTC 2002 daily train number differs from the FTC 2002 publication (p. 120).

Table 0-14: Trains on FBFL in the FTC 2014 study (for comparison FTC 2002)

Today resp. without the FBFL this traffic is mainly using the Padborg/Great Belt route (freight and night trains) resp. the regional passenger trains on both sides of Fehmarn Belt end close to the harbours (in Germany in Puttgarden) without connection

The main results of the FTC 2014 study can be summarized as follows:

- With regard to cars, around 5.400 vehicles per day are forecast before the opening, rising to around 9,400 after the opening. Annual growth is forecast to be around 2 % four years after the opening, declining slightly to 1,5 % by 2035.
- With regard to lorries, annual growth is forecast to be around 1,3 % four years after the opening declining to 1,2 % in 2035. When compared to other forecasts and analyses, the result is on the conservative side.
- The number of freight trains expected to use the fixed link in 2022 will be 61 freight trains per day rising by 23 per cent to 74 freight trains per day in 2035.
- The estimated traffic jump for the road link is 54 per cent. This will arise in part as a result of the creation of new traffic through increased accessibility and shorter travel time and in part through the transfer from other transport corridors. For precautionary reasons, the traffic jump is assumed to be phased in over the first four years of operations.

1 INTRODUCTION

1.1 Objectives of the FTC-2014 Study

The purpose of the FTC[9] 2014 study is to prepare up-to-date long-term forecasts for the traffic and transport volumes which are to be expected with the planned Fehmarn Fixed Link (FBFL) as basis for the ongoing planning process in terms of business and in-detail technical planning.

By that the study is also intended to

a) update and
b) extend

the FTC-study of 2002[10], which was on the Danish side the basis for the decision to prepare the construction of a FBFL and played an important role also for the international agreement between the Kingdom of Denmark and the Bundesrepublik Deutschland[11] on the project. The 'update' should be carried out with regard to

° the actual traffic development in the study area since the FTC-study 2002
° the changes with regard to the main conditions and 'drivers' for the traffic development.

'Extended' should be the forecast with regard to the forecast horizon and the time-schedule for the opening of the Fixed Fehmarn Link (FBFL).

The forecast for the FBFL had to consider both passenger and freight traffic. There are two main questions which had to be answered by the study based on model calculations:

9 FTC = Fehmarn Traffic Consortium (Caro Bro, Copenhagen, ISL Bremen, Hague Consulting Group, The Hague, BVU Freiburg, ITP Munich). The international consortium prepared the studies of 1999 and 2002 on the basis of a sophisticated traffic model. BVU and ITP were part of the consortium and responsible for the model and the main model calculations. Therefore there is a continuity of the forecasts FTC 2002 -> FTC 2014.

10 FTC Fehmarnbelt Traffic Consortium: Fehmarn Belt Forecast 2002 Final Report, on behalf of Trafikministeriet, København, Bundesministerium für Verkehr, Bau- und Wohnungswesen, Berlin, April 2003
FTC Fehmarnbelt Traffic Consortium: Fehmarn Belt Forecast 2002, Reference Cases, Supplement to Final Report of April 2003, November 2003

11 Treaty for the Fixed Link across the Fehmarnbelt between Denmark and Germany, signed by the national Transport Ministers on 3rd Sept. of 2008.

(1) The **relevant traffic and its development** in the study area, that means the traffic between Scandinavia on the one side and Germany and the Continent on the other side.

(2) What is the **share** of this traffic, which the FBFL can gain compared to alternative modes and routes?

1.2 The FTC forecast of 2002

The FTC (Fehmarn Traffic Consortium) prepared in several phases (see Table 1-1) large scale with regard to empirical knowledge and methodology, state-of-the-art studies on the traffic and transport volumes which would be expected to use a Fehmarn Fixed Link. Clients were the transport ministries in Denmark and Germany who selected a team of experts in traffic analyses, transport modelling, sea transport etc. to prepare the studies. The results were the basis for feasibility studies, for macro-economic and financial analyses of the project and for political decisions.

Study (working period)	Client	Authors	Propose of the Study
Preparatory study[1)] (1990 - 1992)	DSB, DB in co-operation with the ministries	Hoff&Overgaard, Intraplan	Pre-studies (pre-feasibility studies
1. FTC-Forecast 1999[2)] (1993 - 1999)	Danish and German transport ministry	FTC (Carl Bro, ISL, ITP, BVU, HCG)	Feasibility study, Input for cost-benefit analyses
2. FTC-Forecast[3)] 2002 (2002 - 2003)	Danish and German transport ministry	FTC (Carl Bro, ISL, ITP, BVU)	Study update, harmonization with the German Master Plan of transport, basis for political decisions

1) Hoff & Overgaard a/s, Appraisal of Fixed Link across Fehmarn Belt, on behalf of Scandinavian Link, January 1990
Intraplan Consult GmbH, Verkehrsnachfrageprognose für die Eisenbahnverbindung Hamburg - Kopenhagen (Teil Personenverkehr), on behalf of der Danske Statsbaner (DSB) und der Deutschen Bundesbahn DB, April 1992
2) FTC Fehmarnbelt Traffic Consortium, Fehmarnbelt Traffic Demand Study, Final Report, on behalf of Bundesministerium für Verkehr, Bonn, und Trafikministeriet, København, January 1999
3) FTC Fehmarnbelt Traffic Consortium, Fehmarn Belt Forecast 2002 Final Report, on behalf of Trafikministeriet, København, Bundesministerium für Verkehr, Bau- und Wohnungswesen, Berlin, April 2003

Table 1-1: Overview of the former demand forecasts of the transport ministries for the FBFL

The studies were carried out on the basis of multimodal transport models both for passenger and goods traffic. The following modes have been included:

- freight traffic: rail conventional, rail combined, road
- passenger traffic: passenger car, rail, bus, ferry-walk-on (passengers on ferries without using other modes) as well as air traffic in the study area

The model calculations were carried out on the basis of **OD-matrices** with a detailed zonal system and a detailed segmentation (trip purposes, freight sectors). The OD-matrices included not only the traffic and transport flows between Rødby and Puttgarden, but all potentially relevant flows. These were all **traffic and transport flows between Eastern Denmark, Sweden, Norway and Finland** on the one side and **Germany and the Continen**t (including the British Islands) on the other side. With regard to the **traffic alternatives** the whole ferry traffic between these areas had been considered including the hinterland infrastructure (rail, road) and the fixed link over the Great Belt at the Oresund. For passenger traffic also the relevant flight-connections in the study corridor had been considered. The **study area** includes the whole Europe (excluding the Baltic States and the CIS-states with decreasing spatial disaggregation in the areas far away from the Baltic Sea.

Base year for the forecast was **2001**. The traffic and transport volumes had been analysed on the basis of the then available detailed ferry statistics (and airside statistics). For the freight traffic the transport flows had been disaggregated on the basis of the OD-data of the German Kraftfahrtbundesamtes (KBA) and similar disaggregated data of the German Railways (incl. transit through Germany). For passenger traffic **passenger surveys** on all relevant ferries (not only between Rødby and Puttgarden) were the basis for the OD-matrices. The results for 1999 have been updated for 2001 on the basis of the traffic development per ferry line and mode. For railway traffic additionally ticket-sales data with OD-information had been included as well as passenger surveys on airports in Northern Europe (Copenhagen, Stockholm, Oslo).

In the forecast model **exogenous** (population, GDP, employment, car ownership) and **endogenous** (transport infrastructure and supply and user costs for all modes) variables had been considered. In the models the effects of t**raffic growth, spatial distribution, modal-split and route choice** had been considered. The forecast had been prepared for a **situation without and with the FBFL** to be able to isolate the 'project effects' from the other drivers of traffic growth.

The **traffic and transport supply** of all modes had been modelized in form of intermodal transport chains ferry - rail/road. The modelized behaviour of the travelers is based on revealed and stated preference surveys.

Whereas 1999 several **scenarios** with infrastructure alternatives for the FBFL had been prepared: Reference Case (without FBFL), Scenario 2+4 (2 tracks + 4 road lanes), 2+0, 1+2 without changing the other variables, in the FTC-study of 2002 two main forecast cases (Case A/Case B) had been considered, reflecting the different view in the two countries with regard to the future transport policies.

- Case A is compatible to the relevant so called 'integrative scenario' of the German Bundesverkehrswegeplan (BVWP)[12] 2003
- Case B reflects the assumptions of the so called 'trend scenario' of BVWP 2003 and was in line with the assumptions of the Danish transport policy.

Base Case B was relevant for the decision making in Denmark and is therefore high-lighted in Table 1-2.

12 BVU Beratergruppe Verkehr + Umwelt GmbH, ifo Institut für Wirtschaftsforschung, Intraplan Consult GmbH und Planco Consulting GmbH: Verkehrsprognose 2015 für die Bundesverkehrswegeplanung, im Auftrag des Bundesministeriums für Verkehr, Bau- und Wohnungswesen, April 2001

Mode/Cost Component	**Reference Case A[1)]/ Base Case A**	**Reference Case B[1)]/ Base Case B[2)]**
	Change of user costs 2015 to 2001 in %	
Car	+ 15	**- 10**
Lorry	- 4	**- 6**
Bus	± 0	**± 0**
rail passenger traffic	- 30 (private) ± 0 (business)	**± 0**
rail freight traffic	- 18	**± 0**
Air	+ 9 (- 25 Low Cost)	**± 0 (- 25 Low-Cost)**
ferry fare level	± 0	**± 0**
toll FBFL	as ferry costs Rødby - Puttgarden (2002)[3)]	**as ferry costs Rødby - Puttgar-den (2002)**[3)]

1) Reference Case without FBFL, Base Case with FBFL
2) Basis for decision in Denmark for the construction of FBFL
3) 46 € car, 259 € lorry (single trip, prices of 2002)

Table 1-2: Forecast assumptions for user costs/transport costs (change 2015 to 2001 in %, without inflation) in the Cases A and B[13]

The forecast assumptions with regard to **economy and population** (see Table 1-3) had been the same in both scenarios.

[13] Source: Fehmarnbelt Traffic Consoritum: Fehmarn Belt Forecast 2002, page 12

Country	Population2015 (in million)	GDP growth 2001 – 2015 in % p.a.	Cars/1000 inhab-itants 2015
Germany	83,5	2,0	597
Denmark	5,4	1,7	420
Sweden	9,3	2,3	546
Norway	4,7	2,4	486

Table 1-3: Forecast assumptions for socio-economy in the FTC-study of 2002[14]

The **socio-economic data** for Germany, which were available on regional level, had been used for the BVWP. The data for the Nordic countries had been submitted by the Danish Transport Ministry.

With regard to **transport infrastructure** and supply the following was assumed: in the with case (with FBFL for both cases A and B) a complete four lane motorway was assumed between Hamburg and Copenhagen. For the railway line in the southern and northern access to the FBFL a complete electrified and upgraded (160 km/h) double track line (without Fehmarnsund bridge, Gulborgsund, Storström) was assumed.

With regard to the **passenger trains** between Hamburg and Copenhagen 12 intercity train-pairs per day crossing the FBFL were assumed, partly continuing north of Copenhagen to Stockholm and Göteborg. Apart from the intercity trains it was assumed that both regional lines between Lübeck to Puttgarden in Germany and Rødby to Copenhagen in Denmark would be connected by running over the FBFL, (8 train-pairs).

In the with case (with FBFL) **no parallel ferry** has been assumed in the FTC 2002 base cases A and B. That means the existing line would be taken out of service when the FBFL opens. Apart from that no changes in the ferry services were assumed in 2015 compared to 2002.

Next to the cases A and B, which were different in the assumptions about user costs and transport policy several **scenarios** with regard to ferry supply and ferry fare levels (see overview in Table 1-4) had been calculated.

[14] Source: Fehmarnbelt Traffic Consoritum: Fehmarn Belt Forecast 2002, page 51

FBFL	Set of assumptions about transport policy/user costs	
	A (compatible to BVWP)	**B (compatible to Danish assumptions)**
no	Reference Case A ferries as 2002)	Reference Case B (ferries as 2002)
yes (base forecast)	Base Case A (without ferry Rødby - Puttgarden)	Base Case B (without ferry Rødby - Puttgarden)
yes (Scenario 1)	additional ferry services[1)] apart from Rødby - Puttgarden, which is closed	- not calculated
yes (Scenario 2)	like Scenario 1, lower ferry fare levels	- not calculated
yes (Scenario 3)	reduced ferry frequencies outside Rødby - Puttgarden [1)], higher ferry fare levels	- not calculated
yes (Scenario 4)	like Scenario 2 + parallel passen-ger ferry Rødby - Puttgarden	- not calculated

1) e.g.. Rostock - Gedser

Table 1-4: Overview about the scenarios in the FTC forecast 2002

The scenarios/scenario variants have been calculated only on basis of Base Case A. The relative changes (scenario compared to Base Case A), however were assigned also to Base Case B.

In **Scenario 4** the ferry services and a lower ferry fare level for the other ferry lines in the study and a continuation of the parallel ferry after the opening of the FBFL was assumed.

In Table 1-5 the main results (Base Case B) for the **total passenger traffic** between East Denmark and Sweden/Norway/Finland on the one side and the other Europe on the other side are shown.

Mode	Passengers/year (in 1000)	Modal-Split in %
Base year 2001		
Rail	854	3,6
Car	8.498	35,5
Bus	2.739	11,4
ferry walk-on passengers[1)]	1.929	8,1
air[2)]	9.905	41,4
Total	**23.925**	**100,0**
Reference Case B 2015 (without FBFL)		
Rail	1.067	3,0
Car	11.587	32,5
Bus	2.974	8,3
ferry walk-on passengers[1)]	2.395	6,7
Luft[2)]	17.619	49,5
Total	**35.642**	**100,0**
Base Case B 2015 (with FBFL)		
Rail	1.423	4,0
Car	12.422	34,5
Bus	2.938	8,2
ferry walk-on passengers[1)]	1.855	5,1
air[2)]	17.361	48,2
Total	**35.999**	**100,0**

1) ferry walk-on passengers = passengers without any other mode
2) total air traffic Denmark, Sweden, Norway, Finland - Rest Europe
Source: FTC Fehmarnbelt Traffic Consortium Fehmarn Belt Forecast 2002, Reference Cases, Supplement to Final Report of April 2003, November 2003

Table 1-5: Total traffic between Eastern Denmark/Norway/Sweden/Finland and the rest of Europa Reference Case B and Base Case B 2015 according to FTC forecast 2002

There would be a considerable growth of traffic between 2001 and 2015, from 23,9 million passenger trips to 35,6 million passenger trips (nearly 50 % growth). The largest share of the growth would take place in air traffic including relations with longer distances like Sweden - Spain/ Turkey/Eastern Europe. The traffic with land based modes (car, bus, rail) is growing from 12,1 million to 15,6 million trips (+ 29 %). By the FBFL the number of passenger trips in the study area is growing slightly by 0,35 million passenger trips (induced traffic and redistributed traffic). More important is the modal shift: the land based modes passenger car (+ 0,8 million resp. 7 %), rail (+ 0,35 million here the relative change is the highest with 33 %) increase whereas the bus traffic is stagnating (- 0,04 ,million or - 1,2 %), air traffic (- 0,26 million or - 1,5 %) and the number of ferry walk-on passengers (- 0,54 million or - 23%) are losing. The latter is caused by the stop of service of the Rødby - Puttgarden line.

According to the FTC study of 2002 on the **ferry line Rødby - Puttgarden** the traffic is growing from 6,38 million passenger trips in 2001 to 7,62 million passenger trips in the year 2015 **without FBFL (Reference Case B)**, that is as growth of 20 %. Due to the FBFL (Base Case B) traffic is growing compared to the Reference Case B from 7,62 to 9,83 million passenger trips (see Table 1-6).

Mode	Base year 2001		Reference Case B 2015		Base Case B 2015		Difference Base Case B to Reference Case B 2015	
	(in 1000/year)	%	(in 1000/year)	%	(in 1000/year)	%	(in 1000/year)	%
Rail	352	5,5	560	7,3	1.386	14,1	826	147,5
Car	4.058	63,6	4.949	64,9	6.809	69,2	1.860	37,9
Bus	1.248	19,6	1.404	18,4	1.638	16,7	234	16,7
ferry walk-on passengers	718	11,3	711	9,3	0	0,0	- 711	-100,0
Total/year	**6.376[1)]**	**100,0**	**7.624**	**100,0**	**9.833**	**100,0**	**2.209**	**29,0**
	(in 1000/day)		(in 1000/day)		(in 1000/day)		(in 1000/day)	
Passengers (car, bus, rail, ferry walk-on)	**17.468**		**20.888**		**26.940**		**6.052**	
Car	**3.718**		**5.238**		**7.786**		**2.548**	**48,6**
Bus	**88**		**112**		**129**		**17**	**15,2**

Table 1-6: Fehmarnbelt passenger traffic Reference Case B und Base Case B 2015 according to FTC-study 2002

The growth of about 2,2 million passenger trips results from

- a changed modal-split from air traffic (+ 0,35 million passenger trips, mainly in favour of Intercity rail traffic),
- indirect by induced and redistributed traffic (the FBFL will strengthen the interaction between Denmark and Germany, + 0,8 million passenger trips). This however will be to a big extent compensated by the loss of walk-on-passengers (mainly day-trip), 0,7 million.)

° changed route choice (from other ferry lines and to a small extent from Great Belt, in total 1,75 million [15]passenger trips)

The FBFL traffic in terms of passenger vehicles in 2015 is about 7.900 vehicles in average daily traffic (ADT), which is about double the figure of 2001 on the ferry line Rødby - Puttgarden in 2001.

For **freight traffic** (see Table 1-7) the transport volume was growing according to the FTC study between 2001 and 2015 between Scandinavia (without Jylland) and the other Europe from 29,6 to 45,9 million t (+ 55 %).

This number was unchanged between Reference Case and Base Case. However, the modal-split is changing considerably in favour of rail, because the FBFL offers compared to the Jylland-line (Copenhagen - Odense - Flensburg - Hamburg) a considerable shorter and faster route with higher capacity.

15 Source: Fehmarnbelt Traffic Consoritum: Fehmarn Belt Forecast 2002 - Reference Cases, Supplement to Final Report of April 2003, page 15

Mode	1000 t/year	1000 lorries resp. waggons/year	Modal-Split in %
Base Year 2001			
Road	23.034	1.502	77,8
rail conventional	5.579	277	18,8
rail combined	999	102	3,4
Total	**29.612**	**1881**	**100,0**
Reference Case B 2015			
Road	35.736	2.365	77,8
rail conventional	8.340	429	18,2
rail combined	1.847	182	4,0
Total	**45.923**	**2.976**	**100,0**
Base Case B 2015			
Road	35.381	2.348	77,0
rail conventional	8.677	446	18,9
rail combined	1.865	182	4,1
Total	**45.923**	**2.976**	**100,0**

Table 1-7: Forecast of freight traffic between Denmark/Scandinavia without Jylland and the other Europa per mode, Reference Case and Base Case B 2015 according FTC-2002 study

Additionally there are route choice effects. In total the freight transport crossing the FBFL resp. Rødby - Puttgarden route would in 2015 amount to 15,2 million t resp. 452 thousand lorries and 469 waggons/year (see Table 1-8).

Mode	Base Year 2001		Reference Case B 2015		Base Case B 2015		Difference Base Case B to Reference Case B 2015	
	1000 t/ year	vehicles[1] (in 1000/ year)	1000 t/ year	vehicles[1] (in 1000/ year)	1000 t/ year	vehicles[1] (in 1000/ year)	1000 t/ year	vehicles[1] (in 1000/ year)
road	4.434	274	6.665	417	7.206	452	541	35
rail	4.447[2]	255[2]	7.207[2]	430[2]	7.983	469	776	39
total	**8.881**	**529**	**13.872**	**847**	**15.189**	**921**	**1.317**	**74**

1) in rail traffic: waggons
2) without FBFL via Great Belt

Table 1-8: Fehmarnbelt freight traffic Reference Case B and Base Case B 2015 (yearly figures) according to FTC 2002 study

The **ADT-vehicle traffic** on the FBFL resp. the route Rødby - Puttgarden would amount to the figures shown in Table 1-9.

Vehicles	Base Year 2001	Reference Case B 2015 without FBFL	Base Case B 2015 with FBFL
private cars	3.718	5.238	7.786
Busses	88	112	129
Lorries	751	1.142	1.238
Total vehicles	**4.557**	**6.492**	**9.153**
freight rail waggons	0[1)]	0[2)]	1.285
passenger trains	9	8	40[3)]

1) 751 via Jylland route (Copenhagen - Odense - Flensburg - Hamburg)
2) 1.178 via Jylland route
3) incl. connection of the existing regional train lines (Lübeck - Puttgarden and Rødby – Nyköbing/Falster - Copenhagen)

Table 1-9: Forecast of ADT vehicle traffic on the FBFL resp. on the route Rødby - Puttgarden according to the FTC 2002 study

Next to the 1.285 freight rail waggons in Base Case B 40 passenger trains would be assumed which cross the FBFL. From that are

° 24 long distance trains (12 train pairs, thereof 1 night train pair, which today is led via Flensburg/Padborg[16]) and
° 16 trains (8 train pairs) of regional traffic. Here it is assumed that the lines Lübeck - Puttgarden in Germany and Rødby/Nyköbing towards Copenhagen in Denmark will be connected (via the FBFL with Puttgarden as transfer point).

Forecast year of the FTC 2002 study was **2015**. However, there was also an **outlook to 2025 in form of a 'trend forecast'**. For that two variants have been calculated:

° a 'low case', with extrapolation of the absolute yearly traffic growth between 2001 and 2015 (without FBFL effects) to the period 2015 to 2025

16 Next to the night train-pair there are today 4 (winter) to 6 (Summer) EC/IC-train-pairs, das that means the growth of train services compared to today war in average 6 trains-pairs/day

° a 'high case', with more than doubling the traffic growth between 2001 and 2015 compared to the low case.

This **outlook to 2025** (see Table 1-10) resulted in an additional traffic growth in the Base Case B from 9.153 vehicles/day to 10.124 vehicles/day in the Low Case and to 11.683 vehicles/day in the High Case (ADT). The number of rail passengers raised from 3.797 slightly to 3.848 (Low Case) and 3.924 (High Case). Stronger was the growth of railway goods traffic, from 1.285 to 1.611 wagons (Low Case) resp. 1.959 (High Case).

Vehicle mode/Segment	2001 (ferry)	Base Case B with FBFL	Outlook 2025 with FBFL	
		2015	low	high
Car	3.718	7.786	8.486	9.694
Buses	88	129	140	153
Lorries	751	1.238	1.498	1.836
Total vehicles	**4.557**	**9.153**	**10.124**	**11.683**
rail passengers	964	3.797	3.848	3.924
freight rail waggons	0[1)]	1.285	1.611	1.959

1) 699 via Jylland route (Copenhagen - Odense - Flensburg - Hamburg)

Table 1-10: Outlook 2025 of the FTC 2002 forecast, traffic between Rødby und Puttgarden resp. FBFL (ADT figures)

From the other scenarios calculated in the FTC-study of 2002 (see Table 1-4) the **Scenario 4 is** the most important. In this scenario the effects of an aggressive counter-strategy of the ferry companies by lower fares (generally - 25 % compared to the Base Case A[17]) including a parallel ferry between Rødby und Puttgarden had been calculated. The results of this scenario, from the viewpoint of FBFL the 'Worst-Case-Scenario', are seen in Table 1-11.

17 This scenario has been calculated in the FTC 2002 Study only on basis of Base Case A. The relative changes can be transferred to Base Case B. In this case the results for Scenario 4 would be as follows: car 6.650, bus (unchanged) 126, lorries 900, rail passengers 3.900, ferry walk-on passengers (unchanged) 471, freight rail waggons 1.200

Vehicle Mode/ Segment	Base Case B 2015 FBFL	Base Case A 2015 FBFL	Scenario 4[1)] FBFL	Scenario 4[1)] ferry Rødby - Puttg.
car	7.786	7.496	6.408	559
bus	129	129	126	3
Lorries	1.238	1.132	824	121
total vehicles	**9.153**	**8.757**	**7.358**	**683**
rail passengers	3.797	4.101	4.178	0
passengers ferry walk-on	0	0	0	471
freight rail waggons	1.285	1.671	1.570	0

1) Parallel ferry Rødby Puttgarden, other ferries 25 % lower fare level and 25 % higher fare level on Oresund Fixed Link compared to Base Case A

Table 1-11: Vehicles and freight rail waggons (in ADT) in the Worst Case Scenario compared to Base Case B and Base Case A[18]

1.3 FBFL Forecasts since 2002

On the German side, in the context of the '**Überprüfung des Bedarfsplans für die Bundesschienenwege'** (Infrastructure requirement planning for federal railways)**,** among others an economic cost-benefit analysis had been calculated for the German part of the hinterland railway access of FBFL (Puttgarden - Lübeck, (Planfall 43) [19]). The FBFL itself was not subject of the study resp. was assumed as existing. Basis for the forecast of the Bedarfsplanüberprüfung was the 'Forecast of the traffic flows in Germany in 2025'[20] with the base year 2004, which was extrapolated to 2007.

Because of the 'Bedarfsplanüberprüfung' the FBFL itself was not of interest, but only the access route on the German side, no figures had been delivered for the total FBFL traffic or the growth by the FBFL. There was only an update of the railway alignment and the resulting train services

18 see footnote 17

19 BVU Beratergruppe Verkehr + Umwelt GmbH and Intraplan Consult GmbH: Überprüfung des Bedarfsplans für die Bundesschienenwege, on behalf of Bundesministerium für Verkehr, Bau und Stadtentwicklung, November 2010, page 9-357

20 Intraplan Consult GmbH and BVU Beratergruppe Verkehr + Umwelt GmbH: Prognose 2025 der deutschlandweiten Verkehrsverflechtungen, on behalf of Bundesministerium für Verkehr, Bau und Stadtentwicklung, November 2007

had been analysed. The forecast for the number of freight trains crossing the FBFL has been updated to 78 trains per average workday.

In the context of the planning approval process ('Planfeststellungsverfahren') in Schleswig-Holstein the FTC-study of 2002 was in a study in 2012 extrapolated to 2025 taking the recent traffic development on the Rødby - Puttgarden ferry and on other important routes into consideration.[21] It was not a full scale update of the FTC study because no new database (OD-matrices) and no model based calculations have been made. The analyses of traffic development and of the development of the underlying drivers for the traffic development, however, were comprehensive and detailed enough to give a sufficiently founded picture about the trends of traffic development in the study area. Together with the findings of the FTC study about the effects of the project ifself it is a robust forecast, sufficient for the purpose of the study: delivering traffic figures to evaluate the environmental effects of the project.

The main results of this update are shown in the following tables Table 1-12 and Table 1-13.

Segment	**Unit**	**Reference Case B (without FBFL)**	**Base Case B (with FBFL)**	**for comparison**		**Change in % Base Case Update 2025 : FTC 2015**
				Base year	**FTC-study[1)]**	
		(2025)	**(2025)**	**(2011)**	**(2015)**	
passengers	(1000 pass.)	8.342	10.769	6.028	9.833	9,5
thereof rail passengers	(1000 pass.)	632	1.564	397	1.386	12,8
cars	(1000 veh.)	2.422	3.579	1.564	2.842	25,9
buses	(1000 veh.)	30	34	30	47	-27,7
lorries	(1000 veh.)	612	663	365	452	46,7
freight rail traffic[2)]	(1000 t)	10.362	11.478	7.339	7.983	43,8

1) Base Case B
2) in Reference Case via Jylland route

Table 1-12: FBFL resp. Rødby – Puttgarden traffic 2025, extrapolation of FTC 2002 study, 'Reference Case B' (without FBFL) and 'Base Case B' (with FBFL)

[21] Intraplan Consult GmbH: Verkehrsprognose für eine Feste Fehmarnbeltquerung (Aktualisierung der FTC-Prognose von 2002), on behalf of Fermern A/S, August 2013

Whereas the number of passenger cars 2025 on FBFL would be 25,9 % higher than expected for 2015 in the FTC 2002 study, the number of lorries would increase by 12,8 %, rail freight by 43,8 %. Bus traffic would decrease due to the stagnation in the period 2001 to 2012.

The number of road vehicles and trains as expected in this extrapolation of the FTC 2002 study is shown in Table 1-13.

Segment	2011	2025	2025
	Base year	Reference Case B	Base Case B
		(without FBFL)	(with FBFL)
	per day	per day	per day
car	4.285	6.636	9.805
bus	82	82	93
lorries	1.000	1.677	1.816
total vehicles	5.367	8.395	11.714[3)]
passenger trains[1)]	9	10	40
freight trains[2)]	0	0	78
total trains	9	10	118

1) In Reference Case plus 16 trains, which end in Puttgarden and Rødby, without using the ferry (connected in the Base Case via the FBFL), and plus 2 night trains between Hamburg and Copenhagen via Jylland route
2) In Reference Case 70 (2025) trains via Jylland route
3) matches nearly the figures for the outlook 2025 of the FTC study High Case (11.683 vehicles, thereof 9.694 cars, 153 buses, 1.836 lorries)

Table 1-13: Vehicles/trains in the average daily traffic (ADT) on the FBFL resp. on the Rødby – Puttgarden ferry in 2025, according to the extrapolation of the FTC 2002 study

Compared to about 5.400 road vehicles/day in 2011 on the Rødby – Puttgarden ferry traffic would grow to about 8.400 vehicles/day without the FBFL. In the case with FBFL the number would increase to about 11.700 vehicles/day which is about the figure of the FTC 2002 forecast ('high case'). The number of train is in total 118 in the with case.

1.4 Scope of Work in the FTC 2014 study

The FTC-model has been updated in the sense, that the scope and level of detail concerning

- the study area
- the zonal system
- the relevant traffic
- the differentiation into modes (road, rail, ferry, air)
- the sectorial structure of traffic

remain comparable to the FTC 2002 study.

Relevant is only the traffic between

- Denmark, east of Great Belt, Sweden, Norway, Finland on the one side and
- Germany, other continent (excl. CIS, Baltic States, Eastern Poland) on the other side

That means that the same way as in the FTC 2002 study, the following traffic flows are not considered:

- between eastern Denmark and western Denmark
- between Sweden, Norway, Finland and western Denmark
- between western Denmark and Germany resp. the rest of Europe
- between Sweden, Norway, Finland and the Baltic States, the CIS and eastern Poland

Figure 1-1: Zonal system in the core study area

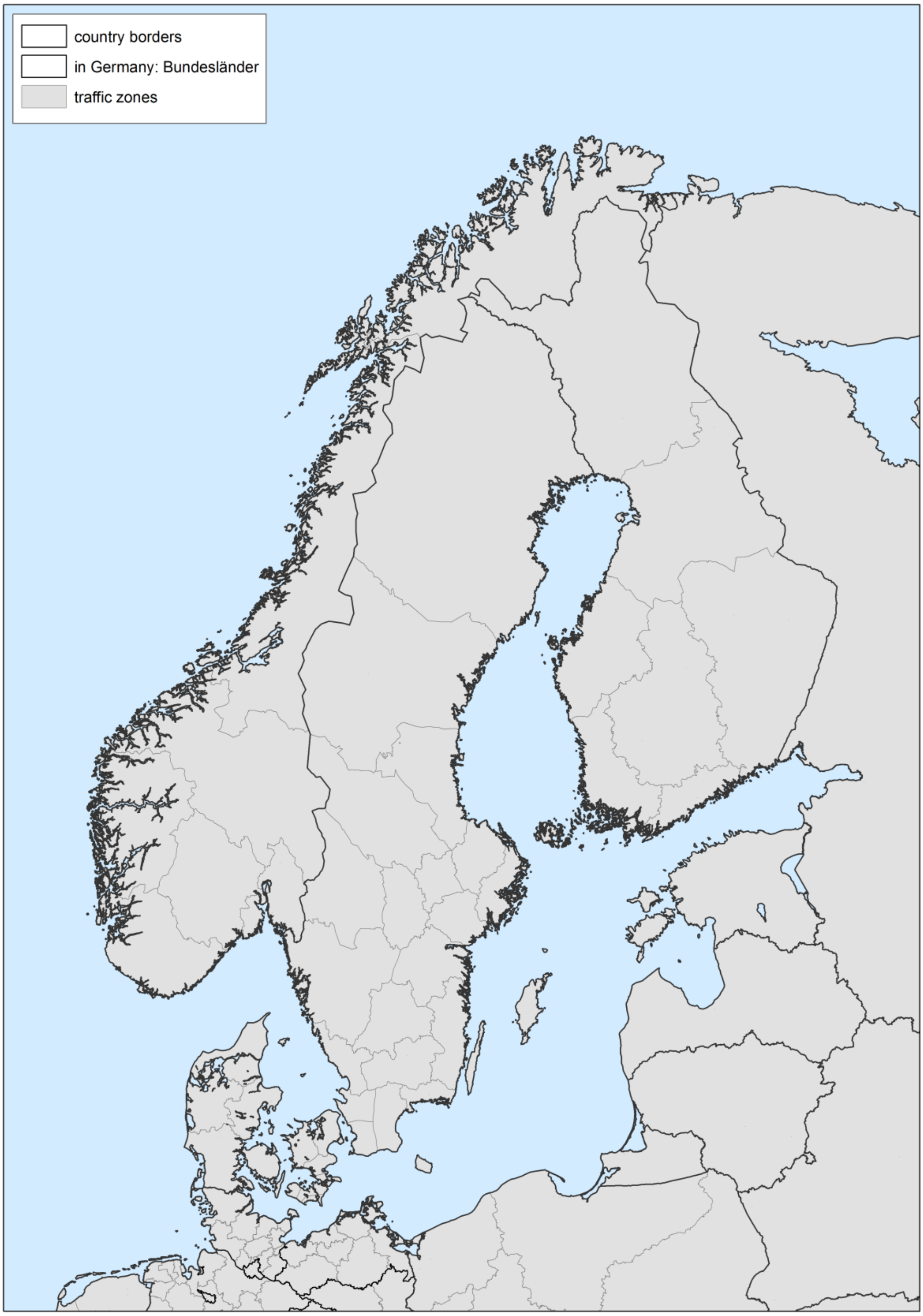


Figure 1-2: Zonal system in Northern Europe

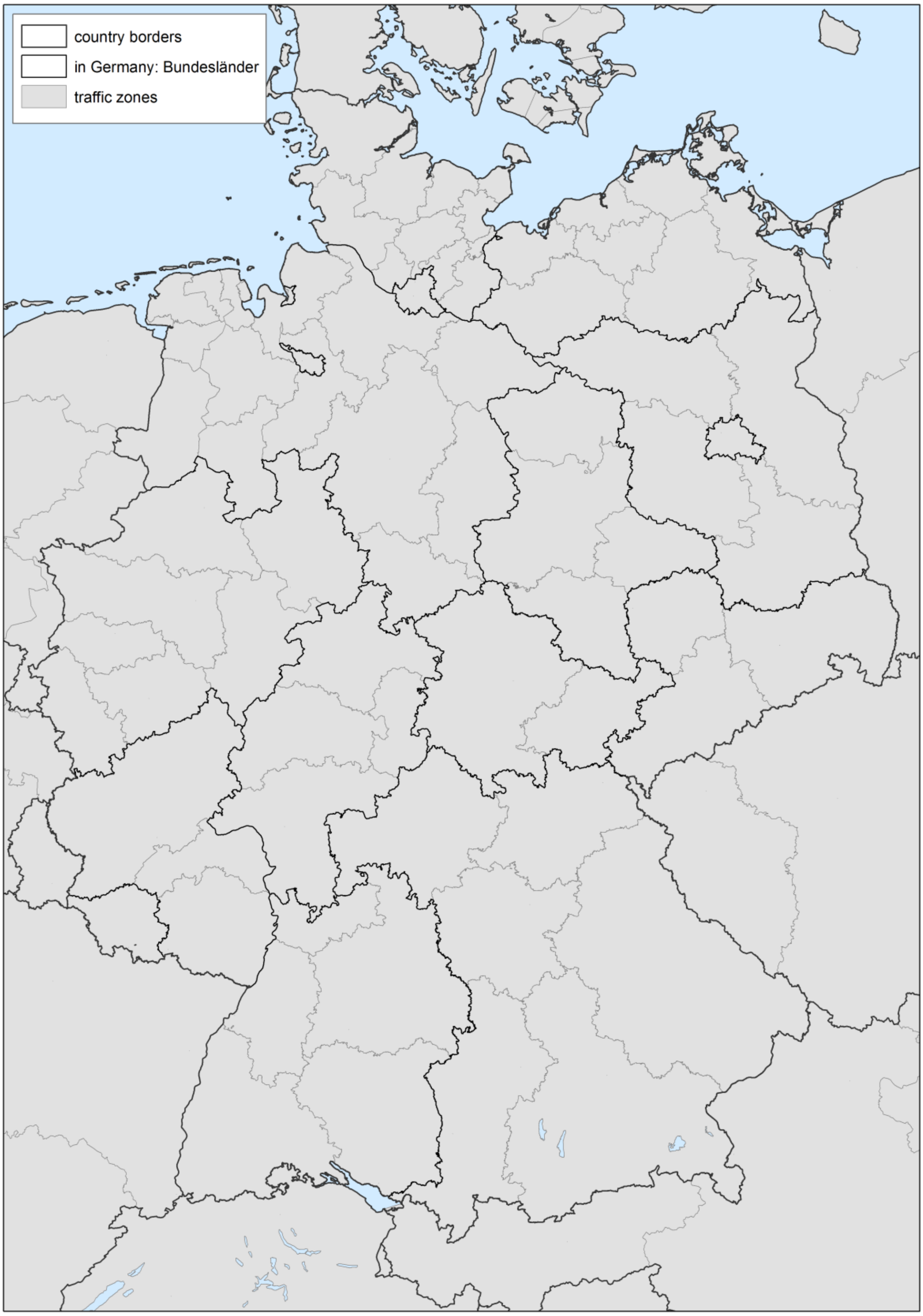


Figure 1-3: Zonal system in Germany

Figure 1-4: Zonal system in the rest of Europe

From experience with the old FTC studies it is known that the **'catchment areas'** of the ferry lines on the Baltic sea are **quite large**: Specially lorries are driving through more or less the whole continent. But even in passenger traffic there are many long distance trips. Mostly in summertime and specially for holiday traffic there are travelers cruising by car or camper vans all the way from Italy to Northern Norway and vice versa there are quite a few Scandinavian travelers driving by car to Southern France, Croatia or even to Spain. The single traffic flows of this type are small, but the **numbers in total are a considerable a potential** for the FBFL project.

For that reason it was necessary to define the **study area for the FTC study** 'generously' that is considering all traffic flows between Eastern Denmark, Sweden, Norway and Finland on the one side and the **whole continent** including the Mediterranean and Southeast England on the other side, even if the vast majority of relevant land based trips is related to the **'core study area',** which roughly can be defined as Eastern Denmark and Sweden on the one side and Germany on the other side.

With regard to the considered **modes and relevant traffic units** there is no difference to the FTC 2002 study (see Table 1-14). As in the FTC 2002 study ferry traffic is not considered as a single mode, but as a part of the transport chains. Air traffic had to be considered in passenger traffic to be able to calculate modal shifts from air to land due to the fact that the FBFL permits considerable time savings. For systematic reasons also for air traffic the total traffic between Scandinavia (east of Great Belt) and the continent has been considered, even if only a small share of it is competing with land based modes.

Traffic Volumes (per year, per ADT)	
passenger traffic	**freight traffic**
- car passengers (incl. motorcycles)	- road (tons)
- bus passengers	
- rail passengers	- rail combined (tons)
	- rail conventional (tons)
- ferry walk-on passengers	
- air passengers	
Vehicles (per year, per ADT)	
- cars (incl. motorcycles)	- lorries
- buses	
	- rail wagons
- passenger trains	- freight trains

Table 1-14: Modes and traffic units of the FTC study

Whereas for passenger traffic the segmentation into trip purposes has not changed substantially[22], there are some changes in the sectorial structure of freight traffic due to EUROSTAT definitions (see Table 1-15).

[22] Only one minor change due to statistical reasons: In the FTC 2002 study the limit of duration for the purpose 'holidays' was 'from 8 days'. In the study on hand this limit is at 5 days

FTC 2002

Commodity groups used in the old FTC studies (based on NST/R)		Mil. Tons 2001
0	Cereals, fruits and vegetables	1,0
1	Foodstuff and animal fodder	2,3
2	Wood and cork, textiles	2,8
3	Fuels	0,1
4	Ore, metals	4,0
5	Building materials	0,7
6	Fertilizers, chemicals	3,2
7	Transport equipment and machinery	3,6
8	Other manufactured articles	8,4
9	Paper pulp and waste paper	0,8
10	Miscellaneous articles	2,9
	TOTAL	29,6

FTC 2013

Proposal for new commodity groups (based on NST-2007)		NST-2007 divisions	Mil. Tons 2010
0	Agriculture, hunting and forestry	01	4,8
1	Food products, beverages and tobacco	04	6,1
2	Wood and cork, pulp, paper	06	6,4
3	Coal, crude petroleum, natural gas, coke, petroleum products	02,07	0,2
4	Ores, mining products, other mineral products	03,09	2,7
5	Metals	10	4,3
6	Chemicals, chemical products	08	2,4
7	Transport equipment and machinery	11,12	3,1
8	Other manufactured articles	05,13,14,15,16,17	5,0
9	Miscellaneous articles	18,19,20	7,5
	TOTAL		42,6

Table 1-15: Changes between FTC 2002 study and FTC 2014[23] in the sectoral structure of freight traffic

As in the FTC-model of 2002 **all relevant factors for the traffic development** of the FBFL are considered

- the autonomous growth (due to economy, population, car ownership etc.)
- the modal-split development (apart from the Fixed Link also dependent on user costs and hinterland infrastructure) for passenger traffic additionally 'induced traffic'
- the route choice (including competition with the ferry-lines).

As in the FTC 2002 study the results are presented both for the study area as well as for the FBFL itself. The results are calculated both in terms of traffic units (passengers, tons) as well as in vehicle units (cars, buses, lorries, trains/wagons).

The model is fed with the most recent data on

- demand/OD-matrices
- supply/network models incl. hinterland network and ferries
- prices/user costs incl. for ferries,

for the base year (2011) and for the forecast horizons as well (see below).

With regard to model sensitivities the model had to be re-estimated due to recent surveys and statistical data, which are available in Denmark, Germany and Sweden. The same is valid for the

23 Data from 2014

calibration, which is mainly carried out on the basis of ferry statistics (passengers, cars, busses, lorries), Great Belt traffic counts and railway count data (Jylland/Flensburg).

Different from the FTC 2002 study - which basically focused on one forecast year (2015) - the updated FTC-model of 2014 is designed as a model for **medium and long term forecasts for different forecast years**. Here a two-step-process has been applied:

(1) several main forecast years (pillar years), for which full scale model runs including all inputs and outputs are calculated

(2) qualified inter- and extrapolation on aggregate level resp. for the key results, to get the complete forecast time series.

As pillar years have been fixed

- 2022 with case (first year of operation of the FBFL) in two variants: full FBFL effect and including a ramp-up effect.[24]
- 2022 without case (in comparison with the '2022 with case' with full FBFL effect) to see the effect of FBFL
- 2025 (with FBFL) as year when the ramp-up phase is finished = main medium forecast year
- 2035 (with FBFL) as long term forecast year.

As the planning approval process in Schleswig-Holstein is concentrating on the horizon 2030, and for better comparability with the current BVWP process, all results have been calculated for 2030 as well.

The **total forecast period** goes to 2047 (25 years from 2022, that is the assumed the first full year of operation of FBFL).

Two scenarios have been calculated. The first scenario is the **Case A,** using the set of assumptions as fixed for the planned German **BVWP** 2015, that is for the user costs and transport prices, the socio-economic key figures and key assumptions with regard to the infrastructure. The second scenario based on the assumptions by the **Danish Ministry of Transport ect.** which are also being used in the recently developed Danish National Transport Model is the **Case B.**

24 If nothing mentioned specific under the table it is with ramp-up effect.

1.5 Common features and differences between the FTC studies of 2014 and 2002 (overview)

Apart from the update of the base year data and the forecast assumptions the scope of the FTC 2014 is widely the same as in the FTC 2002 study

- for comparability reasons and
- due to the fact that the FTC study of 2002 had an appropriate and widely accepted scope with regard to the methodical framework, the level-of-detail and the quality of data resources.

Of course, the knowledge both in modelling as with regard to empirical findings has grown since 2002, generally and in the study area. Therefore the 'update' and 'extension' is not a direct 're-load' of the FTC model 2002 and its computer programs, but an appropriate re-development.

However with regard to the
- general study approach and basic methods
- the scope and level-of-detail
- the basic definitions

the FTC 2014 Forecast is well comparable to the FTC 2002 study. These parallels and differences of the study on hand (FTC 2014) and its predecessor (FTC 2002) are summarized in the following Table 1-16.

Item/Scope	FTC 2002	FTC 2014
Model based forecast	° traffic growth model (passengers/freight) ° modal-split (passengers/freight) ° induced/distributed traffic (passengers) ° route choice assignment (passengers/freight)	as FTC 2002, models include findings/ quality improvements since 2002
Base year traffic flows	widely empirical, based on ° counts (ferry statistics) ° passenger surveys on most relevant ferries (OD-flows, trip purposes) ° international freight traffic OD statistics, flanked by on board surveys	As 2002 widely empirical with similar sources and quality: ° passenger/freight surveys, no own surveys, but use of those for the Danish Transport Model ° more detailed consideration of Great Belt traffic

Item/Scope	FTC 2002	FTC 2014
	° rail and air OD-flow statistics	data ° other statistical surveys as FTC 2002, partly with better quality (passenger railway, freight OD-data)
Modes considered	Passengers: car, bus, rail, air, ferry walk-on Freight: rail (combined/conventional), road	as FTC 2002
Routes considered	all international ferry lines from Jylland in the West till Swinoujscie in the East	as FTC 2002, more detailed consideration of Great Belt traffic.
Traffic units	demand model: ° passenger: trips ° freight: tons assignment model: ° passenger: cars, bus, passengers in trains ° freight: lorries, rail wagons/trains	as FTC 2002 (freight: more sophisticated train compilation model)
Demand segmentation	° passengers: trip purposes ° freight: freight segments	as FTC 2002 model with detailed segmentation ° passengers: widely same segments and their differentiation as FTC 2002 ° freight: NSTR segmentation of Eurostat has changed since 2002
Relevant traffic/scope of traffic flows	international traffic between Germany and the continent (from Spain to Poland) on the one side and Denmark, Sweden, Norway, Finland on the other side	as FTC 2002
Zonal system	Aggregation in the neighborhood disaggregation of NUTS 3 spatial units of Eurostat	similar to FTC 2002, changes due to territorial re-organi-sation and changes in regional statistics in the countries
Considered variables ('drivers') for traffic growth	° passengers: population, employment, GDP per capita/income levels, car ownership, user cost levels ° freight: GDP, foreign trade flows per sector	as FTC 2002
Considered variables for the modal-split model (passengers: also induced traffic)	° travel/transport time per mode (all time components incl. access/egress, terminal	as FTC 2002

Item/Scope	FTC 2002	FTC 2014
	time, transfer etc.) ° travel/transport costs per mode ° service frequencies ° service levels	
Considered variables for the route choice/assignment	° travel time per route, consideration of service frequencies of the single ferry lines, consideration of 'saved' rest periods when using ferries ° transport costs dependent on route length and incl. fare- and toll-levels	as FTC 2002
Model calibration (OD-matrix and route choice)	° on ferry statistics	° on ferry statistics plus Great Belt traffic counts (share of international traffic)
Base year	2002	2011
Forecast year/period	2015: Base Case (with FBFL) 2015 Reference Case (without FBFL) 2025 trend extrapolation only for FBFL in two variants	2022: 'before case' (without FBFL) 2022 'opening case' (with/without ramp-up-effects, the latter to see effects of FBFL independent from other variables) 2025 'medium term case' (ramp-up finished) 2035 'long term case' (complete time series for 2012 to 2047 for FBFL only)
Scenarios	° Base Case A: 'German/BVWP case') ° Base Case B ('DK case = relevant case for FBFL decision) ° four scenarios with different assumptions on ferry-level of service/price strategies incl. one case with a parallel Rødby-Puttgarden ferry to the FBFL	° Case A (compatible with assumptions of ongoing BVWP) ° Case B (compatible with assumptions of the Danish Ministry of Transport)

Table 1-16: Parallels and differences between the FTC studies from 2002 and 2014

2 BASE YEAR TRAFFIC AND TRAFFIC DEVELOPMENT SINCE THE FTC-STUDY 2002

2.1 Passenger Traffic

2.1.1 Data Sources

The FTC 2014 forecast model was prepared by updating the forecast models of 2002. Apart from the methodological updates described below in chapter 3, the base year model had to be re-calibrated using a large amount of different data sources.

The database of travel relations was accumulated from surveys and statistics, and demand matrices available from previous FTC and other forecasts made by ITP. The matrices of the Danish National Transport model were used for cross-checks of traffic on the Danish side as well as the validation of demand related benchmarks.

In detail the following sources for **demand data** have been used (see Table 2-1).

Apart from the demand data, data had to be collected for the networks resp. the **supply**:

° road network model (all relevant roads, type of roads)
° rail network model (lines, frequencies, travel time, travel costs)
° air traffic model (flights per OD and connecting flights, travel time, travel costs, access/ egress)
° ferry timetables and fares, access/egress situation

The multimodal supply model consisting of all relevant roads, the complete European railway network with all significant lines including frequencies and costs as well as an air traffic model with all necessary attributes was used in the forecasts. Sources included the database of existing infrastructure and connections, as well as network development plans from all around the continent.

Data source	Level-of-detail	role in the study
(1) Ferry statistics (statbank Denmark, trafik analys Sweden)	- passengers and vehicles per ferry-line and vehicle type (yearly, since 2000)	- overall traffic volumes in relevant study corridor - calibration of route choice model
(2) Great Belt traffic statistics (Størebelt A/S)	- vehicles per vehicle type and year	- together with surveys on intern. traffic on Great Belt (counts of license plans) the share of traffic could be estimated, which is relevant for the study
(3) Passenger surveys 2010 on Baltic Sea ferries (for the Danish Traffic Model)	- sample for the most important ferries in the study area	- OD structures - trip purposes - modal split
(4) Air traffic flows between airports (Statistisches Bundesamt/ EUROSTAT)	- traffic flows between Scandinavian airports and airports in Germany and the other Europe	- overall air traffic volumes in study corridor (supplementary to (1)) - regional pattern of traffic
(5) Railway country-country flows (statbank Denmark, Statistisches Bundesamt)	- passenger railway traffic between countries, in Germany per Bundesland	- calibration for railway matrices on country/ Bundesland level
(6) OD-matrices from European Traffic Model (ITP from the Railteam study 2010/2011); data among others from extrapolated German OD-matrices 2007	- OD matrices for all modes incl. traffic between Germany and the Scandinavian countries	- starting point for the FTC 2014 matrices
(7) Matrices of the Danish Transport Model (part international traffic)	- zonal system in Denmark	- spatial disaggregation of (6) on Danish side - check of overall traffic volumes and structures

Table 2-1: Data sources for the compilation of the base year matrices of passenger traffic

With regard to the varying **fares** a special data collection for the client could be used. With regard to the s**ocio-economic data** the following data have been used:

- inhabitants per zone and age group
- employment per zone
- car ownership per zone

- GDP/GDP p.c. per zone
- touristic accommodation per zone

Socio-economic data of all traffic relevant indicators were compiled on zonal level (see zonal system in chapter 1.4).

Main sources for these data were from the statistical offices in Denmark, Germany and Sweden and the 'New Cronos' regional database of EUROSTAT.

2.1.2 Compilation of a consistent database for passenger traffic

In Figure 2-1 the process of the compilation of the OD-matrices for passenger traffic is shown.

Starting point are the European matrices of ITP for 2007 which were used for several international studies (Railteam) and which are compatible to German matrices for long distance traffic. The relevant traffic flows for the FTC-study were extracted and extrapolated from 2007 to 2011 with help of key figures about ferry traffic (plus Great Belt international traffic), railway traffic and air traffic on country-country level.

These matrices had to be refined with regard to the zonal system on the Danish/Scandinavian side which was done with help of the traffic flow data from the Danish Transport Model and from regional demographic data. For the main traffic flows the passenger surveys on ferries have been used to adjust the OD structure, trip purposes and the modal split. These matrices were assigned to the networks and calibrated in detail on the basis of the ferry statistics (plus Great Belt) per selected link.

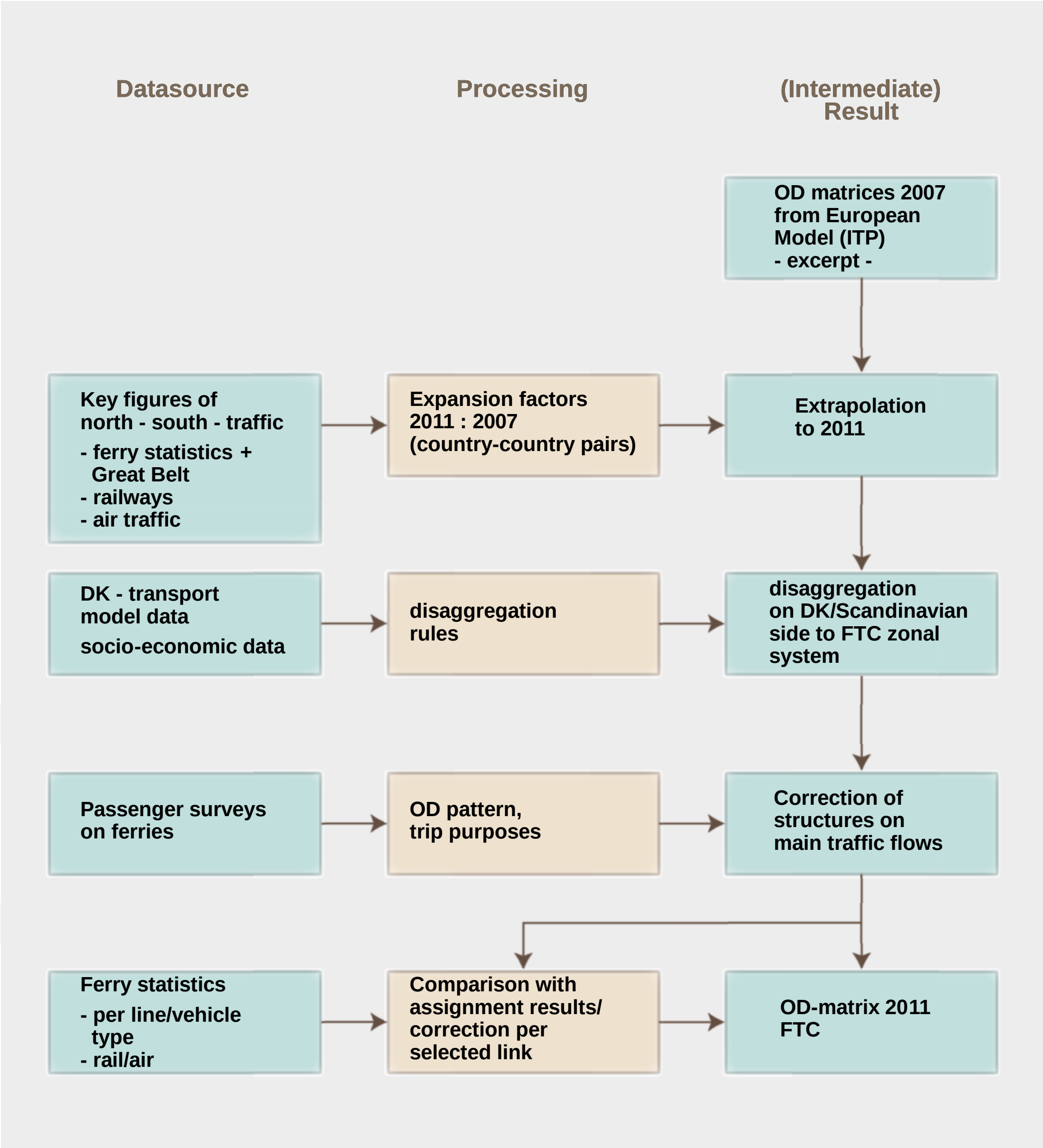
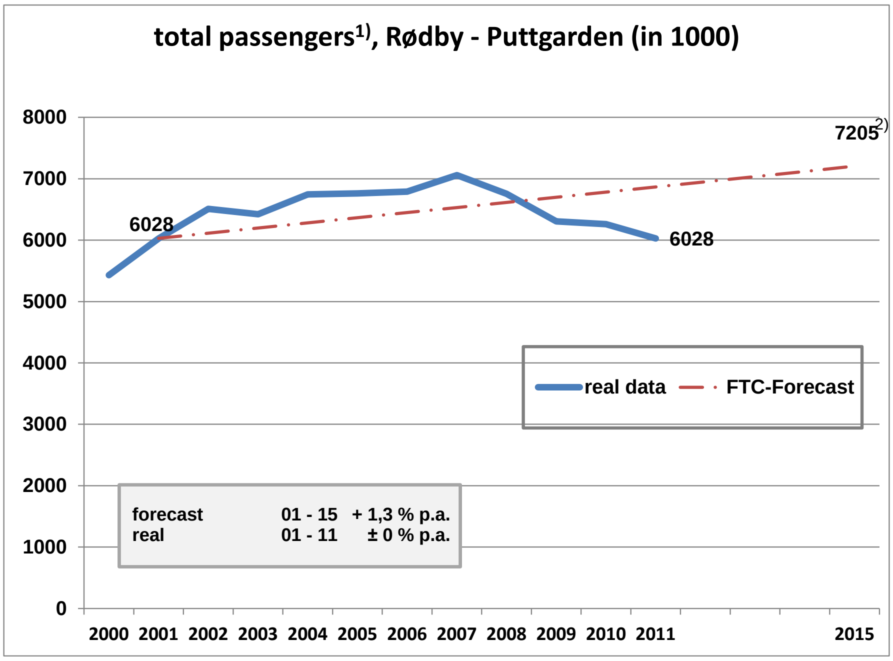


Figure 2-1: Processing of the FTC-matrix for passenger traffic

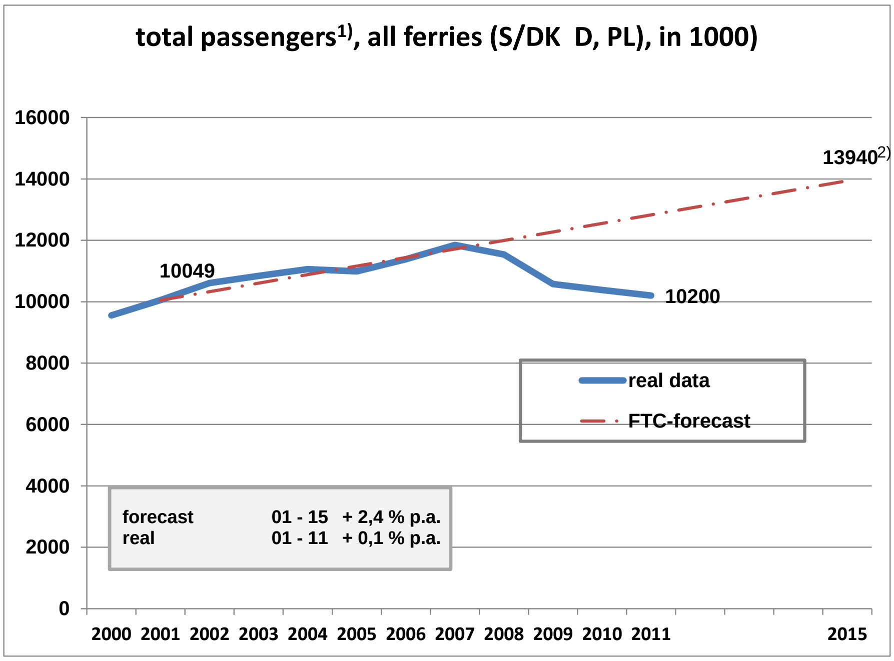
2.1.3 Traffic development 2000 – 2012

After a period of robust growth between 2000/2002 and 2007, which was well in line with the FTC forecast of 2002, ferry traffic dropped after 2007 nearly to the level of the base year 2001 of the FTC 2002 study. This can be observed both for the number of passengers as for the number of car transports and both for the Rødby - Puttgarden ferry as for all ferry lines in the study corridor (see Figure 2-2 to Figure 2-5).



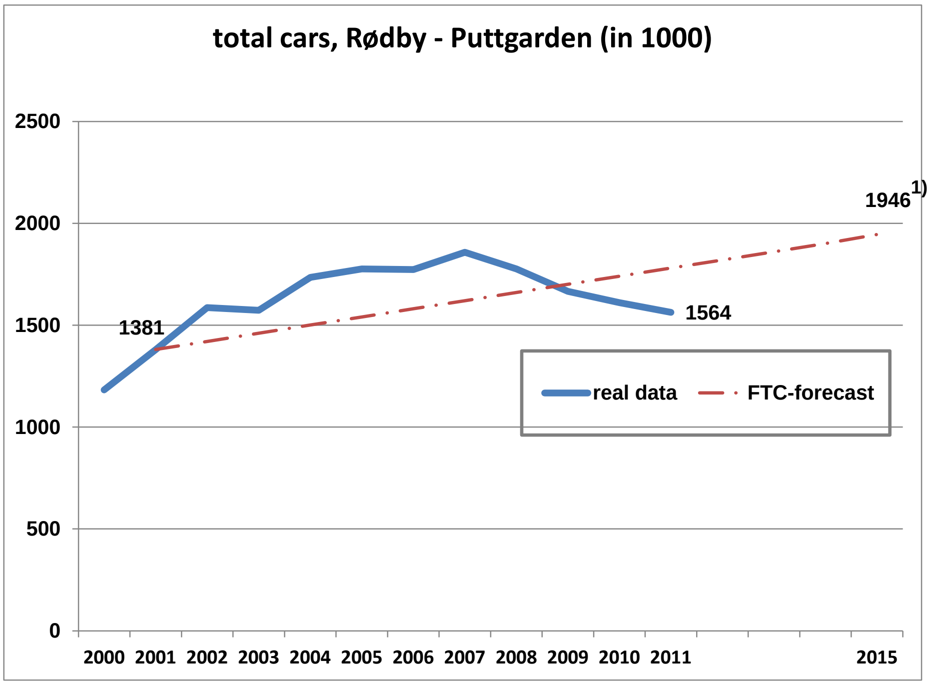
1) passengers in cars, bus, rail or ferry-walk-on
2) Reference Case B, results of assignment for the ferry lines, adjusted to the official statistics

Figure 2-2: Traffic development on the Rødby-Puttgarden ferry (blue line) and comparison with the FTC forecast of 2002 (red line) - total passengers



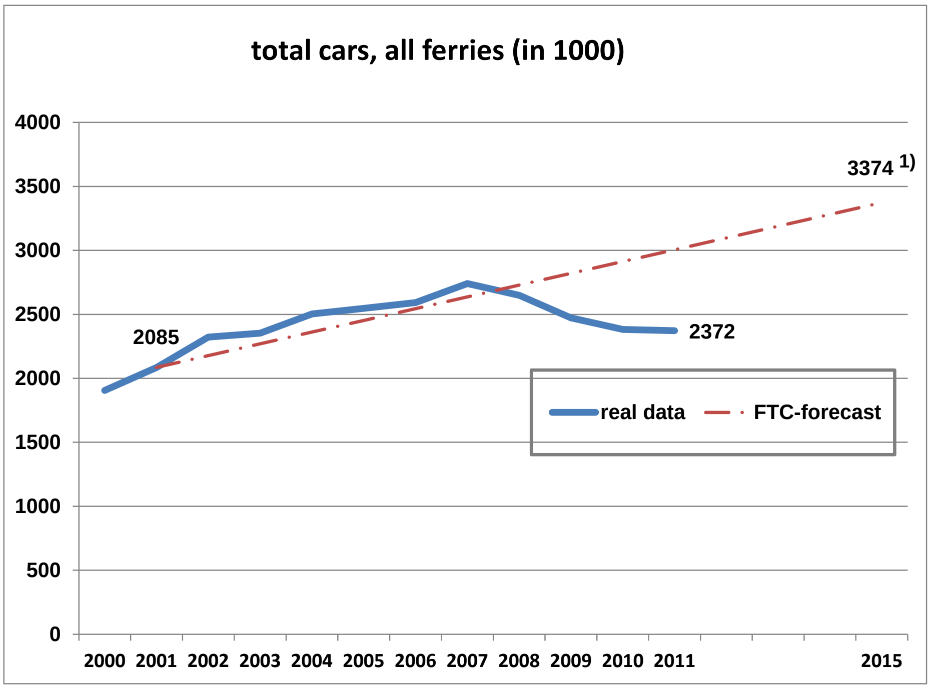
1) passengers in cars, bus, rail or ferry-walk-on
2) Reference Case B, results of assignment for the ferry lines, adjusted to the official statistics

Figure 2-3: Traffic development on all ferries for from Denmark to Poland (blue line) and comparison with the FTC forecast of 2002 (red line) - total passengers



1) Reference Case B, results of assignment for the ferry lines, adjusted to the official statistics

Figure 2-4: Traffic development on the Rødby-Puttgarden ferry (blue line) and comparison with the FTC forecast of 2002 (red line) - car transports on ferry



1) Reference Case B, results of assignment for the ferry lines, adjusted to the official statistics

Figure 2-5: Traffic development on all ferries (blue line) and comparison with the FTC forecast of 2002 (red line) - car transports on ferries

The reasons for the stagnation of traffic are threefold

(1) From 2007 traffic dropped due to the world economic crisis, which started 2008 and influenced considerably international travel even in the study area.

(2) After a period of severe price competition around the base year of the FTC study 2002, ferry companies consolidated and prices went up. Especially for walk-on-traffic and short trips, stimulated by special offers, prices went up with the effect of decreasing passenger figures.

(3) The Great Belt toll rates were reduced by 20 % in 2005 and stayed constant since then in real terms (adjusted only to inflation) and in air traffic there was a boom of Low-fare-airlines and offers, which stimulated the traffic and led partly to shifts from land based resp. ferry traffic to air traffic.

On **Great Belt** (see Figure 2-6) a strong and almost steady growth can be seen. The economic crisis had only a slight effect. A considerable amount of traffic from the ferries, esp. Rødby - Puttgarden, must have shifted to the Great Belt-route especially since the toll rates have been reduced by 20 % in 2005.

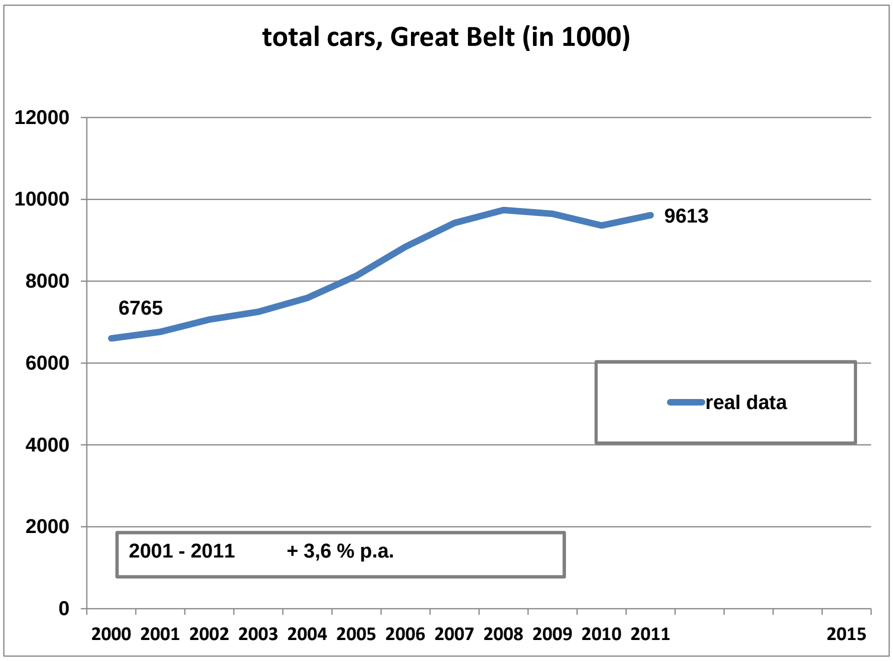


Figure 2-6: Traffic growth on Great Belt (passenger cars)

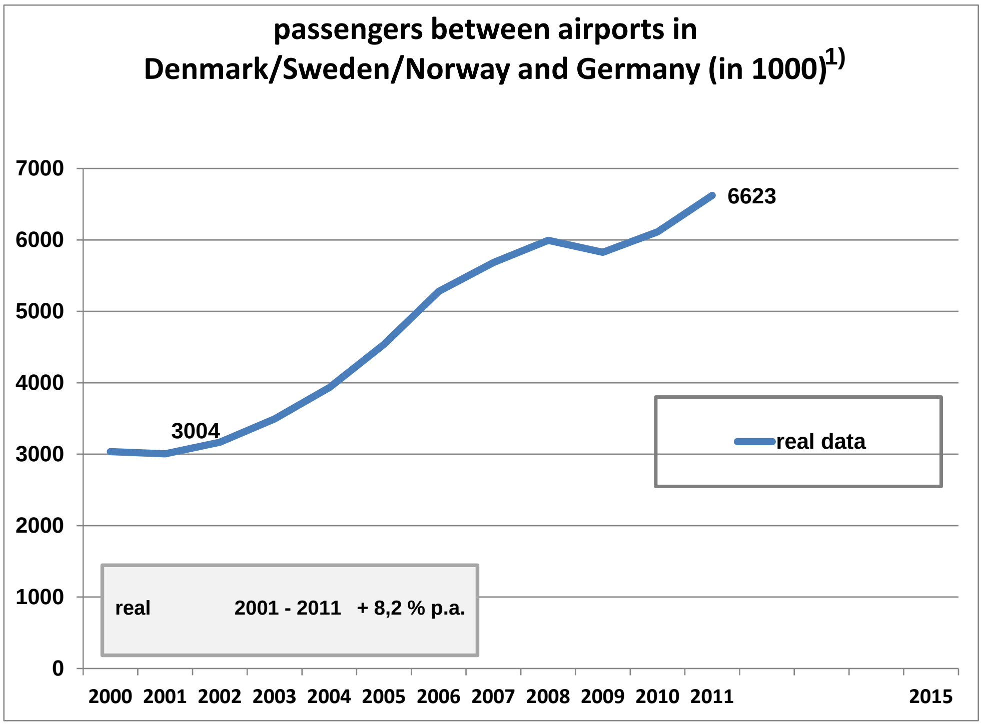
A considerable share of traffic has been observed being related to international traffic.[25] Assuming that cars registered in Eastern Denmark are using the Great Belt to the same extent as foreigners for international trips, the share of traffic crossing Great Belt in the direction Germany/Continent on the one side and Easter Denmark and the Scandinavian Peninsula on the other side is around 8 % of passenger traffic crossing the Great Belt. The model calculations come, consistent with that figure to 713 thousand cars and 1.437 thousand passengers per year.

For the relation between Hamburg and Copenhagen the Great Belt route means a detour of about 140 km compared to the Fehmarn Belt route. However, in term of travel time the routes are nearly the same: The cruising time for the Rødby-Puttgarden ferry is 45 minutes. Including waiting time (15 minutes/average) and access/egress time (together 15 minutes) it takes 75 minutes, matching the detour via the Great Belt. However, even including fuel costs the Great Belt route is cheaper (bridge toll 33 €, year round, against 65 € assumed average for the Rødby-Puttgarden ferry, strong seasonal variation). Especially in summer the price spread is considerably in favour of the Great Belt. At the same time in summer there may be capacity problems on the ferry and especially for camper vans/caravans the prices are higher on the ferry. Therefore especially holiday traffic (for price and capacity reasons) and business traffic (for flexibility and reliability reasons) are using to a high extent the Great Belt instead of the Rødby-Puttgarden ferry.

Air traffic between Scandinavia and Germany (see Figure 2-7) has more than doubled between 2001 and 2011. A growth rate of 8,2 % per annum in average could not be without effects on the land-based resp. ferry-bound traffic.

---

25 Plate counts in summer give a share of 5 to 6 % of foreign cars, in winter the share is 2 to 3 %.



1) Including transfer passengers

Figure 2-7: Traffic growth between airports in Scandinavia and Germany

2.1.4 Total traffic Scandinavia - Continent per mode and regional structure

In Table 2-2 the total traffic 2011 in the study corridor, that is Northern Europe (here: Norway, Sweden, Finland, Denmark east of Great Belt) and Germany/the rest of Europe (without CIS, Baltic States), is shown.

Most important mode for this traffic is air traffic, which counts for 56 % of the market. This is due to the distance structure in the north-south-traffic. However, it has to be considered that there is a big share of 'very long' distances, for example between Scandinavia and the Mediterranean, between Finland and Western Europe etc. which is rather naturally assigned to air traffic. For the traffic flows between eastern Denmark and Germany for example the share of air traffic is much lower, about 10 % (see Table 2-4). The reason to consider also the air traffic for example between Italy and Scandinavia is the fact that there is land based traffic also on this long distances (mainly holiday traffic), which is relevant also for a future FBFL. To cover the whole traffic market means also to include these traffic flows.

Mode	2011	
	1000 passengers/ year	Modal -Split in percent
Rail	460	1,5
Car	8 970	29,4
Air	17 226	56,5
Bus	2 320	7,6
Ferry Walk On	1.512	5,0
Total	**30.488**	**100**

Table 2-2: Passengers and modal-split in 2011 for the **total traffic between Northern Europe** (Norway, Sweden, Finland, Denmark only east of Great Belt) **and the rest of Europe** (without CIS, Baltic States)

In the contrary to the other modes, **only a share of air traffic is related to the 'core study area'**, that is here: Eastern Denmark and Sweden in the north and Germany in the south (see Table 2-3):

Mode	2011	
	1000 passengers/ year	modal split in percent
Rail	266	2,4
Car	6 230	56,0
Air	1 657	14,9
Bus	1 518	13,7
Ferry Walk On	1.446	13,0
Total	**11.117**	**100**

Table 2-3: Passengers and modal split in 2011 for the traffic between **East Denmark and Sweden** in the north and **Germany** in the south

Second most important mode in the whole study area is car traffic, which counts for nearly 30 % of the total traffic. But in the core study area car traffic is by far the most important mode (see below Table 2-4). Rail traffic is of relative low importance (modal share only 1,5 % in the whole study area, 2,4 % in the core study area), less than bus traffic (mainly charter bus) and even less than the 'special' ferry-walk-on traffic.

In Table 2-4 and Table 2-5 the traffic flows for 2011 are shown on a more detailed level. Comparing the two tables, it can be seen that nearly half of the north-south-traffic is related to Germany. Here the most important mode (about 50 %) is car traffic (see Table 2-4), whereas the traffic Scandinavia to the rest of Europe (see Table 2-5) is to more than 80 % bound to air traffic, which only to a small extent can be captured by a future FBFL resp. by modal split. Germany to East Denmark is the most important traffic flow, potentially relevant for the FBFL and in the second rank the traffic between Germany and Sweden.

Relation		**1000 passenger trips/year**					
		Rail	**Car**	**Air**	**Bus**	**Walk-On**	**Total**
Germany	East-Denmark	203	3.690	675	873	1.191	6.632
Germany	Sweden	63	2.540	982	645	255	4.485
Germany	Norway	4	809	1.205	195	12	2.225
Germany	Finland	5	67	583	46	32	733
Germany	**Total**	**275**	**7.106**	**3.446**	**1.760**	**1.490**	**14.077**

Table 2-4: Traffic between Germany and Scandinavia

Relation		1000 passenger trips/year					
		Rail	Car	Air	Bus	Walk-On	Total
Rest-Europa	East-Denmark	109	623	3.679	167	22	**4.601**
Rest-Europa	Sweden	66	894	5.572	251	0	**6.782**
Rest-Europa	Norway	4	301	2.652	86	0	**3.044**
Rest-Europa	Finland	6	46	1.877	56	0	**1.985**
Rest-Europa	**Total**	**185**	**1.864**	**13.780**	**560**	**22**	**16.411**

Table 2-5: Traffic between the other Europe and Scandinavia

The distribution of passenger traffic per region is illustrated in the following maps, differentiated into Northern Europe and the rest of Europe as well as in origin round trips and destination round trips. Especially the figures given to trips per inhabitant show a clear relationship of distance: The closer the region to the Baltic Sea/resp. the Fehmarn Belt, the higher is the traffic per inhabitant.

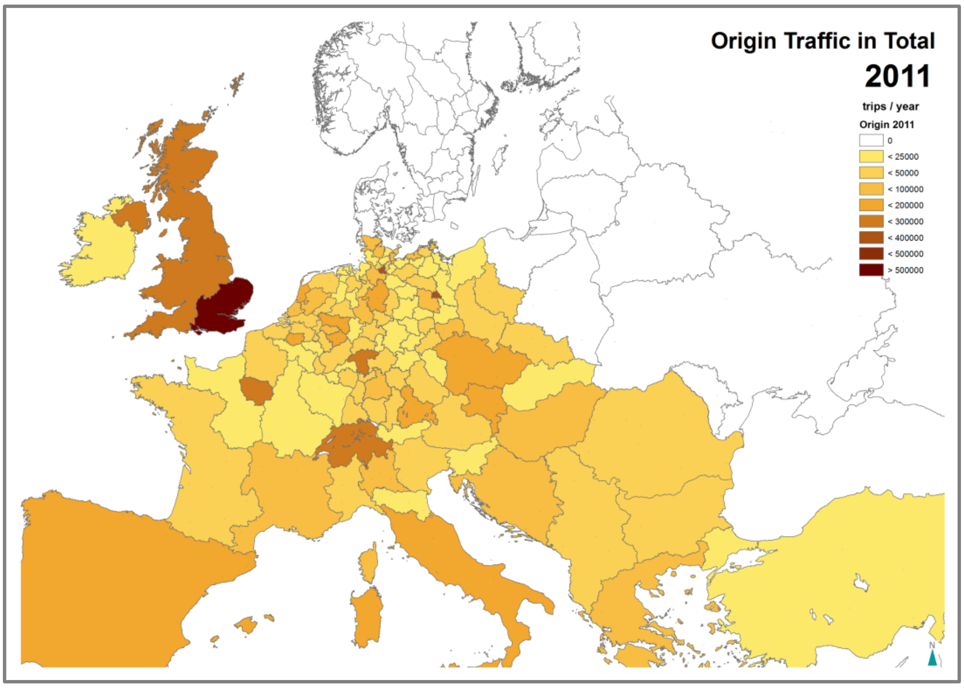


Figure 2-8: Scandinavian bound traffic on the continent per region - originating traffic

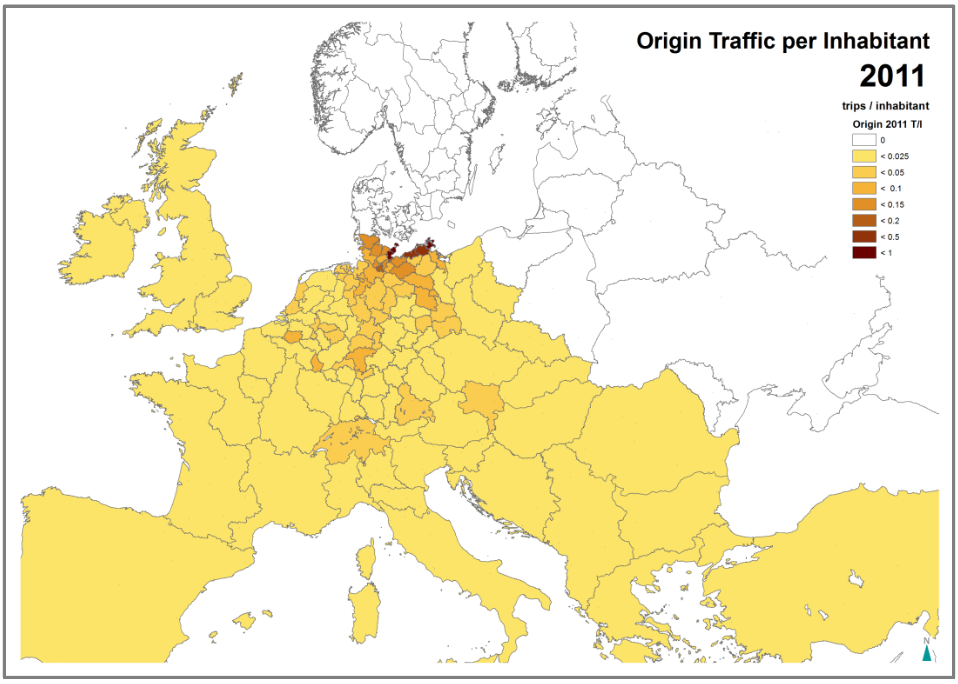


Figure 2-9: Scandinavian bound traffic on the continent per inhabitant - originating traffic

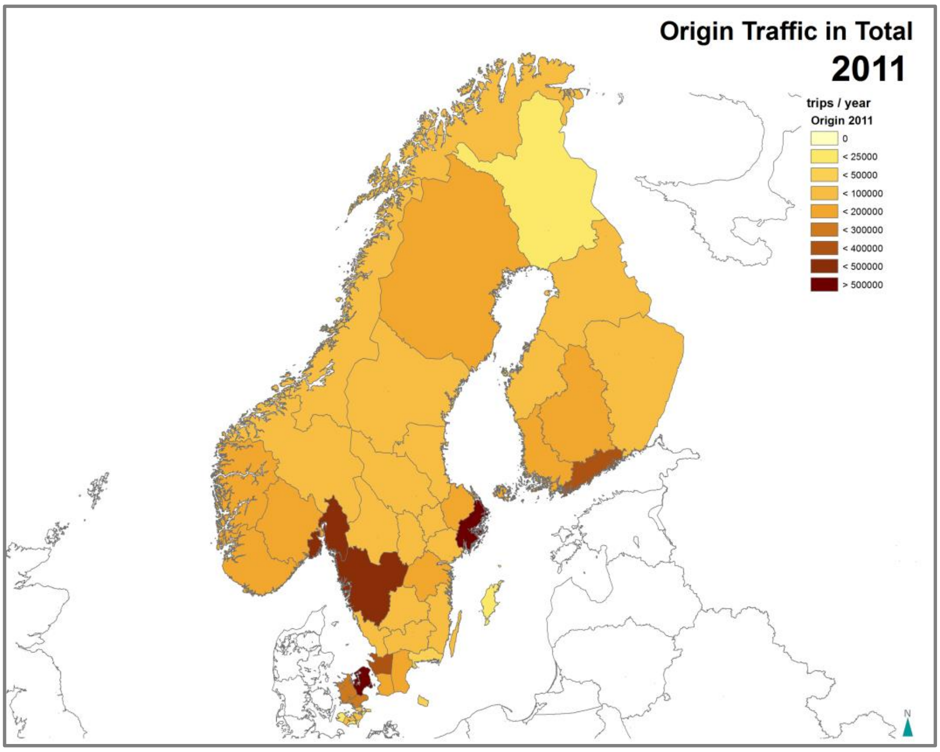


Figure 2-10: Continent based traffic per region in Northern Europe (without west Denmark) - originating traffic

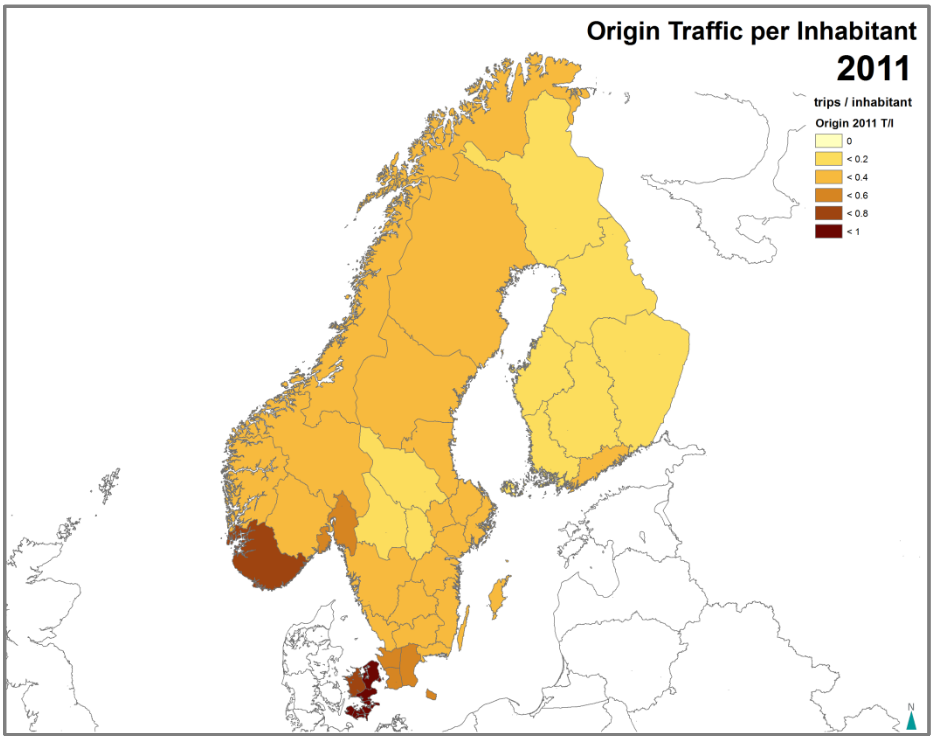


Figure 2-11: Continent based traffic per inhabitant in Northern Europe (without west Denmark) - originating traffic

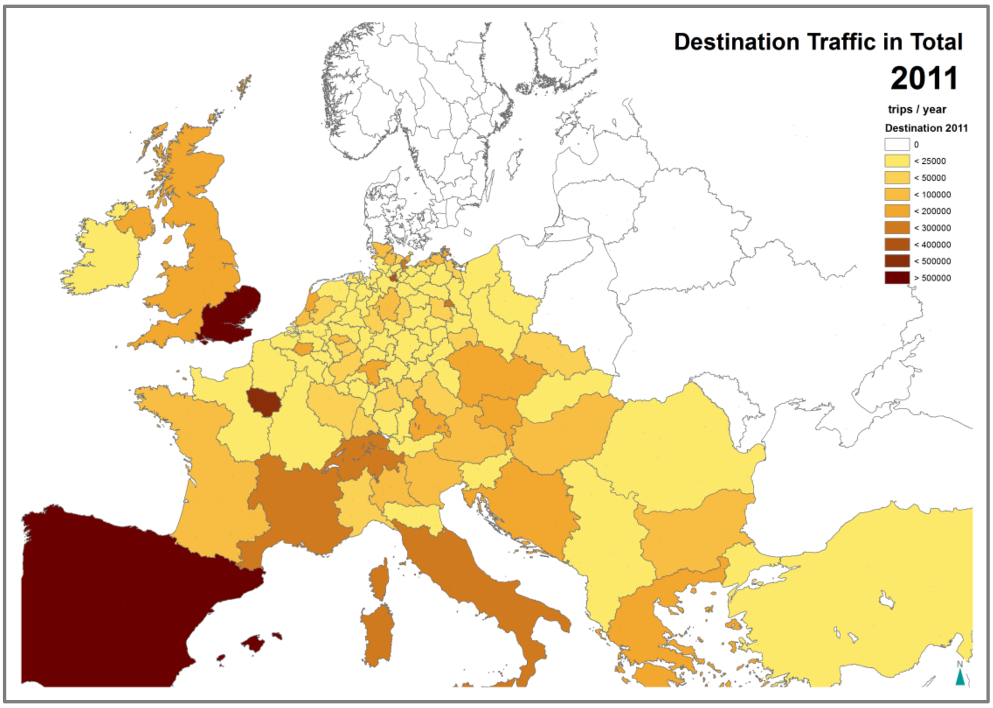


Figure 2-12: Scandinavian bound traffic on the continent per region - destination traffic

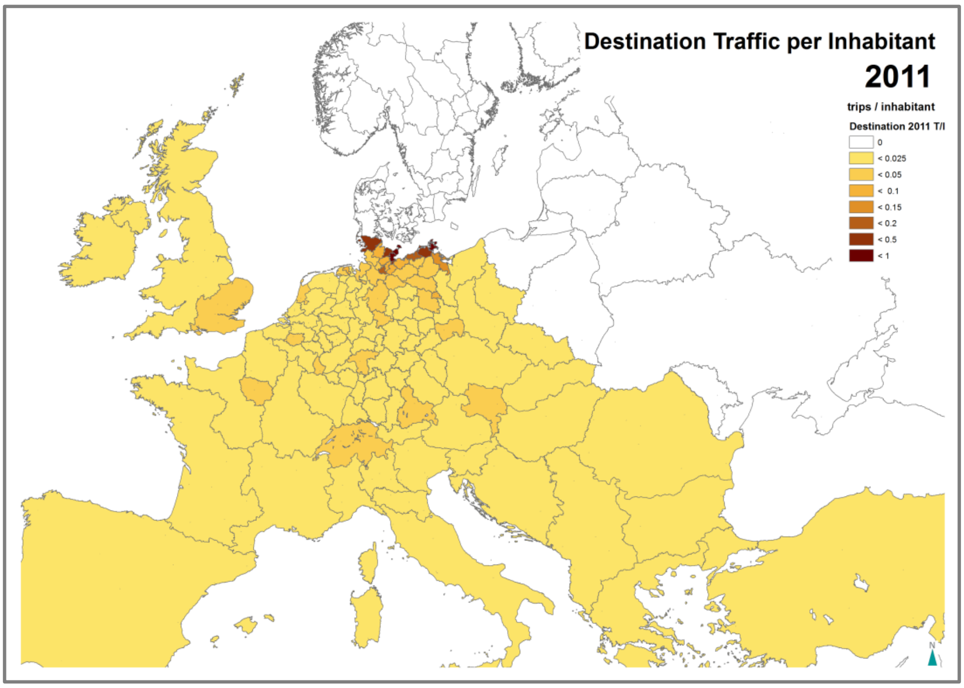


Figure 2-13: Scandinavian bound traffic on the continent per inhabitant - destination traffic

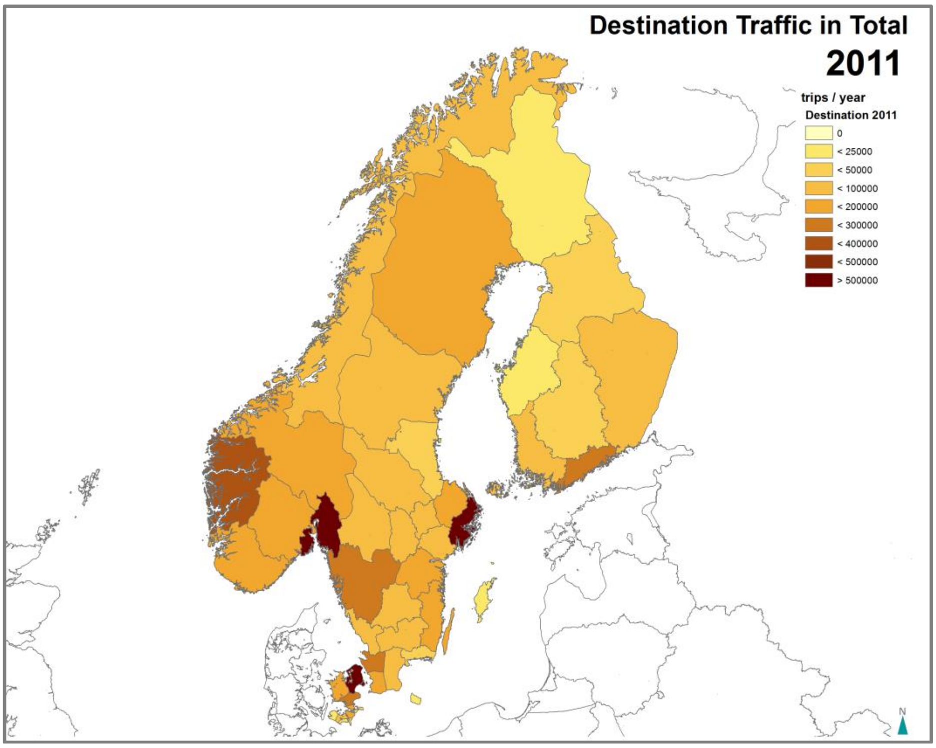


Figure 2-14: Continent based traffic per region in Northern Europe (without west Denmark) - destination traffic

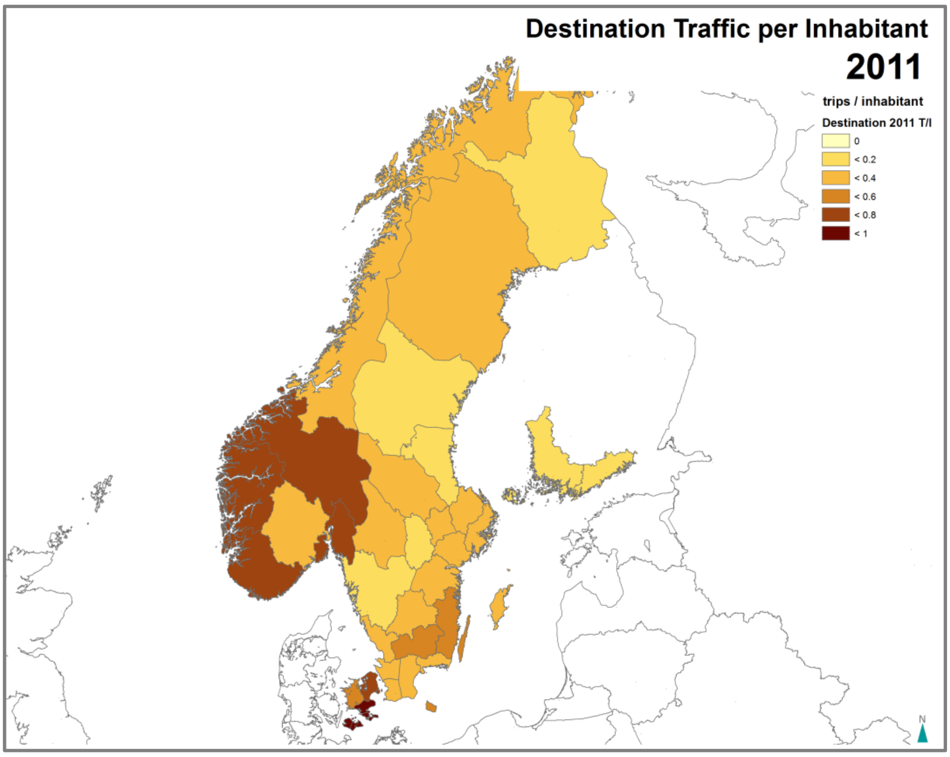


Figure 2-15: Continent based traffic per inhabitant in Northern Europe (without west Denmark) - destination traffic

2.1.5 Changes between 2011 and 2001

In Table 2-6 it is shown that between 2001 (base year of the FTC 2002 study) and 2011 (base year of the FTC 2014 study), **traffic growth** was considerable, but **more or less exclusively related to air traffic**. Especially the long distance land based traffic has been reduced, mainly for bus and rail. [26] Apart from that ferry-walk-on traffic has been reduced considerably since 2001. There was indeed a shift between land based traffic to air traffic due to Low Cost Airlines activities and an increase in direct flights including many new destinations between Scandinavian airports and the Continent. This development has not stopped and consequences and future developments have to be considered in the forecast in FTC 2014. Only by that the **relevant traffic for the FBFL** can be evaluated in a proper way. This is also the reason that air traffic had to be considered in a comprehensive way in the FTC-study.

	1000 passengers/year		
	2011	**2001**	**change in %**
Rail	460	854	-46,1
Car	8 970	8.498	5,6
Air	17 226	9.905	73,9
Bus	2 320	2.739	-15,3
ferry Walk On	1.512	1.929	-21,6
total	**30.488**	**23.925**	**27,4**
thereof land based	11.750	12.091	-2,8

Table 2-6: Traffic growth between 2001 and 2011 for the total traffic between Northern Europe (Norway, Sweden, Finland, Denmark only east of Great Belt) and the rest of Europe (without CIS, Baltic States)

[26] Here there may be also some statistical inconsistencies between 2001 and 2011: Statistics on international railway traffic flows between countries and regions are only available from 2005 due to an agreement of EURSTAT. However, the tendency should be clear: very long distance railway traffic (trips longer than 800 km, partly covered by night trains) have been reduced considerably due to air traffic.

2.1.6 Rødby - Puttgarden traffic

The traffic crossing the Fehmarn Belt resp. using the ferry Rødby - Puttgarden in 2011 and for comparison in 2001, is shown in Table 2-7.

	2011	2001	change in %
Passengers (1000/year)	**6.028**	**6.028**	**0**
Thereof			
passenger in cars	3.973	3.690	+8
passengers in bus	1.142	1.268	-10
passengers in trains	394	352	+12
ferry walk-on	519	718	-28
Vehicles (1000/year)			
cars (incl. motorcycles)	1.564	1.380	+13
Buses	30,5	32,1	-5

Table 2-7: Traffic crossing the Fehmarn Belt 2011 and for comparison 2001

The number of passengers 2011 and 2001 are exact the same (no printing error!). However, the structure has changed:

- more passengers in cars and trains
- less passengers in buses and less walk-on passengers.

2.1.7 Trip purposes and nationality 2011

Derived from surveys and assigned to the model relevant segments the structure of **trip purposes** for the travellers on the Rødby - Puttgarden ferry 2011 is shown in Table 2-8.

Trip Purposes	2011	
	(1000)	(%)
business	741	12,3
day commuter[1)]	121	2,0
weekend commuter	301	5,0
shopping	1.206	20,0
other day excursion	663	11,0
visiting friends/relatives	784	13,0
short holidays	796	13,2
holidays	1.416	23,5
Total	**6.028**	**100**

1) work/education

Table 2-8: Trip Purposes 2011 of the passengers on Rødby-Puttgarden ferry

Most of the trips on the ferry are for private purposes, mainly for holidays and shopping. Including 'other day excursions' the latter traffic is to a big extent 'ferry-walk-on' traffic. In this segment the travellers leave their cars at the harbours and 'walk-on' the ferries. Business travellers count for about 12 % of the passengers (mainly by car and rail). Together with daily commuters and weekend commuters the purposes with professional and educational background count for about 19 % of the trips, whereas 81 % of the trips are exclusively for private purposes.

In Table 2-9 the trip purpose structure for the **other ferry lines** including the **Great Belt** (international traffic only) is shown.

Trip Purposes	2011	
	(1000)	(%)
business	1.125	15,6
day commuter[1)]	27	0,4
weekend commuter	450	6,2
shopping	73	1,0
other day excursion	241	3,3
visiting friends/relatives	975	13,5
short holidays	979	13,5
holidays	3.363	46,5
Total	**7.233**	**100**

1) work/education

Table 2-9: Trip Purposes 2011 on the other ferries including international passengers crossing Great Belt

Also here the private purposes are dominating. From that the share of holiday traffic is by far the greatest (nearly 47 %). Business travellers have as share of nearly 16 %.

For the total North-South traffic also **air traffic** has to be taken into consideration (see Table 2-10). Here the share of business travellers is much higher than on the ferries (31 %). Especially on the short haul flights (for example Copenhagen - Germany) the business segment is even dominating.

Trip Purposes	2011	
	(1000)	(%)
business	5.340	31,0
day commuter[1)]	0	0
weekend commuter	345	2,0
shopping	0	0
other day excursion	0	0
visiting friends/relatives	2.756	16,0
short holidays	2.460	14,3
holidays	6.325	36,7
Total	**17.226**	**100**

1) work/education

Table 2-10: Trip Purposes 2011 in air traffic between Scandinavia and Europe

Altogether the trip purpose structure in the North-South traffic can be seen in Table 2-11. Biggest share has the passenger purpose 'holidays' with around 36 % followed by 'business' with nearly 24 %, 'visiting friends/relatives with around 15 % and 'short holidays' with around 14 %. The other purposes, mainly day trips and weekend commuters are relevant for the Rødby-Puttgarden connection, but not on the other routes including air traffic.

Trip Purposes	2011	
	(1000)	(%)
business	7.206	23,6
day commuter[1)]	148	0,5
weekend commuter	1.096	3,6
shopping	1.279	4,2
other day excursion	904	3,0
visiting friends/relatives	4.515	14,8
short holidays	4.235	13,9
holidays	11.105	36,4
Total	**30.488**	**100**

1) work/education

Table 2-11: Trip Purposes 2011 for the total traffic between Northern Europe and the Rest of Europe

It is important to mention that three fourth of the **business segment** today is covered by air traffic. The existing ferry connections including Great Belt are not very attractive for business traffic due to the long travel times.

Apart from the 'day excursions' including 'shopping' **day trips** for example for **work/education** are not very important today, differently from other borders in Europe (including for example between Denmark and Sweden, stimulated by the Öresund connection).

The **nationality of travellers** is not a question of segmentation in the FTC model (no forecast results related to nationality). However, from the surveys the following results on this subject have been found for 2011.

With regard to the **overall North-South traffic** the nationality of the travellers is shown in Table 2-12.

Nationality[1)]	2011	
	(1000)	(%)
German	7.723	25,4
Danish	6.155	20,2
Swedish	6.836	22,4
Norwegian	2.932	9,6
Finnish	1.780	5,8
others	5.050	16,6
Total	**30.476**	**100**

1) residence of travellers

Table 2-12: Nationality of the travellers in the overall North-South traffic (between Eastern Denmark, Sweden, Norway, Finland and Germany/the continent)

Roughly a quarter of the travellers are German residents, followed by Swedish (22,4 %), (Eastern) Danish (around 20 %), Norwegian (nearly 10 %) and Finnish residents (nearly 6 %). Other nations contribute with 16,6 % to the overall traffic.

With regard to **Rødby-Puttgarden** the structure is as shown in Table 2-13.

Nationality[1)]	2011	
	(1000)	(%)
German	2.865	47,5
Danish	1.883	31,3
Swedish	863	14,3
Norwegian	91	1,5
Finnish	44	0,7
others	282	4,7
total	**6.028**	**100**

1) residence of travellers

Table 2-13: Nationality of the travellers between Rödby and Puttgarden 2011

Here the shares of the direct 'neighbours' of the Fehmarn Belt are higher than in the overall North-South traffic:

- German residents count for 47,5 % of the passengers,
- Danish residents for 31,3 %,
- Swedish residents for 14,3 %,
- residents from other nations count for 6,9 % of the passengers.

2.2 Freight Traffic

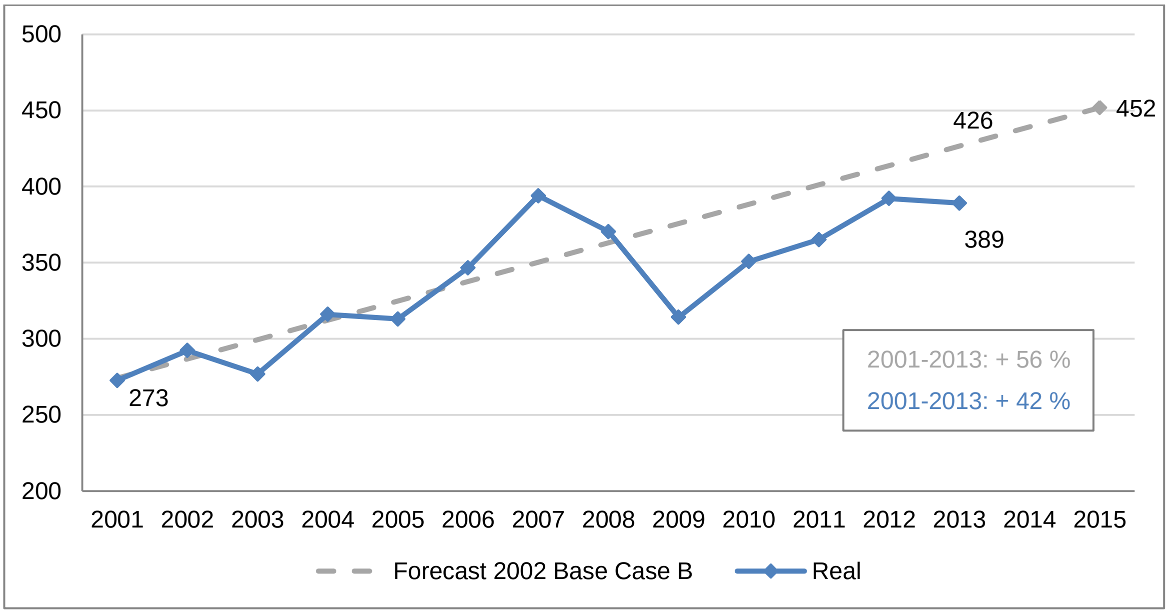
2.2.1 Freight traffic development over the Fehmarn Belt and the comparison with the study results of 2003[27]

The Fehmarn Belt can only be crossed by a ferry line between Rødby and Puttgarden. Since the ferry service does not offer train transportation, Fehmarn Belt freight traffic comprises only lorry traffic.

The actual number of lorries crossing the Fehmarn Belt has increased from 274.000 to 389.000[28] between 2001 and 2013. That implies that in spite of the slump caused by the economic crisis (2007 – 2010), the traffic from Puttgarden to Rødby showed an average yearly growth of 2,5 %. Having peaked again in 2012 with 392.000 lorries transported by the ferries, freight traffic across Fehmarn Belt has almost reached the pre-crisis amount of 394.000 lorries in 2007.

The 2003 enforced forecasts have projected the traffic volume of lorries across the Fehmarn Belt fairly accurately, with Base Case B slightly overestimating the trend of the real time series with a growth of 2,6 % p.a.

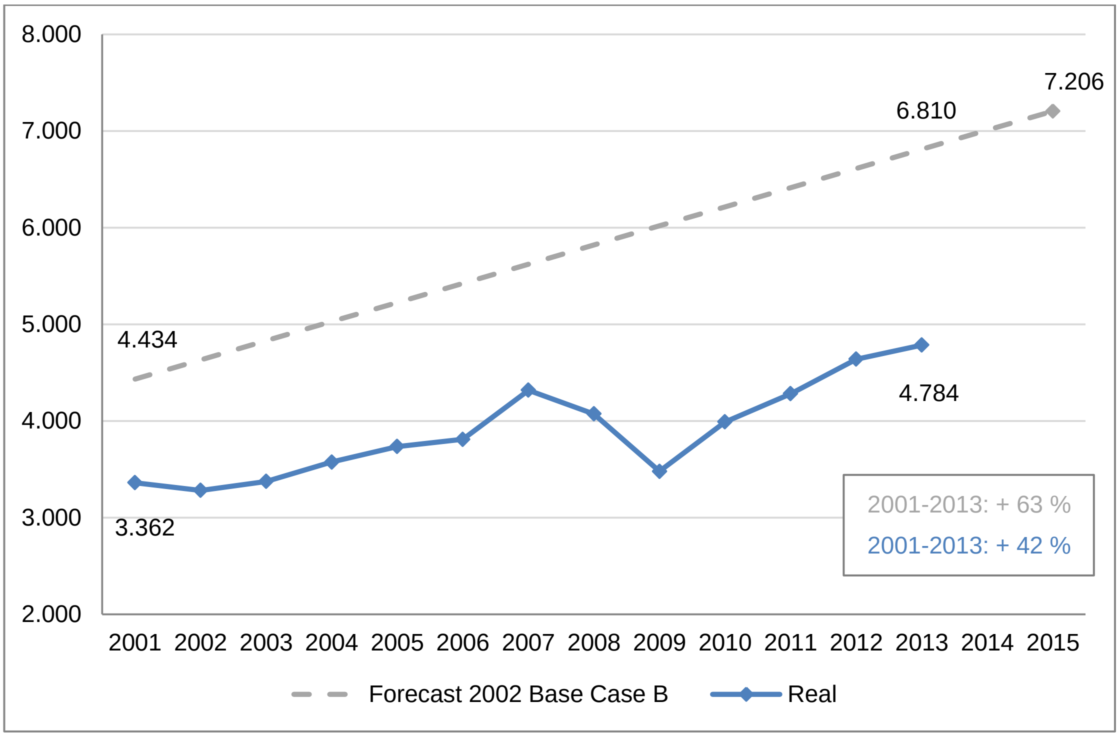
27 FTC Consortium, Fehmarn Belt Forecast 2002, 2003
28 Estimated value based on monthly data from January to November 2013.



Estimated value for 2013 based on volumes until October 2013

Figure 2-16: Forecasted values in 2002 and real traffic volume development Puttgarden – Rødby from 2001 to 2015 in 1.000 lorries per year

Regarding the current traffic volume crossing the Fehmarn Belt in tons, a slower growth of 2,1 % p.a. compared to the number of lorries is observed between 2001 and 2013. However, the recovery of the tonnage after the crisis led to a traffic volume of 4,7 million tons in 2013 and thereby to a higher amount than in 2007. The fact that total traffic volume with respect to tons rose stronger than the amount of lorries after the crisis is due to the increasing average load of lorries, developing from 11,0 t in 2007 to 12,0 t in 2013.



Estimated value for 2013 based on volumes until October 2013

Figure 2-17: Forecasted values in 2002 and real traffic volume development Puttgarden - Rødby from 2001 to 2015 in million tons per year

As depicted in Figure 2-17, freight growth in tons was therefore overestimated in relative and especially in absolute terms in the last study.

Yet, it has to be taken into account that the forecasts were calculated on the assumption of a fixed link absorbing higher amounts of charge through traffic shifts.[29] Since the 2002 forecasts are based on a substantially higher load per lorry (15,6 t in 2013), the overestimated values of the total traffic volume in tons are not reflected in the amount of lorries across Fehmarn Belt described above.

With respect to the development of rail freight traffic, it has to be considered that there is currently no existing connection via the Fehmarn Belt ferries. Hence, the real development of the Great Belt Fixed Link transit traffic from the Continent to East Denmark, Norway, Sweden and Finland is compared to the Fehmarn Belt forecasts in the following. This is due to the fact that in case of

[29] The main reason for this overestimation is a statistical failure in the basis data. In the FTC 2002 study the transport volume for 2001 was depicted with 4,4 million tons against the real value of 3,4 million tons.

an operation of a Fehmarn Belt fixed link, the volume will be derived mainly by the shifts from the Great Belt Fixed Link.

The rail freight volume in tons has increased by 2,4 % p.a. from 2001 to 2011, as set forth in Figure 2-18. Even by taking the potential shifts of other ferry lines towards the Fehmarn Belt Fixed Link into account, the Fehmarn Belt rail volume was thus overestimated in the last study.

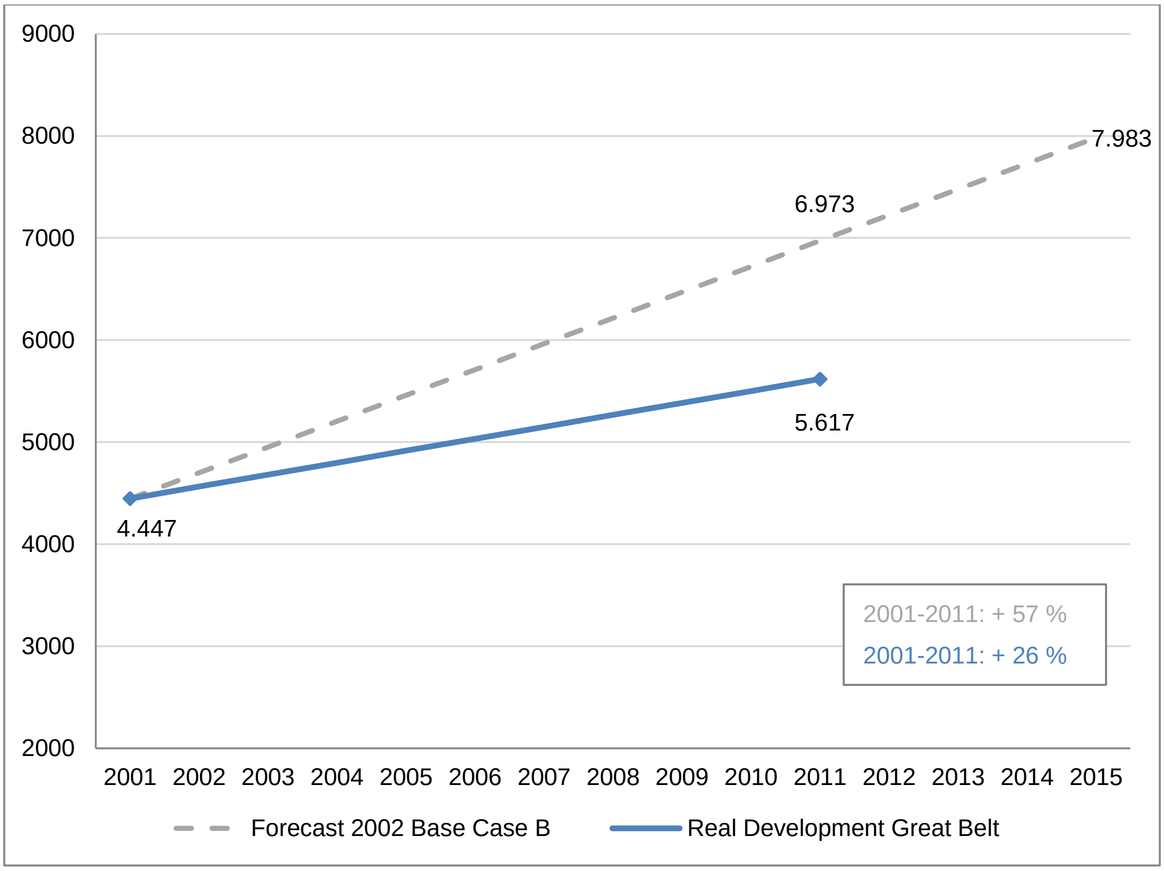


Figure 2-18: Forecasted values for Fehmarn Belt Fixed Link rail freight in 2002 and real transit freight development of Great Belt from 2001 to 2011 in million tons per year

2.2.2 Freight Data and Compilation of a consistent database

In order to update the 2002 forecast, it was necessary to update the statistical basis and recalibrate the used freight model with current traffic statistics for the survey region, which includes transports from the European Continent to East Denmark, Sweden, Norway and Finland.

The main data source for rail traffic flows is the 2011 origin-destination (OD) matrix from the German Statistics Office (Statistisches Bundesamt). The matrix delivers origin and destination volumes regionally broken down to NUTS 3 level for Germany and NUTS 0-3 level for other countries. It is segmented by NST-2007 commodity groups as well as combined and conventional transports.

The overall volumes of the rail OD matrix from the Federal Statistics Office were compared and calibrated in a first step. Therefore, the statistics were checked against various data sources as

(a) the old Fehmarn Belt study (2001),

(b) Railion Denmark (2009)[30],

(c) Rail transport statistics available at Eurostat and the Statistical Offices of Denmark, Norway, Sweden and Finland,

(d) Bundesverkehrswegeplan (BVWP, [Federal Transport Infrastructure Plan (FTIP)] 2015 (2010) as well as the

(e) Danish National Transport Model (2010).

Due to some deviations, isolated corrections were made concerning combined transports from and to Denmark and Sweden.

Since data for Denmark were only available at country level, regional disaggregation was done using the 2009 Railion Denmark statistics. For Finland, Norway and Sweden, NUTS 1-2 codes were available. Where necessary, data was regionally disaggregated using socio-demographic and socio-economic data as GDP, employment or population.

The obtained results compared to the last study and Denmarks Tekniske Universitet (DTU) statistics for 2010 are shown in Table 2-14. The lower traffic volumes for Denmark according to DTU might be explained by transports which are broken in Denmark and therefore coded as

30 Internal data including all wagonload traffic except piece goods provided by DB Schenker Denmark (former Railion Denmark) based on consignment note records. The transport volume in tons and the transport performance in tkm is regionally classified by NUTS 3 zones within Denmark, statistics outside Denmark are available by country.

Danish transports in the German statistics. Moreover, the share of East-Denmark has decreased considerably. This is mainly due to changes in the train production process. Until 2004, Ringsted had the function of a big marshalling yard; however since 2004 this function has become restricted.

With regard to road traffic flows, the OD matrix 2010 used in the German Federal Infrastructure Plan, Bundesverkehrswegeplan (BVWP), 2015 were adopted. A projection to 2011 with Eurostat data was proofed, but the data were preliminary and not very reliable when compared to 2010. We therefore made no further projections from 2010 to 2011. In analogy to the rail matrix, the road matrix is broken down to German NUTS 3 and European NUTS 0-3 regions too. Furthermore, commodities are segmented according to NST 2007 as well as conventional and combined transports.

Country	2001 (FTC 2002 study)	2010 (DTU)	2011 (FTC 2014)
Denmark	2.065	1.151	**2.555**
- West	779	961	**2.257**
- East	1.286 (62%)	190 (17%)	**298 (12%)**
Norway	326	1.828	**125**
Sweden	4.955	9.610	**5.730**
Finland	8	802	**10**
TOTAL (without DK West)	6.575	12.430	**6.163**

Table 2-14: Comparison of OD Rail Flows in million t

The road OD matrix was also checked against the old Fehmarn Belt study (2001), road transport statistics available at Eurostat and the Statistical Offices as well as the Danish National Transport Model (2010). As a result corrections were made concerning traffic in Sweden. About 6 million tons from/to Sweden were identified that are coded as hinterland transports of the ferry ports Kiel, Lübeck, Rostock, Sassnitz and Swinoujscie in the BVWP matrix. These 6 million tons were recoded as transports from/to Sweden resulting in an overall volume of 15,5 million tons for Sweden (this volume is also consistent to the foreign trade statistics).

In a last step, road data had to be regionally disaggregated. In the main data source (BVWP) there are six Danish and four Swedish traffic zones, Norway and Finland are available only at country level. Regional disaggregation was done – where necessary – using data from the

Kraftfahrtbundesamt (Federal Motor Transport Authority, KBA) or socio-demographic and socio-economic data (GDP, employment, population).

As Table 2-15 demonstrates, the road traffic volumes from the different data sources are basically comparable. When subtracting the relevant ferry volumes across the Baltic Sea from the total traffic volume (without West Denmark), a charge of 700.000 t remains for the transport via the land border. In addition to the transport volume of 16,4 million t from/to West Denmark, a total traffic volume of 17,1 million t crossing the land border results.

According to the traffic count made by the Federal Highway Research Institute BASt, 4.254 lorries and buses crossed the land border in the year 2010 per workday. Assuming 280 workdays, 1,2 million heavy vehicles result in the year 2010 with an average lorry load of about 14,3 t. The data is reliable because the average load in the corridor is about 15,3 t per lorry.

Country	**2001 (FTC 2002 study)**	**2010 (DTU)**	**2011 (FTC 2014)**
Denmark **- West** **- East**	16.895 13.274 3.621 (21 %)	23.031 19.611 3.420 (15 %)	**20.035** **16.445** **3.590 (18 %)**
Norway	2.883	2.293	**2.617**
Sweden	14.927	13.106	**15.500**
Finland	1.603	402	**904**
TOTAL (without DK West)	23.034	19.221	**22.611**

Table 2-15: Comparison of OD Road Flows in 1.000 t

2.2.3 Traffic development 2001 - 2011

Since 2001, the total road traffic volume between the Scandinavian countries and Continental Europe, displayed in Table 2-16 has increased modestly. However, without West Denmark, a slight reduction of the overall traffic volume by 0,2 % p.a. to 22,6 million t in 2011 can be observed. Especially Finland's transports to Continental Europe decreased substantially by 5,6 % p.a., whilst Sweden's transports are the only ones with a rising trend.

Country	2001	2011	Growth p.a.
Denmark	16.895	20.035	1.7%
- West	13.274	16.445	2.2%
- East	3.621	3.590	-0.1%
Norway	2.883	2.617	-1.0%
Sweden	14.927	15.500	0.4%
Finland	1.603	904	-5.6%
Total (without Denmark West)	**23.034**	**22.611**	**-0.2%**

Table 2-16: Road Traffic Flows between Scandinavian Countries and Continental Europe in 2001 and 2011 in million t

With regard to rail transportation between Scandinavia and Continental Europe, slight decreases between 2001 and 2011, on average by 0,6 % p.a., have led to a volume of 6,2 million t in 2011. East Denmark's drastic declines were not offset by the significant increases of Sweden's transport volume.

Country	2001	2011	Growth p.a.
Denmark	2.065	2.555	2.2%
- West	779	2.257	11.2%
- East	1.286	298	-13.6%
Norway	326	125	-9.1%
Sweden	4.955	5.730	1.5%
Finland	8	10	2.3%
Total (without Denmark West)	**6.575**	**6.163**	**-0.6%**

Table 2-17: Rail Traffic Flows between Scandinavian Countries and Continental Europe in 2001 and 2011 in 1.000 t

2.2.4 Total traffic between Scandinavia and Continental Europe in 2011

In the following, the total traffic patterns (except sea freight) between Scandinavia and Continental Europe in 2011 are analyzed, taking under consideration the commodity structure, the origin countries and destinations of the traffic as well as the chosen routes.

As set forth in Table 2-18 the mostly transported goods[31] by road and rail between Scandinavia and Continental Europe are miscellaneous articles, i.e. in particular containerized goods, representing about 20 % of all transported goods across the Baltic Sea. In accordance with the foreign trade structure (see chapter 4) wood and wood products as well as metals are the most transported commodities besides manufactured goods. Whilst coal, petroleum and coke account for a large share of foreign trade volume between the considered states, they play a minor role for rail and road transportation, in due to alternative favorable modes like ships and pipelines.

	Road		Rail conv.		Rail comb.		Total
	Volume	Modal Share	Volume	Modal Share	Volume	Modal Share	Volume
Agriculture, hunting and forestry	2.499	100%	8	0%	0	0%	2.507
Food products, beverages and tobacco	2.531	98%	53	2%	0	0%	2.584
Wood and cork, pulp, paper	3.026	75%	1.034	25%	0	0%	4.060
Coal, petroleum, natural gas, coke	118	99%	1	1%	0	0%	119
Ores, mining and mineral products	1.204	90%	135	10%	0	0%	1.339
Metals	2.264	59%	1.581	41%	0	0%	3.845
Chemicals, chemical products	1.525	85%	264	15%	0	0%	1.789
Transport equipment and machinery	2.471	97%	89	3%	0	0%	2.560
Other manufactured articles	3.947	96%	159	4%	0	0%	4.106
Miscellaneous articles	3.025	52%	608	10%	2.233	38%	5.866
Sum	**22.611**	**79%**	**3.931**	**14%**	**2.233**	**8%**	**28.775**

Table 2-18: Traffic volume in million t between Scandinavia and Continental Europe by commodity groups and transport modes in 2011

In spite of the long transport distances, lorries haul the vast majority of the transport amount between Scandinavia and Continental Europe. 21 % of the volume is carried by railway, 8 % of which within intermodal transportation. The relatively high share of the latter is due to the large amount of shipped miscellaneous articles, whereas conventional railway transport exhibits high shares in the transport of wood and wood products as well as metals. Due to high transport volumes of these commodities, which are more suited to being transported by rail, lorries carry only 79 % of the total tonnage although shipping more than 96 % in five commodity groups.

[31] Since traffic data was harmonized with the FTC study from 2002, the trade commodity group structure NST2007 had to be transformed into the classification of Table 2-15. The correspondence table is presented in the Annex.

The traffic flows between Scandinavia and Continental Europe are fairly balanced: In 2011, 14.127 million t were imported from Scandinavia to Europe whilst 14.647 million t were exported to Denmark, Sweden, Finland and Norway. As already observed in the trade analysis, Germany is the most important trade partner for Scandinavian countries. 40 % of the total traffic volume crossing the Baltic Sea via rail or lorry in 2011 was destined to or came from Germany. Furthermore, the Netherlands and Poland are of particular importance for the freight volume. 68 % of total traffic amount is due to the trade between Scandinavia and these countries, the remaining volumes are distributed to other European countries with little quantities as illustrated in Table 2-19.

	Import from Scandinavia		Export to Scandinavia		Total	
	Volume	**Share**	**Volume**	**Share**	**Volume**	**Share**
Austria	506	4%	667	5%	1.173	4%
Belgium	465	3%	538	4%	1.003	3%
Bulgaria	32	0%	70	0%	102	0%
Croatia	47	0%	27	0%	74	0%
Czech Rep.	637	5%	649	4%	1.286	4%
France	578	4%	845	6%	1.423	5%
Germany	5.904	42%	5.572	38%	11.476	40%
Great Britain	58	0%	33	0%	91	0%
Greece	33	0%	34	0%	67	0%
Hungary	214	2%	255	2%	469	2%
Ireland	7	0%	23	0%	30	0%
Italy	827	6%	655	4%	1.482	5%
Luxemburg	66	0%	90	1%	156	1%
Netherlands	2.230	16%	2.655	18%	4.885	17%
Poland	1.579	11%	1.639	11%	3.218	11%
Portugal	92	1%	26	0%	118	0%
Romania	88	1%	149	1%	237	1%
Serbia	10	0%	7	0%	17	0%
Slovenia	57	0%	68	0%	125	0%
Slovakia	117	1%	98	1%	215	1%
Spain	410	3%	464	3%	874	3%
Switzerland	136	1%	79	1%	215	1%
Turkey	34	0%	4	0%	38	0%
SUM	**14.127**	**100%**	**14.647**	**100%**	**28.774**	**100%**

Table 2-19: Traffic volume in 1.000 t between Scandinavia and Continental Europe by continental countries and direction in 2011

Among the Scandinavian countries, Sweden accounts for the largest share of the traffic volume with Continental Europe. As set forth in Table 2-20, East Denmark's and Norway's share of all rail and road transportation between Scandinavia and Continental Europe is just 14 % and 10 %, respectively. Finland plays a minor role in the study relevant traffic with Continental Europe.

	Exports to Continent		**Imports from Continent**		**Total**	
	Volume	**Share**	**Volume**	**Share**	**Volume**	**Share**
Denmark	1.794	13%	2.094	14%	3.888	14%
Norway	1.298	9%	1.444	10%	2.742	10%
Sweden	10.655	75%	10.575	72%	21.230	74%
Finland	380	3%	533	4%	913	3%
SUM	**14.127**	**100%**	**14.647**	**100%**	**28.774**	**100%**

Table 2-20: Traffic volume in 1.000 t between Scandinavia and Continental Europe by Scandinavian countries and direction in 2011

Freight traffic between Scandinavia and Continental Europe passes basically either a ferry or the German-Danish border followed by the Great Belt Fixed Link. The distribution of the traffic loads to the different transport routes is depicted in Table 2-21.

A large amount of road freight between Scandinavia and Continental Europe, nearly 13 million t and 700.000 lorries in 2011, uses the ferry services between German ports and Trelleborg or Malmö. The most frequently used link for trade between Continental Europe and Scandinavia though is the ferry from Puttgarden to Rødby carrying 366.000 lorries in 2011.

	Road		Rail	
	tons	lorries	tons	wagons
Puttgarden-Rødby	4.282	366	-	-
Lübeck-Helsinki	744	62	-	-
Travemünde-Trelleborg	4.378	217	-	-
Travemünde-Malmö	4.150	206	-	-
Landb. Flensburg-Padborg	670	49	-	-
Kiel-Göteborg	1.107	85	-	-
Kiel-Oslo	383	42	-	-
Rostock-Gedser	1.093	91	-	-
Rostock-Trelleborg	4.169	262	239	11
Rostock-Helsinki	160	13	-	-
Sassnitz-Ronne	25	2	-	-
Sassnitz-Trelleborg	219	15	308	13
Swinoujscie-Ystad	794	56	-	-
Great Belt	262	20	4.898	215
Hirtshals-Kristiansand	66	6	-	-
Hirtshals-Bergen	7	1	-	-
Hirtshals-Larvik	47	4	-	-
Frederikshavn-Göteborg	111	7	-	-
Frederikshavn-Oslo	44	4	-	-
Grenaa-Varberg	132	8	-	-
Swinoujscie-Trelleborg	438	32	-	-

Table 2-21: Distribution of Road and Rail Traffic Volume (in 1.000) of Transports between Scandinavia and Continental Europe by transport route in 2011

Whilst a variety of ferry services offers the possibility for lorry transportation over the Baltic Sea beside the land cross connection, there are three possible railway connections for transportation between the continent and the study region: from Rostock or Sassnitz to Trelleborg and the Great Belt Fixed Link. Because railway ferry transfers are comparably expensive and complex, the major part of the trains chooses the route via the Great Belt, instead of the ferry connections via Trelleborg.

In contrast to the road link between Scandinavia and Continental Europe, rail traffic is restricted by a low number of route options which contributes to the fairly low modal split of rail transportation.

3 FORECAST METHOD

The FTC 2014 Forecast is an update of the 2002 traffic forecast for the Femern Fixed Link. Therefore the models used both for passenger and freight transportation are highly similar to the ones used in 2002. However methodological improvements in the transportation modelling science made it necessary to improve some parts of the modelling tools used in 2002. Nevertheless the structure of both the passenger and freight transport models remained substantially the same.

3.1 Forecast Model Passenger Traffic[32]

The forecasting procedure for passenger traffic is shown in Figure 3-1. Due to the different forecast years, for which different assumptions with regard to socio-economy, supply and user costs had to be considered, the model runs had to be carried out step by step, using the procedures

- traffic growth model
- modal-split-model/induced traffic
- route choice and assignment per mode.

The model used for the FTC 2014 forecast is structurally similar to the one used in the previous forecasts by the FTC consortium. The approach allows a two level procedure by forecasting general travel growth and distributing it on the transportation system.

Autonomous traffic growth is caused by exogenous factors as the development of the economy, the population, the car ownership and general change in travel behavior. This growth can be estimated by models based on implicitly observed elasticities. The base year traffic relations updated with this growth model result in market forecasts for the traffic demand between Europe and Scandinavia for each of the time horizons. The matrix is based on a zone system containing all the necessary information of structural development as well.

[32] The forecast model for passenger traffic is in its general form compatible to the model applied in the German BVWP-forecasts (Intraplan Consult GmbH, BVU Beratergruppe Verkehr + Umwelt GmbH, IVV Ingenieurgruppe Aachen, Planco Consulting GmbH: Verkehrsverflechtungsprognose 2030, on behalf of the German Transport Ministry, June 2014). There the model and forecasting procedures have been audited in the context of a supervision process (see Bundesministerium für Verkehr und digitale Infrastruktur, Grundkonzeption für den Bundesverkehrswegeplan 2015, Berlin 2012; escpecially chapter 9.1 „Qualitätssicherung der laufenden Arbeiten am BVWP 2014“).

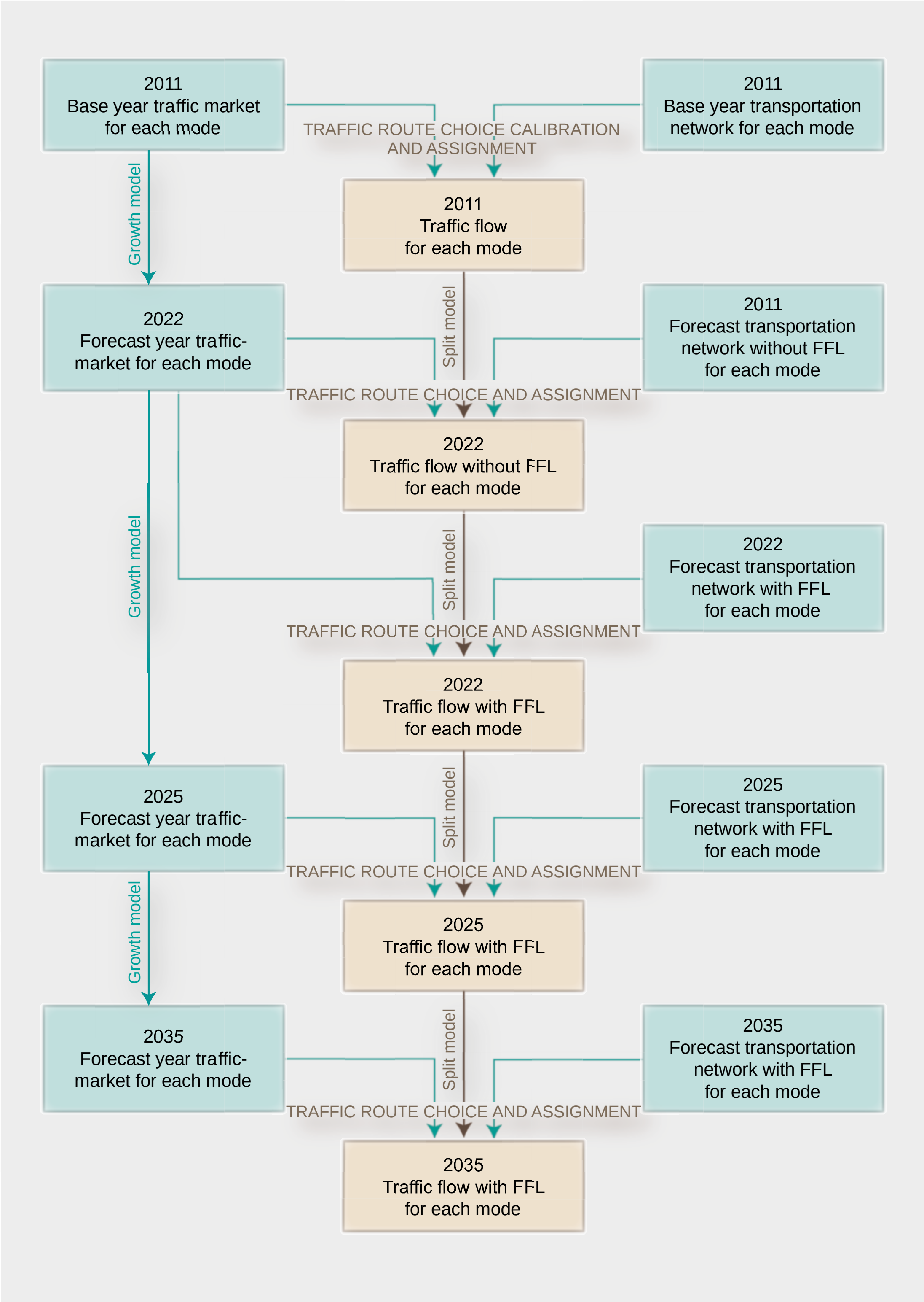


Figure 3-1: Forecast procedure FTC 2014 for passenger traffic

The **growth model** is considering for each zone the growth of the number of trips and growth of the trip length by a function which is also considering different elasticities for the different modes (for example for the variable car ownership). The variables considered are

° population growth per age group
° employment growth
° GDP growth
° car ownership growth
° overall user cost changes per mode.

The forecasted traffic demand is then assigned to the transportation network, containing the development of the transportation infrastructure of the different forecast years. This traffic assignment is preceded by a modal-shift calculation, which depicts the effect of the different resistance developments of the four modes. The modal-shift model also calculates induced demand caused by substantial change of resistance between zones O and D.

The **modal-split** model is a box-cox model type using the variables

° travel time per mode
° travel costs per mode
° level of service per mode

converted to 'generalized costs', which are different for each trip purpose (for example higher value of time for business travelers than for private trips).

The main difference between the forecasting model used in 2002, and the one used in the current study is within the **route-choice** algorithm. Whereas in 2002, all traffic of one trip purpose from a given zone O to the given zone D used the same route, the new multi-route choice algorithm allows a better distribution of traffic among the possible routes. This leads to a more plausible distribution of traffic on the links (Ferries, Great Belt Bridge and the FBFL) between Scandinavia and the rest of Europe. This route choice algorithm minimizes the flaws resulting from uneven costs calibration in the base year and inherently includes route choice mechanisms of passengers travelling on the investigated relation, resulting in better forecasts for route distribution along the forecast horizon.

The route choice and assignment procedures are rather decisive parts of the model for the FTC 2014 study, because the success of the FBFL indeed is also dependent on the share which this connection, as part of the routes in the north - south traffic, can reach compared to other connections. The FBFL will not only replace the existing Rødby-Puttgarden-ferry line, but take traffic also from other ferry routes and from the Great Belt route.

To consider these effects is mainly a question for road traffic. The trains in the north -south traffic will be guided completely via the FBFL, whereas today the night trains use the Great Belt Route.

The route choice procedure for road is considering the Generalized Costs as mentioned above in the context of the modal-split-model.

The variable 'travel time' is considering the following time components

- travel time on the (feeder) road networks
- cruising time of the ferries
- access-/egress times on the ferries
- waiting time for the ferries dependent on the timetables

The variable for user costs are considering

- fuel cost (dependent on occupancy which is different for the single trip purposes)
- ferry prices (average)
- road toll incl. fixed link tolls

The level of service is considering, by travel time and/or travel cost surcharges resp. discounts

- rest times which can be spent on the ferries instead of roadside rests (considered for long journeys)
- capacity restraints in an indirect way as in summer and/or weekends there may be longer waiting times and prices (surcharge of 50 % on waiting time for the trip purpose ‘holidays’ and ‘weekend holidays’ on the ferries.

The Generalized Costs are calculated by adding the travel costs and the travel times multiplied with a Value of Time (VoT). It is highest for business (up to 75 €/hour in the base year), medium for commuter and short trips (around 15 €) and lowest for holidays (around 10 €).

With regard to the possible technical solution for the FBFL resp. to the without case psychological factors such as **'tunnel fear'** has not been considered as model variable in the FTC forecasts, neither in the 2002 study nor in the 2014 update.

Nor has there been a consideration of a 'bridge-factor' nor a 'ferry-factor', That means that differences in the alternatives to cross the Fehmarn Belt have been evaluated due to time and costs of the alternatives but not due to differences in the technical solutions itself.

The latter may have influence on ‘real’ factors like risks and reliability (closing times, delays or temporary speed limits), or on ‘psychological’ factors (tunnel fear, fear of sea-sickness or similar).

Psychological factors seem to be relevant as negative factors especially for the use of long tunnels, like the planned FBFL, because a lot of travelers regard driving through a long tunnel as unpleasant and partly they experience anxiety or oppression.[33]

However, studies show that

(1) this anxiety or unpleasant feeling only to a very low degree influences the real travel behavior, that means avoiding trips or using alternative routes[33].

(2) tunnel-anxiety can be reduced significantly by design of the tunnel respectively lightning, colors or similar[34].

(1) can be observed in many cases especially in Norway or in the Alps, where there are many long tunnels. These are used frequently even when there are alternatives, like old pass roads or similar. The reason to use the tunnels is travel time advantages which are evaluated much higher than 'tunnel-fear'. Apart from that frequent users appreciate advantages of tunnels in bad weather situations compared to 'open roads'. Also in cities, longer road tunnels are attractive for users. Tunnels are used due to 'classical' factors like travel time and costs.

With regard to (2) there has been a lot of progress in the last decades, not only directly with regard to tunnel security, but with regard to avoiding the feeling of anxiety by tunnel design in terms of lane-width, guiding systems, lightning etc. To use modern tunnels is much less oppressive than the use of old tunnels.

Therefore we do not expect any relevant negative effect of the FBFL-tunnel solution on the passenger demand. Generally demand is influenced to a very low extent by the technical solution

[33] Oestenstad, Encountering long road tunnels: opinion polls among car drivers, 1995

[34] SINTEF: 'Tunnel anxiety' can be reduced, Sept. 2013

itself. Tunnel fear is not a relevant factor. We would even maintain that such a negative effect can't be measured at all in a reliable way.

The other technical solutions, including the existing ferry line, may have also 'psychological disadvantages'. A boat journey with rough wind can be unpleasant. And even a bridge crossing may be 'uneasy' under crosswind-situations.

'Objective' disruptions of the traffic flow should be more frequent for ferry lines (rough sea, technical problems with the ships, punctuality) and even for bridges than for tunnels. Studies show, that there are times of closure for certain vehicles or even for all vehicles due to weather conditions on the Öresund–bridge and on the Great Belt bridge[35], apart from frequent temporary speed limits. Due to the situation of the Fehmarn-Belt resp. the situation of a possible bridge (North-South), closure times should be more frequent on a Fehmarn Belt bridge than on the bridges named above[36]. Additionally there will be quite often temporary speed limits thus increasing travel times.

Even these factors have not been taken into consideration in the demand forecasts. Our opinion is that these 'objective' factors would influence the demand to a larger extent than the 'tunnel-fear'.

3.2 Forecast Model Freight Traffic[37]

3.2.1 Foreign Trade and Traffic Forecast

The future traffic development across the Fehmarn Belt and the area under investigation essentially depends on the development of the foreign trade volumes between Denmark, Sweden, Norway and Finland on the one hand and the Continental European countries on the other hand. The projections of the foreign trade volumes have been based upon the projections of the gross

35 Ebba Dellwik, Jakob Mann, Gudrun Rosenhagen: Traffic restrictions due to wind on the Fehmarn Belt bridge (Risø-I-2234(EN)), Roskilde/Hamburg June 2005

36 The study 'Traffic restrictions due to wind on the Fehmarn Belt bridge' expects level 2 closures (for unloaded lorries and caravans) for around 170 hours/year and for level 4 closures (all road vehicles) for 12 hours as well as for cargo trains

37 Like the forecast model for passenger traffic, the traffic model for freight traffic in its general form has been audited in the German BVWP-process.

domestic product in real prices. In order to identify the causes and drivers of the national trade developments, comprehensive country-specific time series data with regard to imported and exported goods and partner countries were analyzed.

The used foreign trade data for the four countries Denmark, Finland, Norway and Sweden originate from Eurostat. For Denmark, data were available between 1992 and 2011, for the other countries time series go back until 1995. The foreign trade data is segmented by 296 SITC commodity groups and by importing or exporting countries.

While the Eurostat foreign trade data which is listed in the SITC classification differs from the NST2007 classification, which is actually used in traffic statistics, the data has to be made comparable. In order to make data comparable, we converted the SITC codes into the NST2007 classification as exposed in the Annex including correspondence tables.[38] We took into consideration, that some NST2007 categories, as 'Mails and parcels” and 'Equipment and material utilized in the transport of goods', are not enclosed in the foreign trade statistics. Besides, trade volumes of natural gas are left out in the trade statistics, because it is mainly transported by pipelines. The categories 'Goods removed in the course of households and office removals”, 'Grouped goods” 'Unidentifiable goods” and 'Other goods” were pooled into one group, such that we obtain 18 commodity groups, listed in Table 3-1.

[38] The chosen FTC classification is depicted including the applied correspondence keys to the SITC classification in the annex. To transform the originally SITC-classified data differentiated by FTC-commodity groups, we calculated country-specific correspondence tables for the imports and exports of each country.

No.	Commodity Group Name
1	Products of agriculture, hunting and forestry, fish and other fishing products
2	Coal and lignite
3	Iron ores and non-ferrous metal ores
4	Food products, beverages and tobacco
5	Textiles and textile products
6	Wood and products of wood and cork (except furniture)
7	Coke and refined petroleum products
8	Chemicals, chemical products, and man-made fivers
9	Other non-metallic mineral products
10	Basic metals, fabricated metal products, except machinery and equipment
11	Machinery and equipment
12	Transport equipment
13	Furniture and other manufactured goods
14	Secondary raw materials, municipal wastes and other wastes
15	Crude petroleum
16	Fertilizer, chemical and natural
17	Stone, sand, gravel, clay, peat and other mining and quarrying products
18	Other goods

Table 3-1: Chosen commodity group classification

Since in addition to the economic development, also good specific trends will influence the future foreign trade development, we conducted a commodity specific analysis of the trade patterns between Scandinavia and Continental Europe.

In the foreign trade analysis, we primarily focus on the relevant freight trade relations for the Fehmarn Belt traffic volume, i.e. the trade between the Northern States and Continental Europe. The considered countries which are listed in Table 3-2, account for the largest share of the Fehmarn Belt traffic.

Continental Europe	Northern States
Austria	Denmark
Belgium	Finland
France	Norway
Germany	Sweden
Italy	
Luxemburg	
Netherlands	
Portugal	
Spain	
Switzerland	
Czech Republic	
Hungary	
Poland	
Slovakia	
Slovenia	

Table 3-2: Relevant Countries for Fehmarn Belt Traffic

The national foreign trade forecasts were conducted in three steps: first, a forecast for each of the displayed commodity groups was made by regression analysis according to the projected GDP development. Hereafter, the export and import volumes were allocated through time series regressions to 16 world regions and subsequently the Eastern and Western European volumes in the same manner to the European countries. As a result of the trade forecast, we obtain commodity specific trade growth factors between the Northern states and the Continental European countries for the forecast period from 2011 to 2022, 2025 and 2035.

For the calculation of the freight traffic forecast OD matrices, the trade growth factors were applied to the 2011 OD traffic matrix according to the respective countries and goods groups. The methodology of the trade and traffic forecast for each Scandinavian country and the forecast horizons 2022, 2025 and 2035 is illustrated in Figure 3-2.

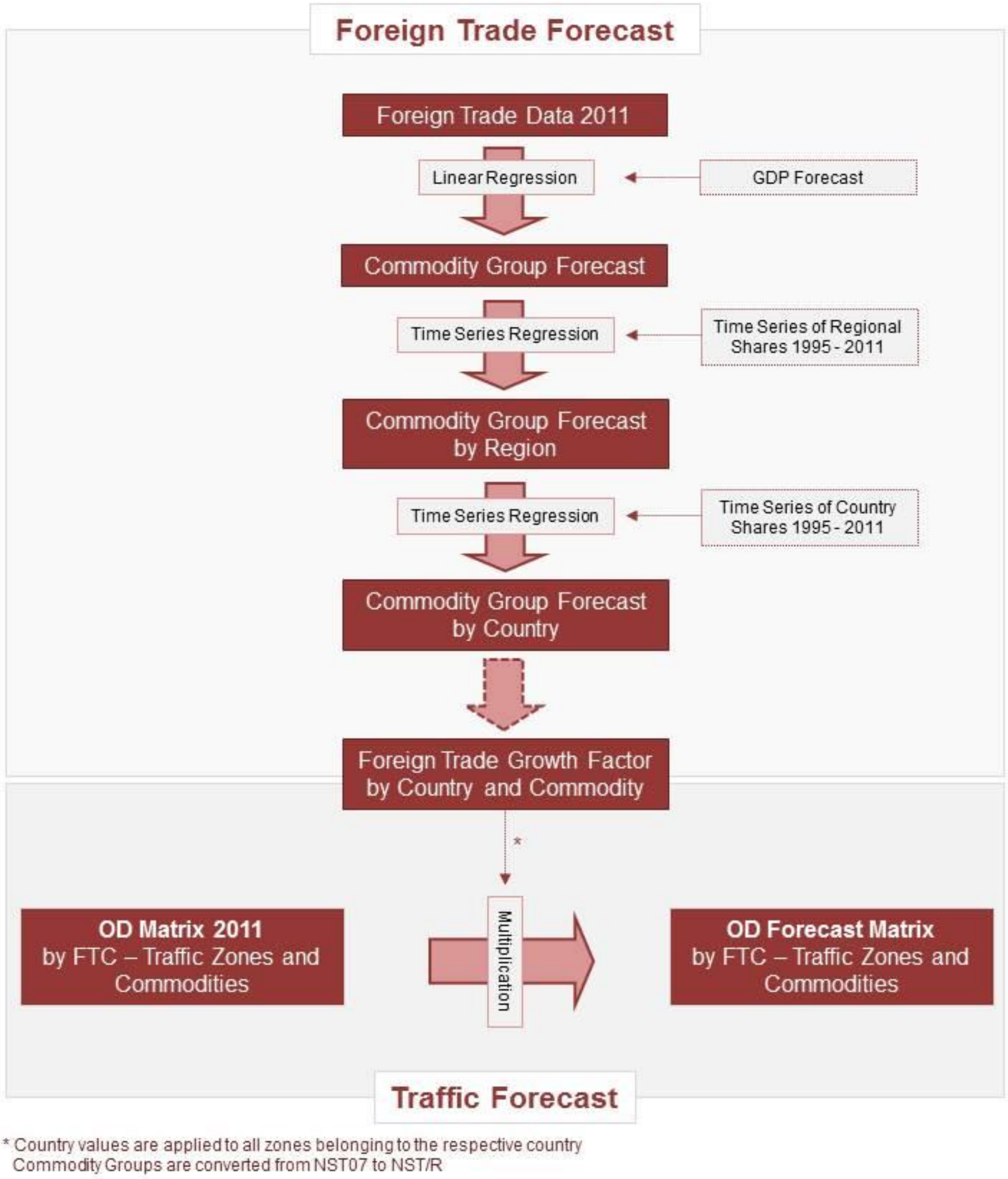


Figure 3-2: Scheme of Forecasting Methodology for Each Scandinavian Country and Forecast Horizon

Since the traffic results should be comparable to the last Fehmarn Belt study, traffic statistics in this study are segmented by an NST/R based classification, which is presented in Table 3-3. Thus, the NST 2007 based classification of the trade statistics had to be converted into the traffic classification, the applied correspondence keys are listed in the annex.

No.	Name
0	Agriculture, hunting and forestry
1	Food products, beverages and tobacco
2	Wood and cork, pulp, paper
3	Coal, petroleum, natural gas, coe
4	Ores, mining and mineral products
5	Metals
6	Chemicals, chemical products
7	Transport equipment and machinery
8	Other manufactured articles
9	Miscellaneous articles

Table 3-3: Chosen Traffic Commodity Classification

3.2.2 Route choice and modal split

As a result of this first step, OD matrices for the different forecast years are generated without consideration of changes in route choice and modal split.

Under consideration of the development of the transport user costs and infrastructure networks in the different years, transport prices and transport times are calculated for each transport relation for the available routes.

For the calculation of the transport costs, the regular ferry freight tariffs were applied. Since the Fehmarn Belt ferry fares vary substantially between empty and loaded lorries, an average price considering the share of empty vehicles was calculated for the ferry Rødby - Puttgarden. Further price discounts are not considered within the model.

Besides transport costs and transport times, other variables influence the forwarders' route choice. This may be e.g. the starting time of the transport, the rest available driving time of the lorry driver, the real departure time of the ferry, different boarder times, the number of calls within a route (if cargo has to be splitted to some customers) or freight forwarders' specific discounts. These variables cannot be considered separately within in the model, so they are taken into account through the calibration and are thus part of the computation of the utility values (generalised costs).

As depicted in Table 3-4, the calibration of the route choice model leads to slight road freight volume increases for the majority of the ferry lines. Obviously the long distance ferries to Helsinki provide the largest benefits not captured by the model.

	before calibration	after calibration	effect of calibration
Lübeck-Helsinki	691	744	7,7%
Travemünde-Trelleborg	4.220	4.378	3,7%
Travemünde-Malmö	3.999	4.170	4,3%
Kiel-Göteborg	1.088	1.107	1,8%
Kiel-Oslo	384	383	-0,2%
Rostock-Gedser	1.051	1.093	4,0%
Rostock-Trelleborg	4.063	4.169	2,6%
Rostock-Helsinki	150	160	6,4%
Sassnitz-Trelleborg	215	219	1,9%
Swinoujscie-Ystad	782	794	1,5%
Swinoujscie-Trelleborg	431	438	1,6%

Table 3-4: Effects of route choice model calibration for road haulage in 1.000 t by ferries in 2011

The BVU route choice model, which has also been used in the recent studies, calculates the traffic distribution between the ferries and the fixed link for each transport relation and commodity group. Under consideration of the herewith derived time and cost changes, modal split changes for the three modes (road, rail conventional and rail combined) are computed.

The modal split is based on a nested logit model, which takes into account both intermodal and intramodal decision-making processes. One point to emphasize is that in the route choice and modal split part of the forecast model no elasticities are used. On the basis of transport costs and transport duration, changes of utility values for each mode are calculated for the application of the logit model.

The number of vehicles therefore depends on

- average loading weights,
- balance of transport volumes and
- efficiency in avoiding empty transports.

The efficiency in avoiding empty transports is measured by an extra parameter which is estimated in the calibration process of the vehicle model.

More details of the model structure can be found in the study of 1999[39].

39 Fehmarnbelt Traffic Consortium, Fehmanrnbelt-Traffic Demand Study, 1999

4 FORECAST ASSUMPTIONS

4.1 Overview

The main forecast drivers for the traffic development with regard to 'autonomous growth' (not dependent from infrastructure/supply or other transport related factors) are

- the development of population (passenger traffic)
- the development of GDP (passenger and freight traffic)
- and the foreign trade for freight traffic.

With regard to the transport system the relevant variables are

- the development of infrastructure and supply, both in the core study area and with regard to the hinterland connections
- the development of user costs

Case A is based on the assumptions of the German Bundesverkehrswegeplan (BVWP) 2015, however the BVWP only calculates with a 2030 forecast horizon. In order to create premises for the 2022, 2025 and the 2035 horizons, qualified inter- and extrapolations were necessary. In some cases, further assumptions had to be made (e.g. the inauguration of competing road or the rail services in the intermediate years).

The main assumptions for the Cases A and B are summarized in the following Table 4-1 together with a comparison to the FTC 2002 study. Details including socio-economic and socio-demographic data for regions and countries, trade data, details on network assumptions etc. can be found in the Annex.

Forecast assumption item		FTC 2014		FTC 2002
1	**Socio-economic Data**	**CASE A**	**CASE B**	
1.1	Population growth	2011 - 2025 DK + 8,6 % D + 0,2 % S + 11,9 % for the relevant market in tendency higher growth	2011 - 2025 DK + 4,7 % D - 1,8 % S + 11,1 % for the relevant market in tendency higher growth	2001 - 2015 DK 0 % D + 1,5 % S + 4,8 %
1.2	GDP growth	2011 - 2025 DK + 18 % D + 18 % S + 20 % lower economic growth	2011 - 2025 DK + 23 % D + 19 % S + 39 % lower economic growth	2001 - 2015 DK + 27 % D + 33 % S + 37 %
1.3	Employment growth	2011 - 2025 DK + 3 % D - 3 % S + 9 % in tendency higher employment growth		2001 - 2015 DK + 6 % D - 6,4 % S +4 %
1.4	Car ownership growth (cars/1000 inhabitants)	2011 - 2025 DK + 14 % D + 9 % S + 5 % lower car ownership growth		2001 - 2015 DK + 16 % D + 11 % S + 24 %
		In tendency less optimistic assumptions for GDP growth		
2	**Infrastructure/Supply**			
2.1	Fehmarn Fixed Link	tunnel (from 2022)		bridge (from 2015)
2.2	Ferry Rødby - Puttgarden	as 2002 study[40]		no parallel ferry to FBFL
2.3	Other ferries	service as 2013		service as 2002
2.4	Feeder road	as FTC 2002 A 20 west as additional feeder road in Germany		four lane feeder routes
2.5	Rail	in DK 200 km/h (shorter travel time) Hamburg - Copenhagen		feeder rail 160 km/h
		stepwise 32/34/38 (thereof 16 regional[41])	stepwise 32/36/40 (thereof 16 regional[41])	40 passenger trains (thereof 16 regional[41]

40 according to detailed analyses (see chapter 8)
41 mainly connecting existing regional trains in Denmark and Germany via FBFL

Forecast assumption item	FTC 2014		FTC 2002
2.5 Other ferries	service as 2013		service as 2002
	In tendency same infrastructure, but implementation later		
3 User Costs			
3.1 FBFL toll	60 € car 300 € lorry (trailer) (2010 prices) => slightly higher for car and lorry	65 € car (2013 prices) 267 € lorry (trailer) (2014 prices) => slightly higher for car and lorry	46 € car 259 € lorry (2002 prices)
3.2 car (out of pocket without FBFL)	2011 - 2025 + 7 %	2011 - 2025 - 34 %	2001 - 2015 - 10 %
3.3 road freight	2011 - 2025 0 %	2011 - 2025 0 % variable costs, +9 % fixed costs	2001 - 2015 - 6 %
3.4 rail passengers	2011 - 2025 + 7 %	2011 - 2025 + 0 %	2001 - 2015 0 %
3.5 rail freight	2011 - 2025 + 0 % conventional, -7 % combined	2011 - 2025 + 0 %	2001 - 2015 0 %
3.6 air	Price level 2010	price level 2013	2001 - 2015 0 % - 25 % (low cost)
	In tendency higher user costs but going out from a higher level		

Table 4-1: Overview about the forecast assumptions for Case A and Case B of the FTC 2014 study and comparison with FTC 2002 (Base Case B)

A comparison of the forecast assumptions of the FTC 2014 study on hand with the FTC 2002 study is difficult due to different base years and forecast horizons. However, some tendencies can be seen.

- **GDP** growth was in reality actually much lower than in 2002 expected due to two economic crises which fell in the forecast period (2002/2003 and 2008/2009). The future assumptions are now less optimistic compared to the time, when the FTC 2002 study was prepared, especially for Germany and Denmark.

- **User cost** development was totally different from the forecast assumptions of then: Instead of decreasing user costs for car, costs increased by more than 1 % p.a. due to the strong growth of fuel prices between 2004 and 2008. Also for rail costs went up in tendency; whereas in air traffic due to Low-Cost-Airlines prices fell considerably even for conventional airlines.[42] For the future in Case A an increase in car user costs is expected, in Case B a stronger decrease.

- **Ferry prices** increased in tendency due to consolidation in the Baltic Sea shipping business, at least for passenger traffic, whereas for lorries due to competition with the Great Belt and Öresund Fixed Link and by special road freight ferries the prices decreased.

4.2 Assumptions for the FBFL and implementation into the model

The FBFL alignment is next to the exiting ferry and travel distance is approximately unchanged. On the southern access the existing two lane highway B 207 on Fehmarn Island will be extended two a four lane highway as well as the section between Heiligenhafen, where existing motorway A1 ends, and the Fehmarnsundbridge, which, as an exception, will stay a two lane road including a single track railway line.[43] Apart from that, the railway line between Lübeck and the FBFL will be upgraded to two tracks, partly re-aligned and completely electrified. On the northern, Danish access there is already a complete motorway (E47), but the railway line will be upgraded.

Travel time for railways between Hamburg and Copenhagen will be reduced from 4:40 hours to about 2:45 hours with HSR-Trains. For passenger car traffic the travel time reduction will be described below in detail. These assumptions have been applied in the FTC-model to calculate demand effects. No difference between a 'bridge' or a 'tunnel'-solution is considered in the forecast as it is not influencing the question of travel time and travel costs. Psychological factors (tunnel anxiety) have not been considered because they are not relevant for demand as have been described in chapter 3.1 above.

[42] AEA Association of European Airlines: Summary of Traffic and Airline Results (S.T.A.R), yearly

[43] There are recent ideas to reconstruct the existing two lane/one track Fehmarnsund Bridge and build a second one with the same width nearby, another idea is a tunnel below Fehmarnsund. These new ideas are not considered here.

In the following Table 4-2 a comparison is made for the **travel time with passenger car** without and with the FBFL:

	section/component	Travel time in minutes		difference with - without FBFL	comments
		without FBFL	with FBFL		
		(existing ferry-services)			
1	cruising time ferry	45	0	-45	timetable
1A	passing time tunnel	0	15	15	70 km/h average
2	av. waiting time ferry	15	0	-15	30 minute headway
3	check in and access ferry	10	0	-10	experience
3A	check in/tolling FBFL	0	2	2	experience
4	egress ferry	5	0	-5	experience
5	four lane extension southern access			-1	120 km/h speed limit[1)] instead of 100 km/h[2)]

1) nomal for 4-lane-roads in Germany
2) normal for German Bundesstraßen

Table 4-2: Travel time savings due to FBFL

Total time savings are approximately 60 minutes. In the model the 59 minutes shown above are assumed.

These assumptions are rather conservative due to the following facts:

(1) Peak capacity risk: During summer and on the weekends (average) waiting time for the ferry may be longer than half of the headway if no booking has been made. Booking may restrict flexibility and requires an earlier arrival in the harbor.

(2) The average cruising speed through the tunnel has been assumed with 70 km/h in the average, but may be well above 85 km/h, saving around 2 minutes.

(3) For the tolling procedure in the average 2 minutes are assumed (there may be queues in peak periods). In the long term we would expect a high share of ‘Easy Passes’, so that apart from a short time speed reduction there is no necessity to stop for most of the trav-elers.

In the **FTC model 2002** cruising time of the Rødby-Puttgarden ferry has been assumed with 52 minutes (today and in the FTC model 2014 45 minutes).

On the other hand the passing time for the FBFL (bridge) had been assumed by 12 minutes (study 2014: 15 minutes).

Time savings then were assumed with 40 minutes for passing (52 – 12), 15 minutes for waiting (30 minutes headway) and 10 minutes for access/egress giving 65 minutes. No other time components have been considered in the FTC study of 2002.

The **effects of the FBFL on the travel time of passenger car traffic** can be illustrated by the two representative examples Hamburg – Copenhagen and Berlin – Copenhagen. They are representative because many other OD relations pass Hamburg and Copenhagen (for example Cologne – Stockholm, Frankfurt am Main – Gothenburg) or Berlin and Copenhagen (for example Prague – Oslo, Leipzig – Helsingborg).

In Table 4-3 for these OD relations the most relevant route alternatives are shown together with the modelized travel time:

OD relation	km	travel time in minutes	thereof ferry/FBFL (incl. access/egress/ waiting)
Hamburg – Copenhagen			
via Rødby – Puttgarden	334 1)	264	75
via Great Belt	474	270	0
via FBFL	334	205	17
Berlin – Copenhagen			
via Rostock – Gedser	444 1)	430	180
via Rødby – Puttgarden	584 1)	409	75
via FBFL	584	350	17

1) including ferry crossing

Table 4-3: Travel time for the most important route alternatives for Hamburg - Copenhagen and Berlin - Copenhagen

For **Hamburg – Copenhagen** today there are two main routes: via Rødby – Puttgarden and via Great Belt. The latter is 140 km longer. Considering waiting time and access/egress times for the ferry the Rødby - Puttgarden route is only 6 minutes faster (in peak periods it may be longer due to capacity restraints on the ferries). Apart from the lower costs, the flexibility of the Great Belt route is much higher than on the route via Rødby – Puttgarden so that today a lot of travelers use the Great Belt route between Hamburg and Copenhagen instead of the Fehmarnbelt ferries. The FBFL (including the improvement on the southern access road) would give a nearly 60 minutes time saving compared to the existing ferry route.

For **Berlin – Copenhagen** the Rostock – Gedser line seems to be the best alternative today, which is 140 km shorter than the route via Puttgarden - Rødby. Due to the restricted headway[44] on the first line (mostly 8 departures a day) the travel time via the latter route is shorter in the average. This gap will widen considerably when the FBFL is open: Time savings by using the FBFL would be at 80 minutes in the average on this relation, on which users then clearly would prefer the FBFL in most cases.

4.3 Modelizing time and cost savings by the Fehmarn Belt Fixed Link

Apart from travel time two additional factors have to be considered in the demand incl. route choice model:

° the toll: here the existing Rødby - Puttgarden average fares have been assumed for the FBFL, both for passenger as for freight traffic. The toll of the other ferries and for the other Fixed Links has been kept on 2013 levels.

° the Value of Time which is important in passenger traffic on the trip purposes, in freight traffic for the drivers costs.

4.3.1 Passenger Traffic

In Table 4-4 for the representative OD relations shown above, again the most relevant route alternatives are shown, here including travel costs:

[44] It is considered in the model an adaption of the users to the headway; so waiting time is not the half of the headway interval but only a share of it.

OD relation	km	travel time in minutes	travel costs per car in €	thereof ferry/fixed link
Hamburg - Copenhagen				
via Rødby - Puttgarden	334[1)]	264	103,0	65,0
via Great Belt	474	270	89,9	33,0
via FBFL	334	205	105,4	65,0
Berlin - Copenhagen				
via Rostock - Gedser	444[1)]	430	128,8	81,5
via Rødby Puttgarden	584[1)]	409	133,0	65,0
via FBFL	584	350	135,4	65.0

1) including ferry crossing

Table 4-4: Basic data for the most important route alternatives for Hamburg Copenhagen and Berlin - Copenhagen incl. travel costs

It can be seen that travel costs between Hamburg and Copenhagen via Great Belt are lower than via Rødby - Puttgarden, more than matching the travel time difference. In the with case, FBFL would be slightly more expensive due to fuel costs for the tunnel passage. However, travel time is much lower than on Great Belt.

For Berlin - Copenhagen travel costs are similar in the three alternatives. Today Rødby - Puttgarden has travel time advantages. In the with case the FBFL gives a clear travel time advantage with only small travel cost disadvantages.

In Table 4-5 the Generalized Costs (user costs plus time, multiplied with a Value of Time) for these alternatives are shown[45]:

Generalized Costs	Costs in € for Business	Costs in € for Private
Hamburg - Copenhagen		
via Rødby - Puttgarden	416	107
via Great Belt	412	103
via FBFL	344	93
Berlin - Copenhagen		
via Rostock - Gedser	645	159
via Rødby Puttgarden	620	155
via FBFL	550	142

Table 4-5: Geneneralized costs (raw) for the most important route alternatives Hamburg - Copenhagen and Berlin - Copenhagen

For **Hamburg – Copenhagen** today the Great Belt is the slightly better route in the average of the year, taking the Generalized Costs into consideration. In reality the route gives advantages also with regard to availability respectively reliability (capacity restraints in peak periods). On the other hand the ferry cruise permits a break which can be necessary on many long journeys. These effects have been considered in the calibration process by de- and surcharges. The route with FBFL however is clearly the best alternative in the future on this relation.

Also for **Berlin – Copenhagen** the FBFL is clearly the best alternative in terms of Generalized costs and clearly the majority of traffic would use the FBFL in the future.

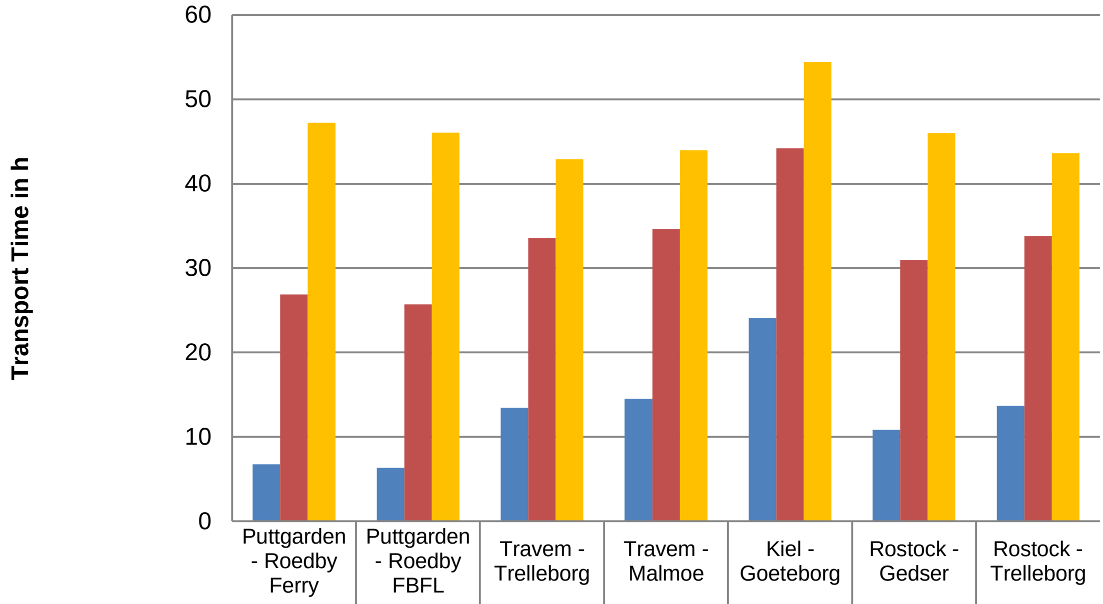
Also from other routes traffic will be diverted to the FBFL. There will be not a 100 % market share on most OD-relations. Routes like Sassnitz – Trelleborg, Frederikshavn – Gothenburg and others still will keep certain market shares, but loose traffic to the FBFL. In the study on hand not an all-or-nothing route-choice- and route-split-procedure is used, but is calculating a distribution

45 Here shown for the early forecast period because user costs and VoT are not constant. The examples give only the principle for the calculations which differ due to trip purposes, forecast year and OD-relation

for each OD-relation to the relevant routes. This distribution has been calibrated on the basis of the ferry statistics.

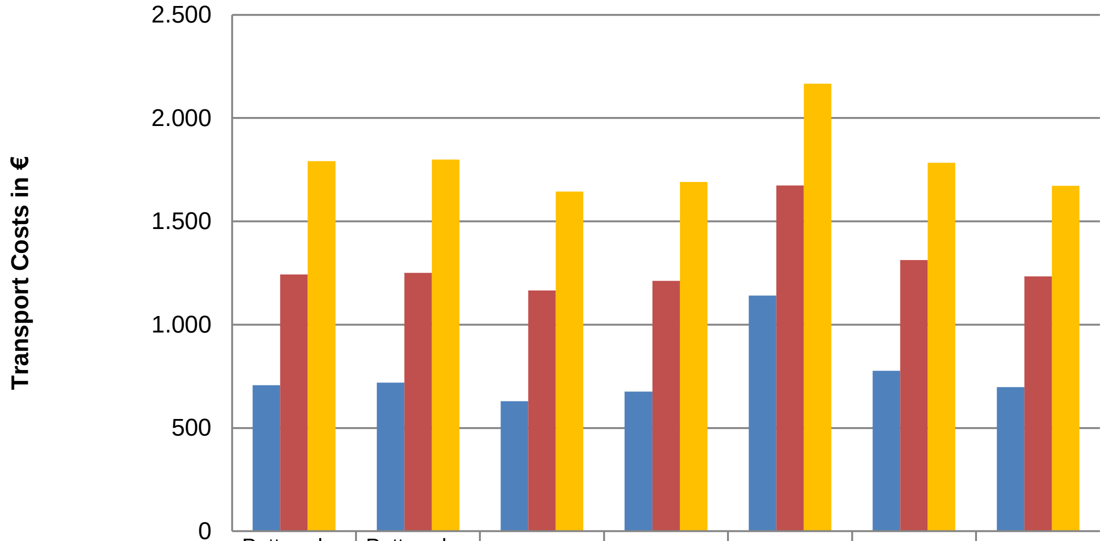
4.3.2 Freight Traffic

In order to illustrate the effects of the Fixed Link for the transport time and costs of lorries, three examples of freight connections were selected (Hamburg – Malmö, Antwerpen – Malmö, Milano – Malmö). The calculations refer to the 2014 price levels of Case B for a lorry with a length of 17 m. Even though the ferry service is assumed to close as response to the opening of the fixed link, we show the differences between the ferry service and the fixed link for freight forwarders.



	Puttgarden - Roedby Ferry	Puttgarden - Roedby FBFL	Travem - Trelleborg	Travem - Malmoe	Kiel - Goeteborg	Rostock - Gedser	Rostock - Trelleborg
Hamburg - Malmö	6,8	6,3	13,5	14,5	24,1	10,8	13,7
Antwerpen - Malmö	26,9	25,7	33,6	34,6	44,2	31,0	33,8
Milano - Malmö	47,2	46,0	42,9	44,0	54,4	46,0	43,6

Figure 4-1: Lorry Transport time on selected freight connections to Malmö via different routes



	Puttgarden - Roedby Ferry	Puttgarden - Roedby FBFL	Travem - Trelleborg	Travem - Malmoe	Kiel - Goeteborg	Rostock - Gedser	Rostock - Trelleborg
Hamburg - Malmö	707	720	630	675	1.141	776	698
Antwerpen - Malmö	1.244	1.251	1.166	1.211	1.673	1.313	1.234
Milano - Malmö	1.791	1.798	1.645	1.690	2.166	1.784	1.673

Figure 4-2: Lorry Transport costs on selected freight connections to Malmö via different routes

The ferry travel times include crossing times, waiting times as well as loading and unloading processes. Concerning the transport time of lorries, the legal requirements of breaks and rest periods were implemented. Moreover, the model takes into account, that the ferry travel times can be used to take these breaks and rest periods.

With respect to the transport time, the FBFL achieves a substantial improvement for the transports from Hamburg and Antwerpen to Malmö. On the other hand, on the route from Milano to Malmö the required rest periods during the long distance ferry crossings lead to time advantages of the ferries from Travemünde to Malmö/Trelleborg and Rostock to Trelleborg compared to the Fixed Link.

Due to the shorter road distances, the long distance ferries exhibit cost advantages compared to the Fehmarn Belt routes. Since the same price for the Fixed Link and the Fehmarn Belt ferry is assumed and the variable lorry costs only occur when using the FBFL, the transport costs via the FBFL exceed the costs via the ferry.

5 RESULTS CASE A

The assumptions of Case A have been developed on the basis of the assumptions for the BVWP 2015. The data and the model calculations, however, are based on the (with regard to the subject) more detailed FTC model. Forecast results therefore may not be comparable between BVWP and FTC.

5.1 Passenger Traffic

In line with the forecasting method

- to prepare in a **first step** a forecast for the **total relevant market** (international traffic between Eastern Denmark, Sweden, Norway, Finland to Germany and the other Continent)
- to calculate the **share** of traffic for the FBFL (resp. in the before case the Rødby - Puttgarden ferry) in the **second step**

the results will be presented in these two steps.

5.1.1 Total Traffic Scandinavia – Continent

In Table 5-1 an overview is given of the total traffic development in the study corridor according to the forecast (Case A).

In total passenger traffic will grow from 30,5 to 57,5 million between 2011 and 2035, resulting in an average growth rate of 2,7 % per annum (from 2025 2,5 % p.a.). The difference between with case (with FBFL) and without case is 169 thousand trips which is 0,4 % of the total, due to induced resp. form other OD's redistributed trips.

However, the biggest absolute growth is assigned to **air traffic** (growth rate of 3,5 % p.a., for 2025: 3,3 % p.a., for comparison: in the past ten years growth has been close to 6 % p.a., see chapter 2). However, in this mode there is a big share of traffic with 1.500 km trip length or more which is only to a minor extent a relevant market for the FBFL or the competing ferries. In the core study area (Eastern Denmark/Sweden with Germany) air traffic is growing with 2,1 % p.a. Here an effect of the FBFL can be observed, reducing air traffic from 2,13 million passengers to 1,95 million (- 8 %).

Mode		1000 passengers/year					average growth 2025 - 2035 (in % p.a.)
	2011	2022 (without Fixed Link	2022 (with Fixed Link)[2)]	2025	2030	2035	
Rail	460	659	1.298	1.338	1.433	1,510	1,2
Car	8.970	10.492	10.788	11.235	12.148	12.895	1,4
Air	17.226	26.011	25.714	28.510	34.446	39.303	3,3
thereof core study area[1)]	1.657	2.132	1.952	1.974	2.223	2.427	2,1
Bus	2.320	2.474	2.447	2.518	2.601	2.668	0,6
Ferry Walk On	1.512	1.424	982	965	957	950	-0,2
Total	**30.488**	**41.060**	**41.229**	**44.566**	**51.584**	**57.326**	**2,5**

1) Core study area: Eastern Denmark/Sweden with Germany
2) 2022 incl. ramp-up-effects

Table 5-1: Forecast results passenger traffic between Scandinavia and Europe - Case A [46]

Land base traffic would grow at a lower rate (in total incl. 'ferry walk-on' by 25 %, that is 0,9 % per annum on average). For comparison: total traffic growth between 2001 and 2011 in the study corridor was 2,5 % p.a., given the fact that there were two economic crises in this period (2002/2003 and 2008(2009) and user costs increased considerable for land based traffic and for ferries in this period.

With regard to the different modes there will be an increase for **car traffic** (1,4 % p.a. in the average) which is stimulated to a considerable extent even by the FBFL (induced traffic, shift from other destinations) due to the travel time savings of more than one hour in the average compared to the Rødby - Puttgarden ferry.[47]

46 Traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side
47 If taking waiting time and embarking/debarking time into consideration

The biggest relative growth of traffic would occur for **rail** for which the number of travelers would more than triple between 2011 and 2035 (2025 - 2035 1,2 %), however, starting from a rather poor modal split today (around 1,5 % of the total traffic, it is also only 3,5% share among the land based modes). The decisive boost for the rail traffic growth is the FBFL which, together with the upgrading of the feeder lines between Copenhagen and Rødby and between Lübeck and Puttgarden, allows a travel time between Hamburg and Copenhagen of approx. 2,5 hours. By that traffic jump rail traffic is nearly doubling, from 0,66 to 1,3 million passengers in 2022 between Scandinavia (without Western Denmark) and the Continent.

Bus traffic would grow at a slower rate, among that less the charter bus services, but more the long distance scheduled bus services which should profit from an FBFL. **Ferry walk-on** would decrease due to the closing of the ferry when the FBFL is opening.

The effect of the FBFL on the **total north-south traffic** on this basis of 2022 can also be seen in Table 5-1. It is summarized in Table 5-2.

Mode	1000 Passengers
Rail	+ 639
Car	+ 296
Air	- 297
Bus	- 27
Ferry Walk On	- 442
Total	**+ 169**

Table 5-2: Effects of the FBFL on the total traffic in the study corridor in Case A (on the basis of 2022, including ramp-up-effects)

The biggest effect is for rail traffic which can increase the share of traffic on cost of short distance air traffic and also at cost of car and bus traffic. Car is growing mainly by induced traffic (more intense relationship between the regions of Ostholstein and Lolland resp. even between the agglomeration of Hamburg and the Öresund region). On the other hand ferry walk-on would decrease. This is mainly a special traffic, stimulated by ferry connections.

In a more detailed overview (see Table 5-3) it can be seen, that the main effects of the FBFL are observed in the country - country relation Germany -Denmark (East), followed by Germany - Sweden and Denmark - Rest of Europe.

Main traffic flow		1000 passenger trips/year					
		Rail	Car	Air	Bus	Walk-On	Total
Germany	East-Denmark	334	291	-97	-11	-439	**78**
	Sweden	197	-18	-83	-20	-2	**74**
	Norway	10	6	-3	0	0	**13**
	Finland	3	0	-2	0	0	**1**
Rest Europe	East-Denmark	39	16	-57	8	-1	**5**
	Sweden	54	-2	-60	-6	0	**-14**
	Norway	1	3	-1	1	0	**4**
	Finland	1	0	6	1	0	**8**
Total		**639**	**296**	**-297**	**-27**	**-442**	**169**

Table 5-3: Effects of the FBFL on the total traffic in the study corridor per country-country-pair (on the basis of 2022, without considering ramp-up-effects) - Case A

The long term traffic per main traffic flow in the study corridor can be seen in the following tables for 2011, 2025, 2030 and 2035.

Main traffic flow		1000 passenger trips					
		Rail	**Car**	**Air**	**Bus**	**Walk-On**	**Total**
Germany	**East-Denmark**	835	4.871	660	1.012	664	**8.042**
	Sweden	135	2.960	1.314	645	242	**5.296**
	Norway	17	946	1.917	202	11	**3.093**
	Finland	10	73	829	47	30	**989**
	Total	**997**	**8.850**	**4.720**	**1.906**	**947**	**17.420**
Rest-Europe	**East-Denmark**	223	837	6.172	198	18	**7.448**
	Sweden	102	1.112	9.451	262	0	**10.927**
	Norway	7	380	5.048	91	0	**5.526**
	Finland	9	56	3.119	61	0	**3.245**
	Total	**341**	**2.385**	**23.790**	**612**	**18**	**27.146**

Table 5-4: Forecast results passengers - main traffic flows for 2025 - Case A

Main traffic flow		1000 passenger trips					
		Rail	Car	Air	Bus	Walk-On	Total
Germany	East-Denmark	885	5.336	763	1.047	659	**8.689**
	Sweden	145	3.093	1.460	641	241	**5.580**
	Norway	19	1.004	2.227	208	10	**3.467**
	Finland	11	75	927	48	29	**1.090**
	Total	**1.059**	**9.508**	**5.377**	**1.943**	**940**	**18.826**
Rest-Europe	East-Denmark	246	932	7.655	218	17	**9.068**
	Sweden	111	1.218	11.347	275	0	**12.952**
	Norway	8	428	6.347	99	0	**6.881**
	Finland	10	62	3.720	66	0	**3.857**
	Total	**374**	**2.640**	**29.069**	**657**	**17**	**32.758**

Table 5-5: Forecast results passengers - main traffic flows for 2030 - Case A

Main traffic flow		1000 passenger trips					
		Rail	Car	Air	Bus	Walk-On	Total
Germany	**East-Denmark**	925	5.716	847	1.076	655	**9.219**
	Sweden	153	3.202	1.580	637	240	**5.812**
	Norway	20	1.051	2.480	212	10	**3.773**
	Finland	11	77	1.007	49	29	**1.173**
	Total	**1.109**	**10.046**	**5.914**	**1.974**	**934**	**19.977**
Rest-Europe	**East-Denmark**	264	1.010	8.869	234	16	**10.393**
	Sweden	119	1.305	12.899	285	0	**14.608**
	Norway	8	468	7.409	105	0	**7.990**
	Finland	10	66	4.212	70	0	**4.358**
	Total	**401**	**2.849**	**33.389**	**694**	**16**	**37.349**

Table 5-6: Forecast results passengers per main traffic flows for 2035 - Case A

Main traffic flow		1000 passenger trips					
		Rail	Car	Air	Bus	Walk-On	Total
Germany	East-Denmark	203	3.690	675	873	1.191	**6.632**
	Sweden	63	2.540	982	645	255	**4.485**
	Norway	4	809	1.205	195	12	**2.225**
	Finland	5	67	583	46	32	**733**
	Total	**275**	**7.106**	**3.446**	**1.760**	**1.490**	**14.077**
Rest-Europe	East-Denmark	109	623	3.679	167	22	**4.601**
	Sweden	66	894	5.572	251	0	**6.782**
	Norway	4	301	2.652	86	0	**3.044**
	Finland	6	46	1.877	56	0	**1.985**
	Total	**185**	**1.864**	**13.780**	**560**	**22**	**16.411**

Table 5-7: **For comparison**: Passenger traffic 2011 per main traffic flow - Case A

5.1.2 Rødby - Puttgarden/FBFL Traffic

The FBFL, assumed to have the first full year of operation 2022, would benefit both from

- a growing market in the traffic between Northern Europe and the Continent
- growing traffic share because the FBFL together with the changes in the hinterland infrastructure provides considerable travel time gains and is other than any ferry line continuously available.

In Table 5-8 the main results for the Fehmarnbelt traffic are shown:

Until 2022, in the without case, there will be a growth of 14 % in passenger numbers (from 6,03 to 6,92 million) which is a market growth of 1,3 % per year. Most passengers would be, as today, car passengers, but with a growing share because the modes bus passengers, the second largest mode, and ferry walk-on are decreasing. The number of cars transported by the ferry line would increase from 1,56 to 1,91million (+ 22 %) equivalent to an annual growth of 1,8%.

	2011	2022 without Fixed Link	2022 with Fixed Link	2025	2030	2035
Passengers (1000/year)	**6.028**	**6.915**	**9.668**	**11.100**	**12.110**	**12.936**
Thereof						
passenger in cars	3.973	4.853	7.063	8.396	9.288	10.018
passengers in bus	1.142	1.050	1.311	1.374	1.394	1.411
passengers in rail	394	591	1.294	1.330	1.427	1.507
ferry walk-on	519	421	0	0	0	0
Vehicles (1000/year)						
cars (incl. motorcycles)	1.564	1.911	2.781	3.314	3.655	3.934
Buses	30,5	28	35	37	37,5	38

Table 5-8: Results for the Rødby - Puttgarden traffic in Case A

When the Fixed Link opens, there will be a jump in traffic. Even by considering a ramp-up-effect[48] the number of passengers crossing the Fehmarn Belt would increase to almost 9,7 million and the number of cars from 1,91 to 2,78 million.

In 2025, when the 'balanced' situation is reached, the number of cars would increase to 3,31 million and the amount of passengers crossing the FBFL would reach more than 11 million. In

48 Assumption: The traffic jump compared to the ferry traffic Rødby - Puttgarden for the car traffic is only reduced to about 70 % in the first year, 85 % in the second year and 95 % in the third year of operation. From the forth year on it is 100 %. For bus and rail there is no ramp-up-effect

the long term (2035), 3,93 million cars and almost 13 million passengers would cross the Fehmarn Belt resp. use the FBFL.

The effects of the FBFL on the Fehmarnbelt traffic can be seen in Table 5-9. In this overview the ramp-up effect is eliminated to be able to see the direct effect of the FBFL

	2022 without Fixed Link	2022 with Fixed Link	change	change in %
Passengers (1000/year)	6.915	10.602	3.687	53,3
thereof				
passenger in cars	4.853	7.997	3.144	64,8
passengers in bus	1.050	1.311	261	24,9
passengers in rail	591	1.294	703	119,0
ferry walk-on	421	0	-421	-100,0
Vehicles (1000/year)				
cars (incl. motorcycles)	1.911	3.149	1.238	64,8
Buses	28	35	7	25,0

Table 5-9: Effects of the Fixed Link (without ramp-up effects) on Fehmarn Belt traffic - Case A

In the year 2022 the number of passengers crossing Fehmarn Belt would increase by more than 50 % (from 6,9 to 10,6 million) and the number of cars by 64,8 % (from 1,91 to 3,15 million).

As shown in chapter 5.1.1, this traffic jump is to a smaller share resulting from induced traffic and to a considerable share from modal-split effects. It has to be put emphasis that the 'induced traffic' is considering no change in the socio-economic structure caused by the FBFL. Such a 'secondary induced traffic' (effects on housing and economic activities resulting for example in more day commuters) is normally a long term effect of projects of this scale thus resulting in additional interactions, which means additional traffic.

The main effects in any case, however, are **route choice effects** (see Table 5-10).

	in 1000 passengers	Share in %
induced traffic (incl. neg. effects by closing ferry walk-on)	180	5
modal-split change (mainly from air)	297	8
route effect rail (from Padborg/Flensburg)	53	1
route effect bus (from other ferries and Great Belt)	290	8
route effect car (from other ferries and Great Belt)	2.867	78
Total	**3.687**	**100**

Table 5-10: Effects of the FBFL in terms of passengers (related to 2022, without ramp-up-effects)

Route choice effects for car (and bus) passengers are for more than 40 % related to the Great Belt, around 30 % for Gedser- Rostock and nearly 30 % for other ferries.

The complete time series for passenger vehicle traffic up to 2047 is given in the following graph (see Figure 5-1). The time series from 2035 is an extrapolation, based on the period 2025 to 2035, however with a reduced growth rate due to the fact that population esp. in Germany is stagnating (reducing the growth rate from 1,7 % in the period 2025 to 2035 to 1,2 % in the period 2035 to 2047).

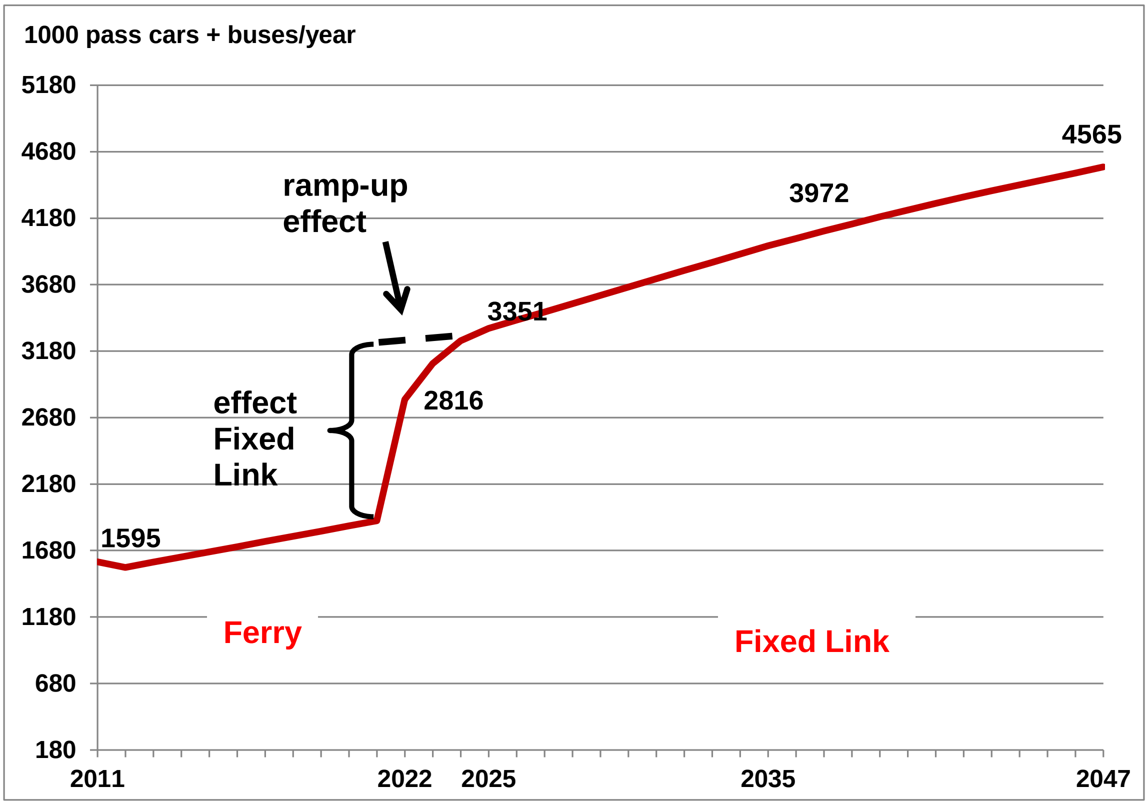


Figure 5-1: Forecast time series cars and buses - Case A

5.2 Results Freight Traffic

In this chapter, the forecasts for the total freight traffic volume between Scandinavia and Continental Europe are presented by commodities, countries and modes. Afterwards, a profound analysis of the Fehmarn Belt road and rail traffic is conducted, focusing on the expected traffic shifts. Further detailed results of the calculations including maps with the assignment results can be found in the annex.

5.2.1 Total Traffic between Scandinavia and Continental Europe

Taking into consideration the above mentioned foreign trade developments between the four northern European countries and the continent, the relevant traffic volume is projected to increase by 1,8 % p.a. to 43,7 million t until 2035, as set forth in Table 5-11.

Main drivers of this process will be the rising trade exchange with chemical products as well as transport equipment and machinery. However, miscellaneous articles, i.e. containerized goods, which have the highest market share in 2011 (20,4 %), will still be the most important transport good with a share of 19,3 % of total traffic. On the other hand, the transport volumes of fuels, ores as well as mining and mineral products will only stagnate or grow slightly as a consequence of the changing trade commodity patterns described above and in the annex.

In comparison to the projected foreign trade developments, the growth rates of the considered land transport volume between Scandinavia and Continental Europe are expected to be slightly higher. This is due to the fact that a considerable share of the bulk commodities is transported across the Baltic Sea by seagoing vessels, whereas land transportation accounts for larger shares of manufactured goods. Because low increases for bulk commodity trades and on the other hand higher growth rates for manufactured goods trades are projected, the forecast for land transportation shows higher rises than the one for the total foreign trade developments.

Commodity group	2011	2022	2025	2030	2035	Growth 2011-2035 p.a.
Agriculture, hunting and forestry	2.507	3.237	3.396	3.667	3.938	1,9%
Food products, beverages and tobacco	2.585	3.305	3.469	3.748	4.026	1,9%
Wood and cork, pulp, paper	4.060	5.307	5.556	5.999	6.441	1,9%
Coal, petroleum, natural gas, coke	119	120	119	118	116	-0,1%
Ores, mining and mineral products	1.338	1.458	1.471	1.497	1.523	0,5%
Metals	3.844	4.978	5.175	5.482	5.789	1,7%
Chemicals, chemical products	1.789	2.455	2.577	2.781	2.984	2,2%
Transport equipment and machinery	2.560	3.347	3.542	3.881	4.219	2,1%
Other manufactured articles	4.106	5.398	5.576	5.883	6.189	1,7%
Miscellaneous articles	5.866	7.640	7.815	8.131	8.447	1,5%
Sum	**28.774**	**37.246**	**38.695**	**41.184**	**43.672**	**1,8%**

Table 5-11: Forecasted Traffic Volume between Scandinavia and Continental Europe for 2022, 2025, 2030 and 2035 by Commodity Groups in 1.000 t

Regarding the regional distribution of the traffic volume to and from Scandinavia, we expect considerable growth rates for the Eastern European emerging economies. Thus, in 2035 traffic flows with the Czech Republic are projected to be stronger than traffic to and from Italy or France. Similar catch up processes are expected in the first instance for Slovakia, Poland and Hungary growing on average p.a. by 4,2 %, 2,5 % and 2,4 %, respectively. Between the Western European countries as France, Italy and Scandinavia, there are already pronounced trade relations such that traffic is projected to increase only modestly.

	2011		2022		2025		2030		2035		Growth 2011-2035 p.a.
	Volume	Share	Volume	Share	Volume	Share	Volume	Share	Volume	Share	
Germany	11.476	40%	14.611	39%	15.144	39%	16.158	39%	17.172	39%	1,7%
Netherlands	4.885	17%	6.222	17%	6.362	16%	6.617	16%	6.872	16%	1,4%
Poland	3.218	11%	4.459	12%	4.790	12%	5.296	13%	5.802	13%	2,5%
Czech Republic	1.286	4%	1.779	5%	1.903	5%	2.090	5%	2.276	5%	2,4%
Italy	1.482	5%	1.864	5%	1.892	5%	1.939	5%	1.985	5%	1,2%
France	1.423	5%	1.821	5%	1.835	5%	1.851	4%	1.866	4%	1,1%
Austria	1.173	4%	1.505	4%	1.552	4%	1.633	4%	1.714	4%	1,6%
Belgium	1.003	3%	1.330	4%	1.392	4%	1.502	4%	1.611	4%	2,0%
Spain	874	3%	1.000	3%	1.013	3%	1.038	3%	1.062	2%	0,8%
Hungary	469	2%	654	2%	697	2%	765	2%	833	2%	2,4%
Slovakia	215	1%	373	1%	417	1%	494	1%	571	1%	4,2%
Romania	237	1%	314	1%	335	1%	370	1%	405	1%	2,3%
Luxemburg	156	1%	205	1%	220	1%	244	1%	267	1%	2,3%
Switzerland	215	1%	237	1%	236	1%	233	1%	229	1%	0,3%
Portugal	118	0%	179	0%	180	0%	181	0%	181	0%	1,8%
Bulgaria	102	0%	137	0%	146	0%	160	0%	174	0%	2,3%
Slovenia	125	0%	141	0%	147	0%	159	0%	170	0%	1,3%
Rest [1)]	317	1%	416	1%	433	1%	458	1%	482	1%	1,8%
Sum	**28.774**	**100%**	**37.246**	**100%**	**38.695**	**100%**	**41.184**	**100%**	**43.673**	**100%**	**1,8%**

Table 5-12: Forecasted Traffic Volume between Scandinavia and Continental Europe for 2022, 2025, 2030 and 2035 by Countries in 1.000 t

As depicted in Table 5-13, among the four Northern European countries, Sweden accounts for the largest amount of trade growth with an increase of approximately 11 million t. This is due to its high absolute volume in 2011 as well because the highest relative growth of traffic volume of more than 54 % is projected for Denmark. However, traffic to and from all Scandinavian countries shows moderate growth rates of 1,8 % p.a., such that no drastic shifts in the distribution of Scandinavian origin and destination countries are expected.

	2011		2022		2025		2030		2035		Growth 2011-2035 p.a.
	Volume	Share	Volume	Share	Volume	Share	Volume	Share	Volume	Share	
Denmark	3.888	14%	5.216	14%	5.433	14%	5.718	14%	6.002	14%	1,8%
Norway	2.742	10%	3.359	9%	3.537	9%	3.767	9%	3.996	9%	1,6%
Sweden	21.230	74%	27.551	74%	28.557	74%	30.435	74%	32.312	74%	1,8%
Finland	913	3%	1.120	3%	1.168	3%	1.265	3%	1.362	3%	1,7%
Sum	**28.774**	**100%**	**37.246**	**100%**	**38.695**	**100%**	**41.184**	**100%**	**43.673**	**100%**	**1,8%**

Table 5-13: Forecasted Traffic Volume between Scandinavia and Continental Europe for 2022, 2025, 2030 and 2035 by Scandinavian Countries in 1.000 t

The projected modal split in Table 5-14 shows that under Case A assumptions, lorry transportation will gain further relevance in the traffic flows between Continental Europe and Scandinavia in the next decades. Lorries will haul 79,5 % of the whole land transport volume in 2035, based on specific commodity and country developments. Firstly, commodities with a high rail share, e.g. miscellaneous articles, will develop less dynamically than goods that are mostly transported by lorry.

Secondly, the countries' share of the modal split reveals that only 5 % of rail transportation, but 16 % of road haulage is due to Danish-European transports in 2011, whilst Sweden accounts for 93 % of the rail transportation and only 69 % of lorry transportation. Since Danish transports will develop more dynamically than the transports of the other countries, rail transportation loses higher shares than lorry transportation in Case A. These developments counteract the effect of the lower transport costs for rail transportation in Case A (rail conventional constant, rail combined -0,5 % p.a.).

		2011	2022 before opening	2022 after opening	2025	2030	2035	Growth 2011-2035 p.a.
road	tons (1.000)	22.610	29.506	29.345	30.587	32.745	34.902	1,8%
	tons share	78,6%	79,2%	78,8%	79,0%	79,3%	79,5%	0,1%
rail	tons(1.000)	6.164	7.740	7.902	8.108	8.543	8.978	1,6%
	tons share	21,40%	20,8%	21,2%	21,0%	20,7%	20,5%	-0,2%
total	tons(1.000)	28.774	37.246	37.247	38.695	41.288	43.880	1,8%
	tons share	100,00%	100,0%	100,0%	100,0%	100,0%	100,0%	0,0%

Table 5-14: Projected Road and Rail Transport between Continental Europe and Scandinavia by vehicles and tons from 2011 to 2035

The long term trend of an increasing share of road transportation in Scandinavian-Continental Europe traffic is temporarily weakened by the opening of the Fixed Link in 2022. Firstly, we assume a ramp-up-effect , such that a certain share of road transportation remains on less favourable routes and traffic is thus shifted from road to rail.

Secondly, as pointed out in chapter 2.2.4 railway connections to Scandinavia are currently limited to three links: Rostock and Travemünde ferries calling on Trelleborg and the Great Belt Fixed Link. On the other hand, a variety of ferries, including the Fehmarn Belt crossing ferry, offers lorry transportation besides the Storebaelt Bridge. The opening of the Fehmarn Belt Fixed Link implies thus a more radical improvement for the railway connection between Scandinavia and the Continent as opposed to the time and cost gains for lorries. This upgrade induces a further modal shift towards rail after the opening of the fixed link. The improvement of the rail connection as well as the ramp-up-effect of lorries are projected to lead to rail freight gains of 162.000 t after the opening.

5.2.2 Fehmarn Belt Traffic

On the basis of the portrayed total traffic developments between Scandinavia and Continental Europe, the projected assignment results with particular focus on the Fehmarn Belt, are presented in this chapter. Further detailed results of the Case A calculations including maps with the assignment results can be found the annex.

Road Traffic

As Figure 5-2 and Figure 5-3 illustrate, the growing long term trend of real traffic volume across the Fehmarn Belt until 2013 will be continued in the future. Whilst lorry traffic grew on average by 3,0 % per year from 2001 to 2013, we expect a slow weakening of the growth rate to 2,8 % p.a. until 2022 under Case A assumptions before the opening.

With respect to the development in tons, the yearly increase is projected to be slightly lower with 2,6 % in contrast to 2,8 % from 2001 to 2013. In accordance with the recent traffic developments across the Fehmarn Belt and the overall expected developments, the average load per lorry will thus decrease from 11,7 to 11,5 t. Including the route shifts after the opening of the FBFL, in the long run we expect the number of lorries to rise by 76 % to 644.000 lorries in 2035, whereas the transport volume will increase by 74 % to 7,5 million t.

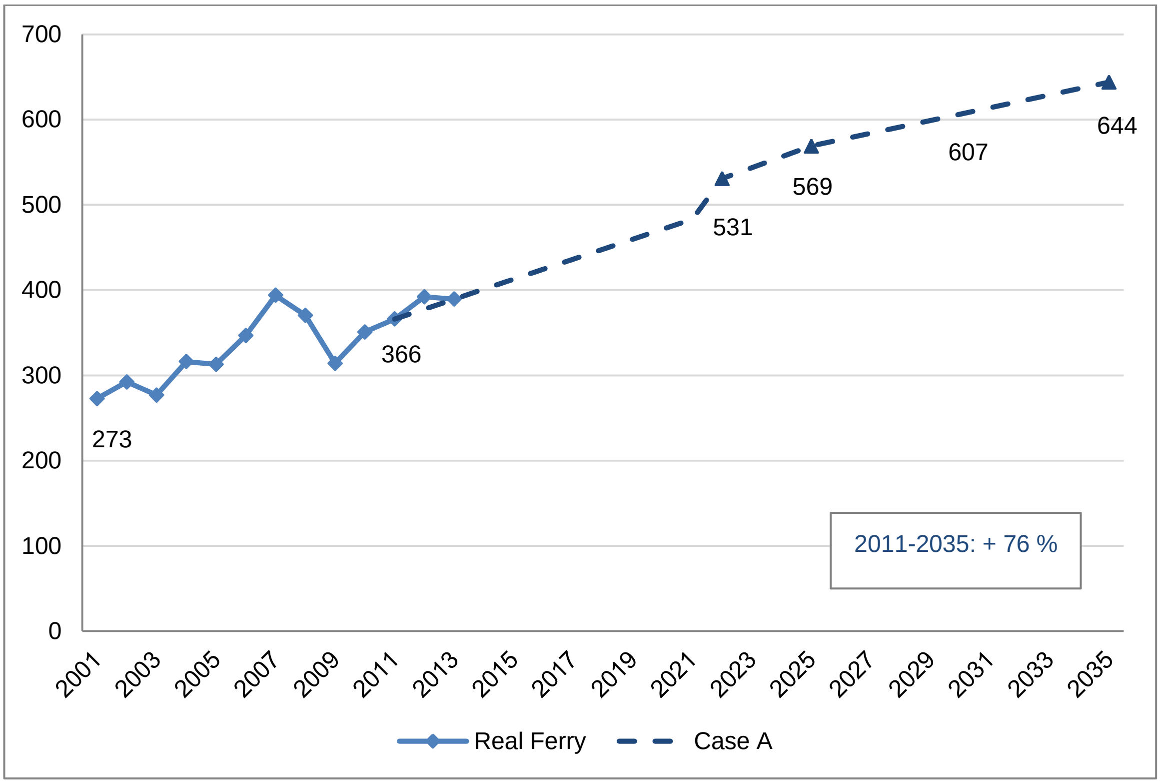


Figure 5-2: Forecasted values for the number of lorries in 1.000 per year crossing the Fehmarn Belt

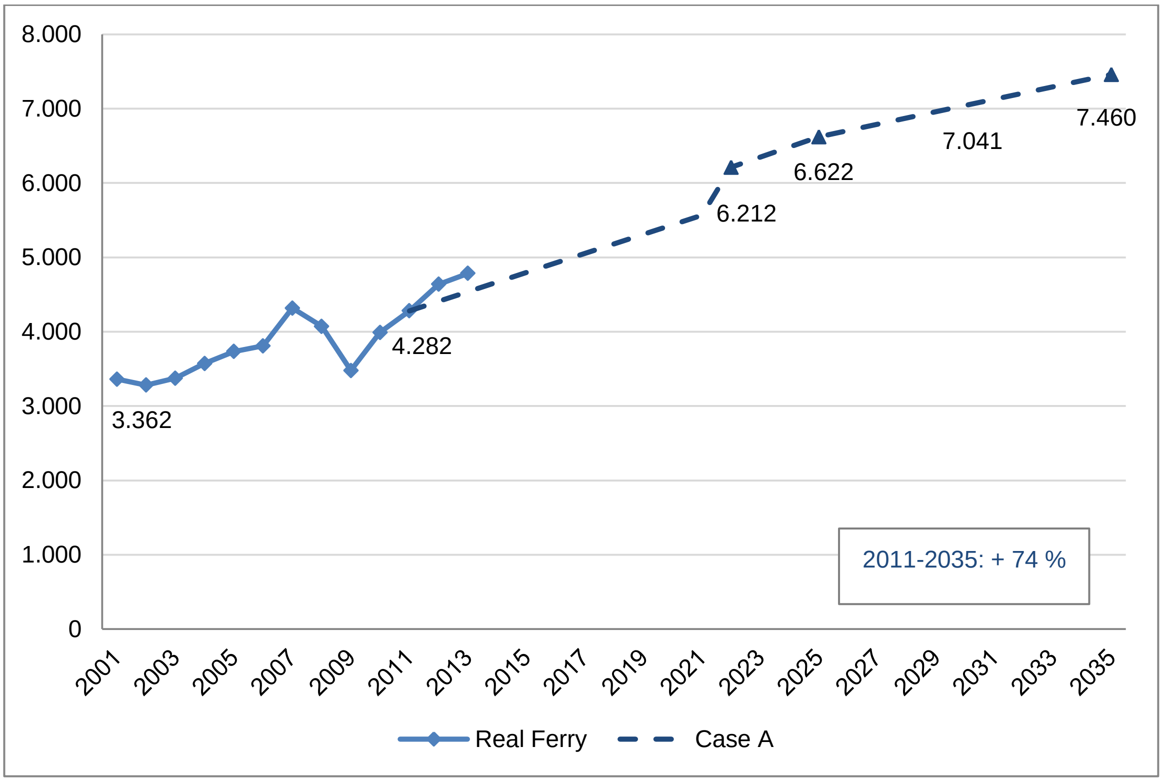


Figure 5-3: Forecasted values for the road transport volume in 1.000 t per year crossing the Fehmarn Belt

With the opening of the Fehmarn Belt Fixed Link, we expect an increase of 36.000 lorries crossing the Fehmarn Belt compared to the ferry services in 2022. Table 5-16 shows the route shifts after the opening of the Fixed Link in 2022. A noticeable advantage concerning the transport time for lorries leads to a substantial route shift from ferry services and the Great Belt to the new fixed link. The overall traffic shift potential to the Fixed Link in 2022 is estimated to be about 40.000 lorries. Yet, by means of the assumed ramp-up-effect in the first three years of operation for road freight transport, the shifted amount of lorries is reduced by 10 % in 2022. Instead of an increase of 40.000 lorries, 36.000 lorries are shifted to the Fehmarn Belt in the first year of operation of the fixed link (see volume in 2022 without ramp-up-effect in Table 5-15)..

	2011	2022 before opening	2022 (without ramp-up) after opening	2025	2030	2035
Lorries (1.000)	366	495	535	569	607	644

Table 5-15: Number of lorries across the Fehmarn Belt in 1.000 (without ramp-up-effect in 2022) in Case A

	without FBFL	with FBFL	change
Puttgarden-Rødby	495	531	36
Lübeck-Helsinki	76	75	-1
Travemünde-Trelleborg	285	276	-9
Travemünde-Malmö	270	262	-8
Landb. Flensburg-Padborg	64	62	-2
Kiel-Göteborg	112	110	-2
Kiel-Oslo	55	54	-1
Rostock-Gedser	121	116	-5
Rostock-Trelleborg	345	336	-9
Rostock-Helsinki	17	16	-1
Sassnitz-Ronne	2	2	0
Sassnitz-Trelleborg	20	19	-1
Swinoujscie-Ystad	75	73	-2
Swinoujscie-Trelleborg	42	41	-1
Great Belt	26	25	-1
Total	**2.005**	**1.998**	**-7**

Table 5-16: Projected Lorry Traffic in 1.000 vehicles per year in 2022 before and after the opening of the Fehmarn Belt Fixed Link(with ramp-up effect) by Transport Routes

The Swedish-German ferries will lose the highest number of lorries to the fixed link, summing up to nearly 40.000 lorries per year. Among the German ports, Travemünde/Lübeck is projected to lose the highest amount of 18.000 lorries per year, whilst Rostock loses 14.000 lorries to the FBFL.

Regardless of the route and the connected countries, all ferry services will cede substantial traffic volume to the fixed link. Ferries to Finland lose only little traffic shares to the FBFL. The shifts of the Baltic Sea ferries and links in absolute terms are displayed in Figure 5-4.

The effects on Great Belt and Öresund can be seen in Table 5-17.

	2022 before opening of FBFL	2022 after opening of FBFL	2025	2030	2035
Öresund	475	482	509	545	580
Great Belt	26	25	26	28	29

Table 5-17: Number of lorries in 1.000 vehicles per year via Öresund and Great Belt in Denmark: (volume only includes traffic between Continental Europe and East Denmark/Sweden/Norway/ Finland) - Case A

That means Öresund would profit from FBFL by around 7 thousand lorries/year, whereas Great Belt would lose around thousand lorries/year.

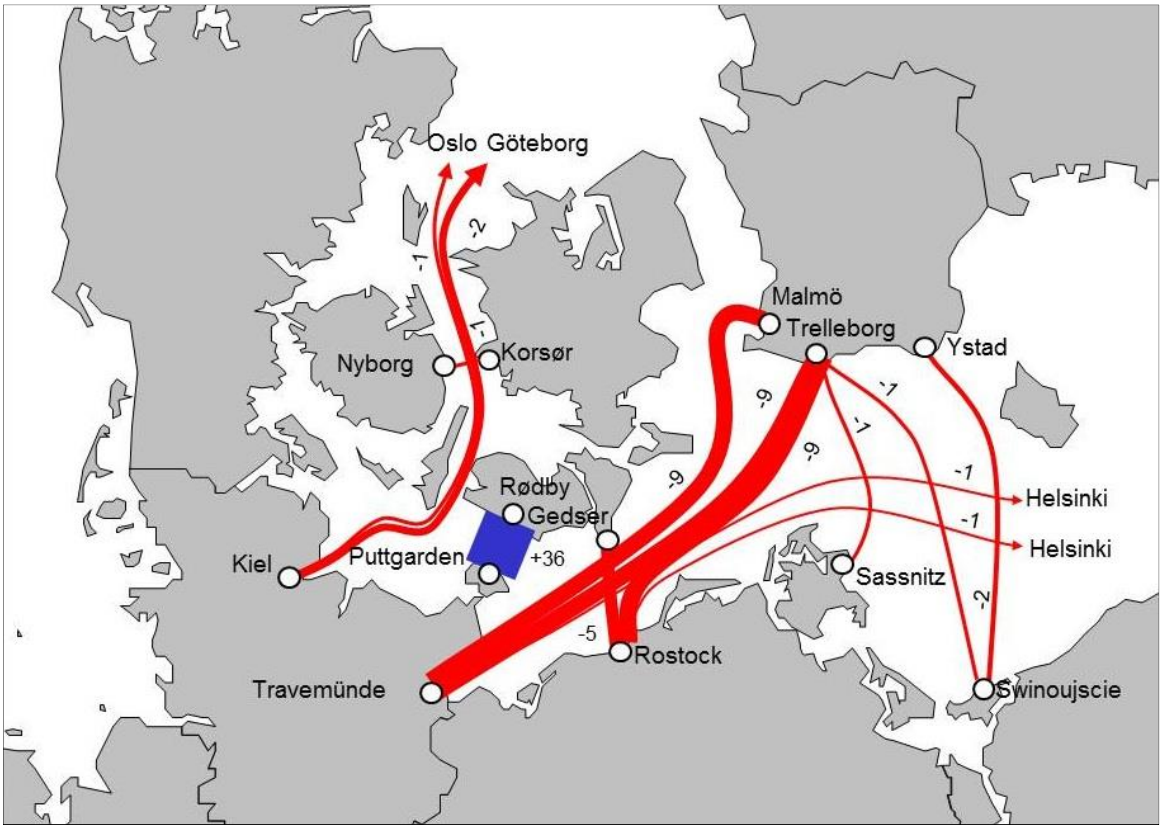


Figure 5-4: Shifts of lorry traffic in 1.000 vehicles per year as response to the opening of the Fehmarn Belt Fixed Link in 2022

Rail Traffic

Compared to road traffic, similar growth rates of rail traffic across the Fehmarn Belt are expected. Figure 5-5 shows the projected development of the rail traffic volume in tons until 2035. Since there does not exist a rail link across Fehmarn Belt, the volume of the Great Belt is displayed until the opening of the FBFL. A growth of the total charge by 50 % will lead to quantities of 8,4 million t across the Fehmarn Belt Fixed Link in 2035.

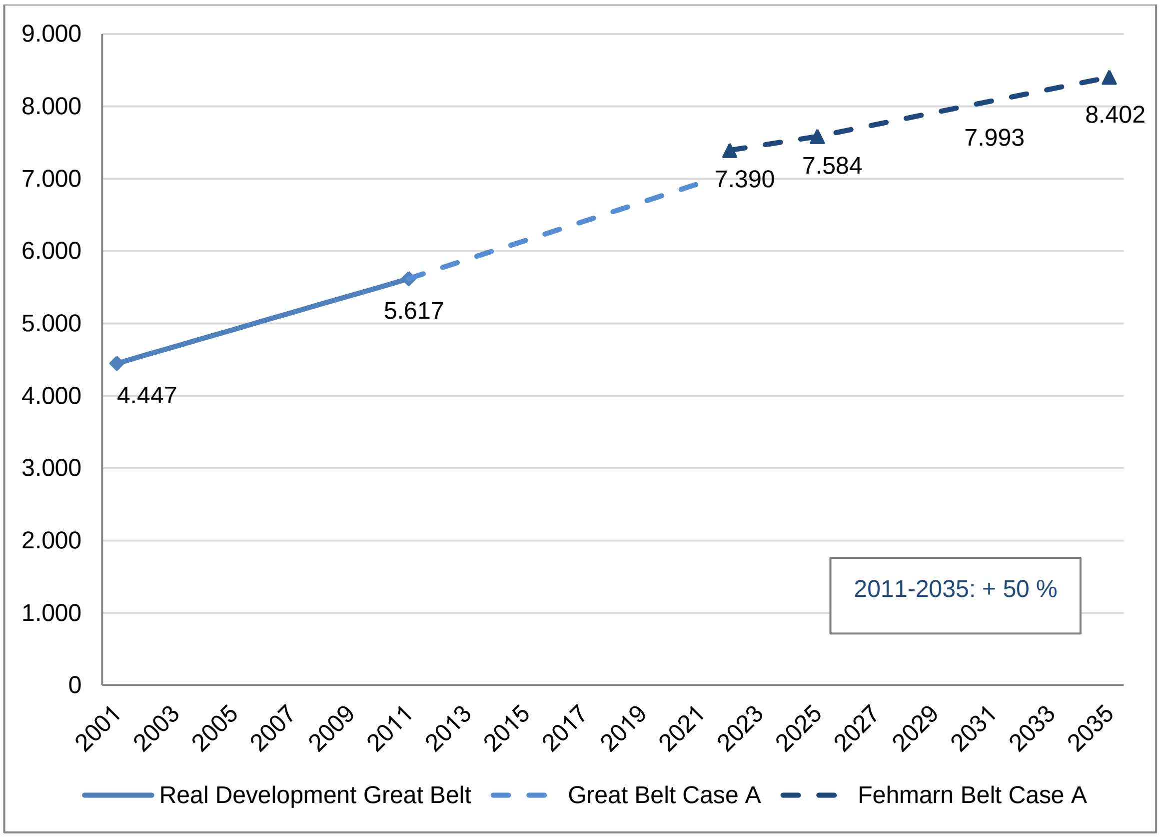


Figure 5-5: Forecasted values for the rail traffic volume in 1.000 t per year crossing the Fehmarn Belt

For rail transportation, we expect the shifts after the opening of the Fehmarn Belt Fixed Link to be more emphasized than for lorries, as depicted in Table 5-18. The railway ferries from Rostock and Sassnitz to Trelleborg will lose approximately 70.000 and 90.000 tons per year respectively. Under the assumption, that the total Great Belt Fixed Link transit traffic will be shifted towards the Fehmarn Belt Fixed Link, 7,4 million tons per year will move from all alternative links to the Fehmarn Belt.

	without FBFL	with FBFL	change
Fehmarnbelt Fixed Link	0	7.390	7.390
Great Belt Fixed Link	7.063	0	-7.063
Rostock-Trelleborg	295	222	-73
Sassnitz-Trelleborg	382	290	-92
Total	**7.740**	**7.902**	**162**

Table 5-18: Projected Rail Traffic in 1.000 tons in 2022 before and after the opening of the Fehmarn Belt Fixed Link by Transport Routes

Besides the route shift, as outlined in the previous chapter, a modal shift is expected towards rail transportation due to a substantial improvement of the railway connection through the fixed link as well as the assumed ramp-up-effect for road transportation. In this way, further gains of traffic volume across the fixed link in the amount of 162.000 tons will be generated in 2022. The obtained absolute changes in traffic volume by modal and route shift are illustrated in Figure 5-6. As a result, a traffic volume of 7,4 million tons is projected after the opening of the Fehmarn Belt Fixed Link.

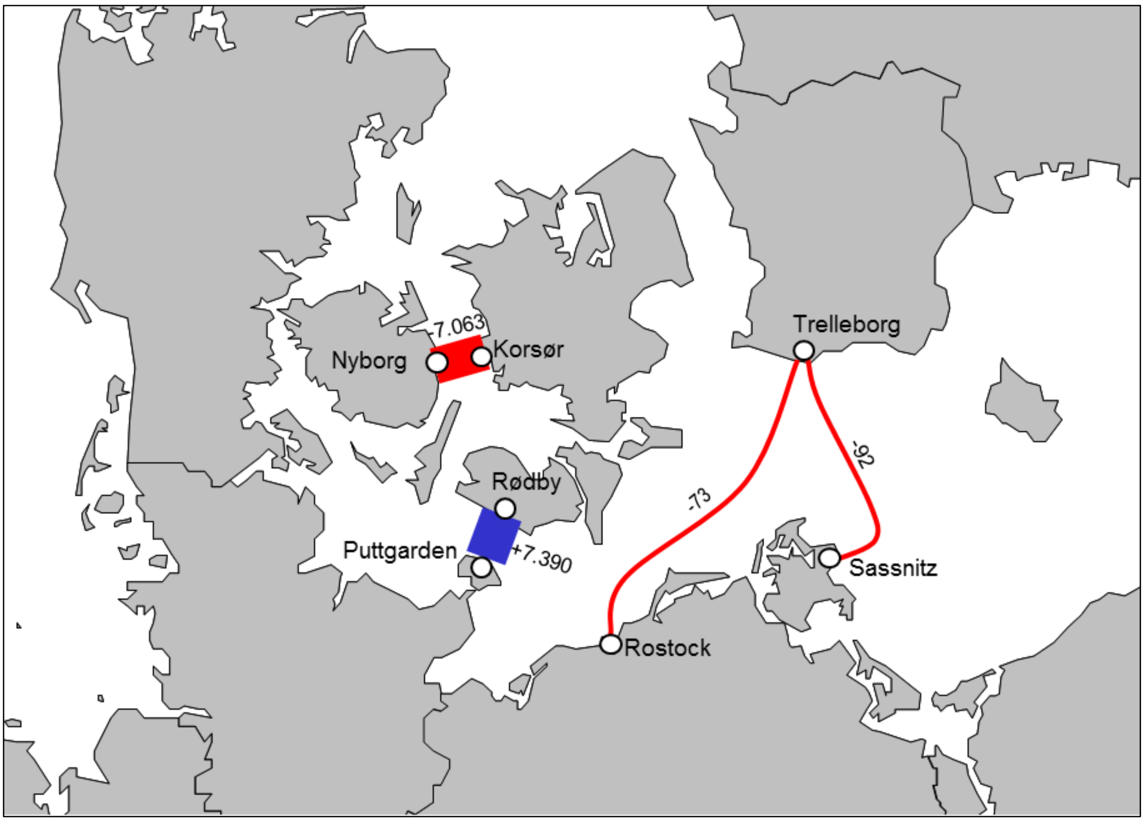


Figure 5-6: Shifts of rail traffic in 1.000 tons per year as response to the opening of the Fehmarn Belt Fixed Link in 2022

5.3 Total vehicle traffic on FBFL in Case A

The forecasts of passenger and freight traffic have been made on **yearly basis**. In the following table they are summarized in term of vehicles using the FBFL (resp. before its opening the ferry line Rødby - Puttgarden), giving also the ADT (average daily traffic) traffic figures which normally are basis for road counts.

	2011	2022 without FBFL	2022 with FBFL[2)]	2025	2030	2035
pass. cars[1)]	4.285	5.236	7.619	9.079	10.014	10.778
buses	84	77	96	101	103	104
lorries	1.003	1.455	1.356	1.559	1.663	1.764
total mot. vehicles	**5.372**	**6.768**	**9.071**	**10.739**	**11.780**	**12.646**

1) incl. motorcycles 2) incl. ramp-up-effects

Table 5-19: Average Daily Traffic (ADT) on Fehmarnbelt, Case A

The average daily traffic would grow from nearly 5,4 thousand vehicles per day to nearly 6,8 thousand in 2022 (without FBFL). Due to the traffic jump the figure would grow to more than 10,7 until 2025. In 2035 the figure would be at 12,65 thousand.

Due to the fact that for passenger traffic the traffic jump is higher than in the freight traffic, whereas for the latter the modal split effect to rail is higher, the share of lorries on the total number of vehicles crossing Fehmarn Belt is going down from 18,7 % to 14 %.

The direct effect of the FBFL ('traffic jump') is shown in Table 5-20.

	Before opening of FBFL in 2022	After opening of FBFL in 2022[1)]	Increase in %
Cars	5.236	8.627	65 %
Busses	77	96	25 %
Lorries	1.356	1.455	7 %
Total	**6.668**	**10.178**	**53 %**

1) excluding ramp-up-effect which are included in Table 5-19

Table 5-20: Traffic jump caused by the FBFL (ADT) - Case A

By the FBFL vehicle traffic on Fehmarn Belt would increase by 53 %, related to the year 2022. The effects for passenger car traffic are at 65 %, for lorries the effects are smaller (7 %).

The reason for the traffic jump is mainly traffic pulled from other routes, ferries-routes as well as the Great Belt fixed link connection. The latter provides today for passenger car drivers a cheaper and a more flexible and even, in spite of the detour of nearly 140 km, an equally fast connection on most relations, compared to the Rødby - Puttgarden ferry, when taking waiting time and time to embark and disembark the ships into consideration. Apart from route choice effects, another reason for the traffic jump is new traffic due to the increased accessibility in consequence of a travel time reduction of around one hour.

6 RESULTS CASE B

The assumptions of Case B have been developed on the basis of the assumptions of the Danish Ministry of Transport (referring page 4). **As in the FTC-study of 2002 the scenario B, based on the assumptions of the Danish Ministry of Transport, is the relevant scenario for the further planning process.** Therefore some results are described in a more detailed way than the results for Case A.

6.1 Passenger Traffic

Equally as for Case A and in line with the methodology described in Chapter 3

° a **first step** a forecast for the **total relevant area** (international traffic between Eastern Denmark, Sweden, Norway, Finland to Germany and the other Continent) and
° the **share** of traffic for the FBFL (resp. in the before case the Rødby - Puttgarden ferry) in the **second step**

will be presented consecutively.

6.1.1 Total Traffic Scandinavia – Continent

In Table 6-1 an overview is given of the total traffic development in the study corridor according to the forecast (Case B).

The autonomous growth would results in an almost doubling of the total traffic until 2035, resulting in an average yearly growth rate of 3 % (from 2025: 2,8 %). The difference between with case (with FBFL) and without case is 105 thousand trips, which is around 0,25 % of the total, due to induced resp. from other OD's redistributed trips.

As well as in the previous case, **air traffic** is growing the most by 4 % p.a. (from 2025: 3,6 %) which is still under the observed growth of the air traffic of the previous 10 years (6 %, see chapter 2). However, in the core study area (Eastern Denmark/Sweden with Germany) air traffic is growing with 2,0 % p.a. (from 2025: 1,9 % p.a.). Here the effect of the FBFL can be observed, reducing air traffic from 2,24 million passengers to 2,08 million (- 7 %).

Mode	2011	2022 (without Fixed Link	2022 (with Fixed Link)[2)]	2025	2030	2035	average growth 2025 - 2035 (in % p.a.)
	1000 passengers/year						
Rail	460	629	1.149	1.155	1.091	1.038	-1,1
Car	8 970	10.769	11.087	11.582	12.528	13.302	1,4
Air	17 226	27.996	27.733	31.299	38.496	44.384	3,6
thereof in the core study area[1)]	1.657	2.244	2.081	2.234	2.488	2.696	1,9
Bus	2 320	2.392	2.361	2.442	2.526	2.594	0,6
Ferry Walk On	1.512	1.413	974	958	949	941	-0,2
Total	**30.488**	**43.199**	**43.304**	**47.436**	**55.589**	**62.259**	**2,8**

1) Core study area: Eastern Denmark/Sweden with Germany
2) 2022 incl. ramp-up-effects

Table 6-1: Forecast results passenger traffic between Scandinavia and Europe - Case B [49]

Similar to Case A, land based traffic would grow slower than air (21 % in total or 1,4 % p.a.). Using the same comparison as in Case A, total traffic growth between 2001 and 2011 in the study corridor was 2,5 % p.a., given the fact that there were two economic crises in this period (2002/2003 and 2008(2009) and user costs increased considerable for land based traffic and for ferries in this period.

Car traffic would increase by 1,7 % p.a. which is caused partially by the inauguration of the FBFL (after 2025 growth is at 1,4 % p.a.). Due to the travel time savings of ne hour in the average compared to the Rødby - Puttgarden ferry[50] there is a considerable shift from other destinations and some induced traffic.

49 Traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side
50 If taking waiting time and embarking/debarking time into consideration

Rail traffic would perform the highest relative growth, as explained in the results for Case A – this is mainly caused by the currently poor modal split boosted up by the FBFL.

Bus traffic is growing similarly to the Case A.

The effect of the FBFL on the **total north-south traffic** in 2022 can also be seen in Table 6-1. It is summarized in Table 6-2.

Mode	1000 passengers
Rail	+ 520
Car	+ 318
Air	- 263
Bus	- 31
Ferry Walk On	- 439
Total	+ 105

Table 6-2: Effects of the FBFL on the total traffic in the study corridor in Case B (on the basis of 2022, incl. ramp-up-effects)

Rail traffic growth is stimulated here as well by shift from short distance flights and to some extent by shift from bus traffic. Car traffic is similarly to the Case A growing by mostly due to the better possibilities between Ostholstein and Lolland or the new location potentials of the Hamburg and Copenhagen regions.

In a more detailed overview (see Table 6-3) it can be seen, that the main effects of the FBFL are observed in the country - country relation Germany -Denmark (East), followed by Germany - Sweden and Denmark - Rest of Europe.

Main traffic flow		Rail	Car	Air	Bus	Walk-On	Total
		1000 passenger trips/day					
Germany	East-Denmark	356	271	-102	-18	-431	**76**
	Sweden	82	20	-61	-16	1	**26**
	Norway	11	6	-5	0	0	**12**
	Finland	3	1	-1	0	0	**3**
Rest of Europe	East-Denmark	42	15	-54	9	-1	**11**
	Sweden	25	1	-38	-6	0	**-18**
	Norway	1	3	-2	0	0	**2**
	Finland	0	1	0	0	0	**1**
Total		**520**	**318**	**-263**	**-31**	**-431**	**113**

Table 6-3: Effects of the FBFL on the total traffic in the study corridor per country-country-pair (on the basis of 2022, without considering ramp-up-effects)

The long term traffic per main traffic flow in the study corridor can be seen in the following tables for 2011, 2025, 2030 and 2035.

Main traffic flow		1000 passenger trips					
		Rail	Car	Air	Bus	Walk-On	Total
Germany	**East-Denmark**	648	5.017	780	954	659	**8.058**
	Sweden	186	3.043	1.454	629	240	**5.552**
	Norway	15	991	2.202	202	11	**3.421**
	Finland	9	74	896	47	30	**1.056**
	Total	**858**	**9.125**	**5.332**	**1.832**	**940**	**18.087**
Rest-Europe	**East-Denmark**	178	843	6.247	192	18	**7.478**
	Sweden	105	1.150	10.448	261	0	**11.964**
	Norway	6	407	5.894	95	0	**6.402**
	Finland	8	57	3.378	62	0	**3.505**
	Total	**297**	**2.457**	**25.967**	**610**	**18**	**29.349**

Table 6-4: Forecast results passengers - main traffic flows for 2025

Main traffic flow		Rail	Car	Air	Bus	Walk-On	Total
		1000 passenger trips					
Germany	East-Denmark	646	5.429	802	977	654	**8.508**
	Sweden	130	3.240	1.686	631	238	**5.925**
	Norway	16	1.049	2.682	209	10	**3.966**
	Finland	8	77	1.033	49	29	**1.196**
	Total	**800**	**9.795**	**6.203**	**1.865**	**932**	**19.596**
Rest-Europe	East-Denmark	185	939	7.525	212	17	**8.878**
	Sweden	93	1.271	12.954	277	0	**14.595**
	Norway	6	459	7.688	104	0	**8.257**
	Finland	7	64	4.125	68	0	**4.263**
	Total	**290**	**2.733**	**32.293**	**661**	**17**	**35.993**

Table 6-5: Forecast results passengers - main traffic flows for 2030

Main traffic flow		1000 passenger trips					
		Rail	Car	Air	Bus	Walk-On	Total
Germany	East-Denmark	645	5.766	820	996	649	**8.876**
	Sweden	84	3.402	1.876	632	237	**6.231**
	Norway	16	1.097	3.075	214	10	**4.412**
	Finland	8	79	1.145	50	29	**1.311**
	Total	**753**	**10.344**	**6.916**	**1.892**	**925**	**20.830**
Rest-Europe	East-Denmark	190	1.017	8.571	229	16	**10.023**
	Sweden	83	1.370	15.005	290	0	**16.748**
	Norway	6	502	9.156	111	0	**9.775**
	Finland	6	69	4.736	72	0	**4.883**
	Total	**285**	**2.958**	**37.468**	**702**	**16**	**41.429**

Table 6-6: Forecast results passengers per main traffic flows for 2035

Main traffic flow		1000 passenger trips					
		Rail	Car	Air	Bus	Walk-On	Total
Germany	**East-Denmark**	203	3.690	675	873	1.191	**6.632**
Germany	**Sweden**	63	2.540	982	645	255	**4.485**
Germany	**Norway**	4	809	1.205	195	12	**2.225**
Germany	**Finland**	5	67	583	46	32	**733**
Germany	**Total**	**275**	**7.106**	**3.446**	**1.760**	**1.490**	**14.077**
Rest-Europa	**East-Denmark**	109	623	3.679	167	22	**4.601**
Rest-Europa	**Sweden**	66	894	5.572	251	0	**6.782**
Rest-Europa	**Norway**	4	301	2.652	86	0	**3.044**
Rest-Europa	**Finland**	6	46	1.877	56	0	**1.985**
Rest-Europa	**Total**	**185**	**1.864**	**13.780**	**560**	**22**	**16.411**

Table 6-7: **For comparison**: Passenger traffic 2011 per main traffic flow

6.1.2 Rødby - Puttgarden/FBFL Traffic

Equally to Case A, the FBFL is assumed to start service in 2022. The situation for the fixed link will be beneficial because of

- the growing market in the traffic between Northern Europe and the Continent and
- the growing share of traffic, because the FBFL together with the changes in the hinterland infrastructure provides considerable travel time gains and is other than any ferry line continuously available.

In Table 6-8 the main results for the Fehmarnbelt traffic are shown: Between 2011 and the opening of the FBFL, there will be a growth of 16 % on the Rødby - Puttgarden axis, this corresponds to a yearly growth of 1,4 % p.a.. There is no change expected in the change of the traffic structure, car passengers would outweigh other modes with an even bigger share of the passenger traffic (66% in 2011, 72 % in 2022 before the opening of the tunnel).

	2011	2022 without Fixed Link	2022 with Fixed Link	2025	2030	2035
Passengers (1000/year)	**6.028**	**6.990**	**9.742**	**11.134**	**12.009**	**12.724**
thereof						
passenger in cars	3.973	5.002	7.329	8.656	9.573	10.324
passengers in bus	1.142	1.014	1.272	1.332	1.352	1.369
passengers in trains	394	557	1.141	1.146	1.083	1.031
ferry walk-on	519	417	0	0	0	0
Vehicles (1000/year)						
cars (incl. motorcy-cles)	1.564	1.969	2.885	3.417	3.767	4.054
buses	31	27	34	36	36,5	37

Table 6-8: Results for the Rødby - Puttgarden traffic in Case B

The opening of the fixed link will of course result in a swift increase of traffic caused by shifts from other modes and new trips induced by the better connection. Similar to Case A, a ramp-up effect[51] had been considered, assuming that the connection would need 3 years after the opening for being used at its full potential.

In 2025 when the traffic will be ‘used to’ the new connection, the number of cars would increase to 3,4 million with 11,1 million passengers on all modes. This would increase to more than 4 million cars and 12,7 million passengers until 2035.

51 Assumption: The traffic jump compared to the ferry traffic Rødby - Puttgarden for the car traffic is only reduced to about 70 % in the first year, 85 % in the second year and 95 % in the third year of operation. From the forth year on it is 100 %. For bus and rail there is no ramp-up-effect

The effects of the FBFL on the Fehmarnbelt traffic can be seen in Table 6-9. In this overview the ramp-up effect is eliminated to be able to see the direct effect of the FBFL.

	2022 without Fixed Link	2022 with Fixed Link	change	change in %
Passengers (1000/year)	**6.990**	**10.712**	**3.722**	**53,2**
thereof				
passenger in cars	5.002	8.299	3.297	64,5
passengers in bus	1.014	1.272	258	25,4
passengers in rail	557	1.141	584	104,8
ferry walk-on	417	0	-417	-100
Vehicles (1000/year)				
cars (incl. motorcycles)	1.969	3.267	1.298	65,9
buses	27	34	7	25,9

Table 6-9: Effects of the Fixed Link (without ramp-up effects) on Fehmarn Belt traffic

Without considering a ramp-up, i.e. assuming an immediate reaction of traffic to the new, better connection via the FBFL, traffic would increase by more than 3,7 million passengers after the opening.

As shown in chapter 6.1.1 this traffic jump is to a smaller share resulting from induced traffic and to a considerable share from modal-split effects. It has to be put emphasis that the 'induced traffic' is considering no change in the socio-economic structure caused by the FBFL. Such a 'secondary induced traffic' (effects on housing and economic activities resulting for example in more day commuters) is normally a long term effect of projects of this scale thus resulting in additional interactions, which means additional traffic.

The main effects in any case, however, are **route choice effects** (see Table 6-10).

	in 1000 passengers	Share in %
induced traffic (incl. neg. effects by closing ferry walk-on)	113	3
modal-split change (mainly from air)	263	7
route effect rail (from Padborg/Flensburg)	53	1
route effect bus (from other ferries and Great Belt)	289	8
route effect car (from other ferries and Great Belt)	3.004	81
Total	**3.722**	**100**

Table 6-10: Effects of the FBFL in terms of passengers (related to 2022, without ramp-up-effects)

Route choice effects for car (and bus) passengers are for more than 40 % related to the Great Belt, around 30 % for Gedser - Rostock and nearly 30 % for other ferries.

Modal-Split effects are to a considerable share shifts from air on **short distance flights** to land based traffic, mainly to rail. This also contributes to the **traffic jump** caused by the FBFL. These effects are summarized in Table 6-11.

OD-relation		in 1000 passenger trips	in % of total air traffic on the O/D
Germany	**East-Denmark**	102	12,1
Germany	**Sweden**	61	4,4
Germany	**Norway**	5	0,3
Germany	**Finland**	1	0,1
Rest-Europe	**East-Denmark**	54	1,0
Rest-Europe	**Sweden**	38	0,4
Rest-Europe	**Norway**	2	0,0
Rest-Europe	**Finland**	0	0
Total		**263**	**0,9**

Table 6-11: Contribution of air traffic to the traffic jump caused by the FBFL due to modal shifts per main O/D 2022 (see annex FTC report 2014 table 3-28 to 3-31)

In total, the effect of the FBFL on air traffic is **263 thousand trips**, shifted mainly from air to rail. It is a **considerable figure**, especially **from the viewpoint of rail traffic**, which has a poor modal share today. However, **from the viewpoint of air traffic it is less than 1 %** of the total air traffic between Northern Europe and the other Europe which would be shifted to the FBFL.

These 263 thousand passengers can be **grouped** as follows:

- **core study area:**
  - 102 thousand air passengers between **Germany and Eastern Denmark** (for example Copenhagen - Hamburg, Copenhagen - Berlin) are converted to the FBFL. This is 39 % of the total shift of 263 thousand passengers; 12 % of total air traffic between Denmark and Germany would be attracted by the FBFL.
  - 61 thousand air passengers between **Germany** and (mainly southern) **Sweden** (for example Malmö - Hamburg via Copenhagen) would be attracted by the FBFL (23 % of the total shift, 4,4 % of total air traffic between Sweden and Germany)
- **other study area:**
  - 54 thousand air passengers between **Denmark** and the **rest of Europe** would use the FBFL instead of the plane. This figure is related to OD's as for example Denmark - Am-

sterdam, Brussels, Prague. This contributes to 21 % of the total shift but only 1% of the total air traffic between Denmark and other Europe

- 38 thousand between (mainly southern) **Sweden** and the **rest of Europe**, for example on the ODs (southern) Sweden to Amsterdam, to Brussels and other short distance connections. This reflects 14 % of the total shift but only 0,4 % of total air traffic between Sweden and the rest of Europe
- Only 10 thousand passengers, 4 % of the effects, are related to **other relations** like Oslo – Hamburg, Berlin or other.

The complete time series for passenger vehicle traffic up to 2047 is given in the following graph (see Figure 6-1). The figures from 2035 to 2047 are extrapolated, based on the period 2025 to 2035, however with a reduced growth rate due to the fact that population esp. in Germany is stagnating, thus reducing the growth rate from 1,7 % in the period 2025 to 2035 to 1,2 % in the period 2035 to 2047.

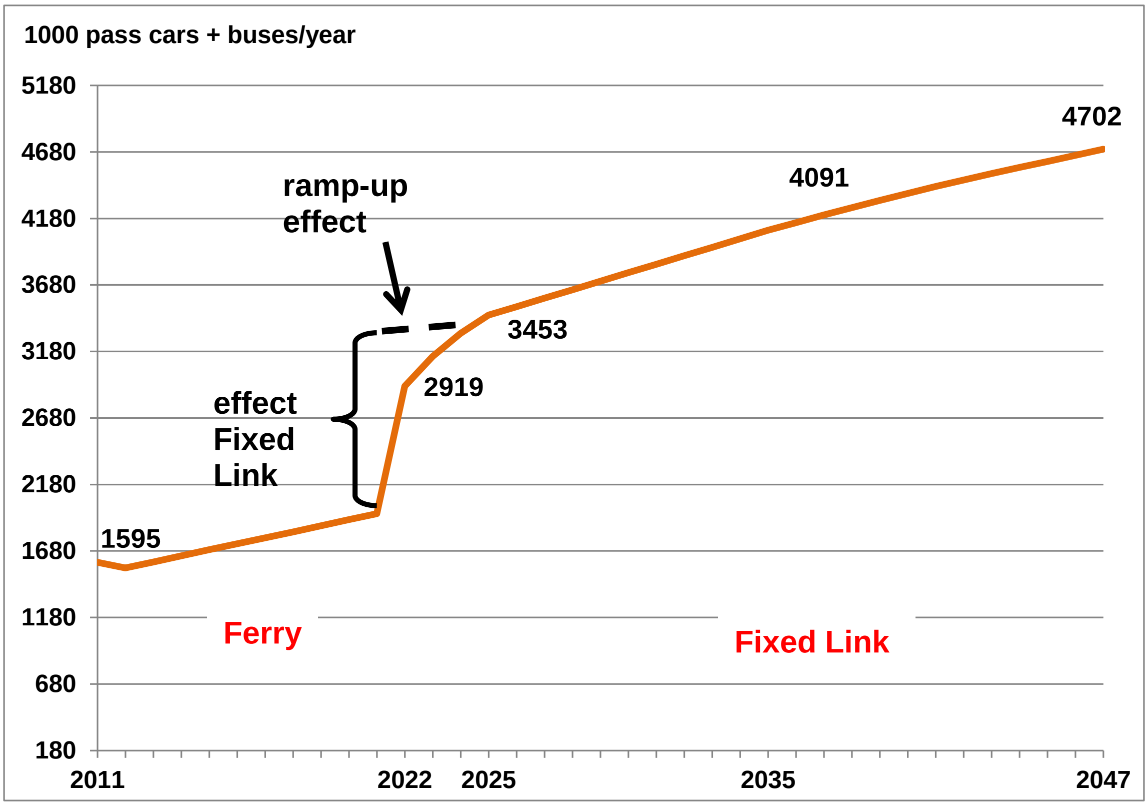


Figure 6-1: Forecast time series cars and buses - Case B

6.1.3 Effects of FBFL on Great Belt and Øresund

By the FBFL considerable time savings will be reached. Travel time by car will be reduced by about an hour, compared to the ferry connection: instead of 75 minutes it takes with FBFL around 15 minutes (including a stop to pay the toll) to pass the Fehmarn Tunnel. In this case there is a considerable advantage of the FBFL against the detour via the **Great Belt**. The results are in the following figures (see Table 6-12).

year/case	passengers	pass. vehicles
	(1000)	(1000)
2011	1.437	711
2022 without FBFL	1.675	854
2022 with FBFL	371	136
difference with/without FBFL	**-1.304**	**-718**

Table 6-12: Effects of FBFL on the international passenger traffic on Great Belt - Case B

Great Belt will 'lose' around 1,3 million passengers and 718 thousand passenger vehicles, around 2000 per day to the FBFL

In Table 6-13 it is shown, that nearly 1,3 million passengers and 474 thousand cars in the traffic between the Scandinavian peninsula and Germany/the continent is using the **Öresund bridge**.

year/case	passengers	pass. vehicles
	(1000)	(1000)
Helsingborg - Helsingör	689	249
Öresund Bridge	1.266	474
other ferries	4.429	1.060
Total	**6.384**	**1.783**

Table 6-13: Split-up of passenger traffic Scandinavian Peninsula - Germany/continent by route 2011

The FBFL will have an effect on this split-up, because direct ferries between the Scandinavian peninsula and Germany/the continent will lose market shares to the FBFL.

If the FBFL wins market shares compared to these ferries, this will have a positive effect on the Öresund connections, mainly on the **Öresund bridge** (see Table 6-14).

year/case	passengers (1000)	pass. vehicles (1000)
2011	1.266	474
2022 without FBFL	1.486	572
2022 with FBFL	2.246	820
difference with/without FBFL	**760**	**248**

Table 6-14: Effects of FBFL on the passenger traffic[52] on the Öresund Bridge - Case B

There will be 760 thousand passengers (including around 120 thousand for rail) and nearly 250 thousand cars more on the Öresund Bridge in the case with FBFL. That means the FBFL will 'generate' traffic for Öresund.

6.1.4 Trip purposes in Case B

The overall numbers in the North-South traffic will grow (see Table 6-15) All purposes will profit from that growth.

52 Traffic between the Scandinavian Peninsula and Europe (without Denmark)

Trip Purposes	2011	2022 (without fixed link)	2022 (with fixed link)	2025	2030	2035
business	7.206	10.233	10.293	11.342	13.416	15.270
day commuter[1)]	148	318	501	623	887	1.080
weekend commuter	1.096	1.995	2.093	2.493	3.323	4.218
shopping	1.279	1.752	1.456	1.539	1.709	1.779
other day excursion	905	1.385	1.331	1.492	1.839	2.070
visiting friends/ relatives	4.514	7.087	7.149	8.122	10.043	11.763
short holidays	4.235	6.056	6.101	6.631	7.660	8.471
holidays	11.105	14.373	14.380	15.194	16.712	17.608
total	**30.488**	**43.199**	**43.304**	**47.436**	**55.589**	**62.259**

1) work/education

Table 6-15: Forecast results passenger traffic between Scandinavia and Europe Case B - passengers per trip purposes

However, in detail there are some differences:

- the domination of '**holiday traffic'** will decrease.
- highest growth rates can be observed for '**visiting friends/relatives'**, a general trend in Europe due to economic and social integration.
- the biggest relative growth is with **day** and **weekend commuters**. This traffic segment will be stimulated by the FBFL, whereas
- **'shopping'** is decreasing due to the end of 'walk-on' passengers, when the ferry line Rødby-Puttgarden is closed.

Considering the percentages of the trip purposes in Table 6-16 it can be seen, that 'holiday traffic' is decreasing its share, but remaining the most important trip purpose in the study area, followed by 'business' (slight increase from 23,6 to 24,5 %) and 'visiting friends/relatives' (from 14,8 to 18,9 %).

Trip Purposes	2011	2022 (without fixed link)	2022 (with fixed link)	2025	2030	2035
business	23,6	23,7	23,8	23,9	24,1	24,5
day commuter[1]	0,5	0,7	1,2	1,3	1,6	1,7
weekend commuter	3,6	4,6	4,8	5,3	6,0	6,8
shopping	4,2	4,1	3,4	3,2	3,1	2,9
other day excursion	3,0	3,2	3,1	3,1	3,3	3,3
visiting friends/ relatives	14,8	16,4	16,5	17,1	18,1	18,9
short holidays	13,9	14,0	14,1	14,0	13,8	13,6
holidays	36,4	33,3	33,1	32,1	30,0	28,3
total	**100**	**100**	**100**	**100**	**100**	**100**

1) work/education

Table 6-16: Forecast results passenger traffic between Scandinavia and Europe Case B - shares of the trip purposes in %

Also **on Rødby-Puttgarden** resp. the FBFL all trip purposes will profit from traffic growth (see Table 6-17). The shares (percentages) of the trip purposes can be seen in Table 6-18.

Trip Purposes	2011	2022 (without fixed link)	2022 (with fixed link)	2025	2030	2035
business	741	816	1.280	1.485	1.604	1.706
day commuter[1]	121	208	408	561	775	925
weekend commuter	301	362	640	766	874	980
shopping	1.206	1.365	1.321	1.308	1.372	1.403
other day excursion	663	795	905	986	1.085	1.160
visiting friends/ relatives	784	941	1.355	1.573	1.704	1.837
short holiday	796	915	1.198	1.318	1.368	1.425
holiday	1.416	1.588	2.635	3.137	3.227	3.288
total	**6.028**	**6.990**	**9.742**	**11.134**	**12.009**	**12.724**

1) work/education

Table 6-17: Passengers (in 1000) on Rødby-Puttgarden (from 2022 FBFL) per trip purpose

In detail there are some considerable effects:

- Whereas in overall traffic the share of **'holiday travellers'** is decreasing it is increasing in the FBFL case due to the traffic jump: especially for the holiday journeys the Great Belt (lower prices, higher capacities) and the other ferries (overnight stay possible) are used today. With the FBFL a big part of this traffic segment will be redirected to the Fehmarn Belt connection.

- **'Shopping/day excursion'** will decrease because this segment is to a big extent 'walk-on-traffic', which will stop when the ferry will be closed down

- For **'business'** the share will increase (from 12,3 to 13,4 %) due to the time gains by the FBFL compared to the ferry, which are especially important for business travellers. There is also a modal shift from short haul air traffic to rail, the latter using the FBFL.

- **'Day commuting'** is easier possible, even taking the high car toll rates into consideration (travellers of this segment are using mainly trains and scheduled buses, thus with a considerable price advantage compared to the car).

Trip Purposes	**2011**	**2022 (without fixed link)**	**2022 (with fixed link)**	**2025**	**2030**	**2035**
business	12,3	11,7	13,1	13,3	13,4	13,4
day commuter[1)]	2,0	3,0	4,2	5,1	6,5	7,3
weekend commuter	5,0	5,2	6,6	6,9	7,3	7,7
shopping	20,0	19,4	13,6	11,7	11,4	11,0
other day excursion	11,0	11,4	9,3	8,9	9,0	9,1
visiting friends/ relatives	13,0	13,5	13,9	14,1	14,2	14,4
short holiday	13,2	13,1	12,3	11,8	11,4	11,2
holiday	23,5	22,7	27,0	28,2	26,8	25,9
total	**100**	**100**	**100**	**100**	**100**	**100**

1) work/education

Table 6-18: Trip purpose structure 2011 of the passengers on Rødby-Puttgarden (from 2022 FBFL) in %

6.2 Results Freight Traffic

6.2.1 Total Traffic Scandinavia -Continent

Under Case B GDP assumptions and the corresponding trade developments described before, total traffic volume between Scandinavia and Continental Europe is predicted to increase by 2,3 % from 2011 to 2035. Table 6-19 shows that the highest growth rates are expected for chemical products (2,9 %) as well as transport equipment and machinery (2,7 %).

Commodity group	2011	2022	2025	2030	2035	Growth 2011-2035 p.a.
Agriculture, hunting and forestry	2.507	3.387	3.571	3.861	4.150	2,1%
Food products, beverages and tobacco	2.585	3.432	3.645	3.990	4.335	2,2%
Wood and cork, pulp, paper	4.060	5.486	5.804	6.348	6.891	2,2%
Coal, petroleum, natural gas, coke	119	121	119	118	116	-0,1%
Ores, mining and mineral products	1.338	1.510	1.536	1.576	1.616	0,8%
Metals	3.844	5.109	5.344	5.737	6.129	2,0%
Chemicals, chemical products	1.789	2.681	2.892	3.239	3.586	2,9%
Transport equipment and machinery	2.560	3.584	3.877	4.393	4.909	2,7%
Other manufactured articles	4.106	6.062	6.300	6.658	7.015	2,3%
Miscellaneous articles	5.866	8.834	9.299	9.848	10.397	2,4%
Sum	**28.774**	**40.207**	**42.387**	**45.766**	**49.144**	**2,3%**

Table 6-19: Projected Case B traffic volume between Scandinavia and Continental Europe between 2011 and 2035 by Commodities in 1.000 t

As set forth in Table 6-20 the projected growth is not equally distributed among the trade regions in Continental Europe. In addition to the Eastern European countries Poland and Czech Republic, Germany will increase its share of Continental European – Scandinavian traffic volume due to gains of chemicals and in combined transport to and from the seaports Hamburg and Bremen/ Bremerhaven.

	2011		2022		2025		2030		2035		Growth 2011-2035 p.a.
	Volume	**Share**	**Volume**	**Share**	**Volume**	**Share**	**Volume**	**Share**	**Volume**	**Share**	
Germany	11.476	40%	16.167	40%	17.105	40%	18.511	40%	19.916	41%	2,3%
Netherlands	4.885	17%	6.733	17%	6.941	16%	7.254	16%	7.567	15%	1,8%
Poland	3.218	11%	4.772	12%	5.223	12%	5.952	13%	6.681	14%	3,1%
Czech Republic	1.286	4%	1.856	5%	2.015	5%	2.264	5%	2.513	5%	2,8%
Italy	1.482	5%	2.029	5%	2.084	5%	2.154	5%	2.223	5%	1,7%
France	1.423	5%	1.915	5%	1.948	5%	1.992	4%	2.036	4%	1,5%
Austria	1.173	4%	1.534	4%	1.591	4%	1.690	4%	1.788	4%	1,8%
Belgium	1.003	3%	1.411	4%	1.488	4%	1.629	4%	1.769	4%	2,4%
Spain	874	3%	1.019	3%	1.036	3%	1.063	2%	1.089	3%	0,9%
Hungary	469	2%	693	2%	750	2%	840	2%	929	2%	2,9%
Slovakia	215	1%	389	1%	441	1%	528	1%	615	1%	4,5%
Romania	237	1%	329	1%	354	1%	396	1%	438	1%	2,6%
Luxemburg	156	1%	204	1%	220	1%	246	1%	271	1%	2,3%
Switzerland	215	1%	246	1%	244	1%	245	1%	246	1%	0,6%
Portugal	118	0%	187	0%	190	0%	193	0%	195	0%	2,1%
Bulgaria	102	0%	140	0%	149	0%	164	0%	178	0%	2,3%
Slovenia	125	0%	148	0%	156	0%	170	0%	183	0%	1,6%
Rest [1)]	317	1%	431	1%	448	1%	476	1%	504	1%	1,8%
Sum	**28.774**	**100%**	**40.203**	**100%**	**42.383**	**100%**	**45.762**	**100%**	**49.141**	**100%**	**2,3%**

Table 6-20: Forecasted Case B traffic volume between Scandinavia and Continental Europe for 2022, 2025, 2030 and 2035 by Countries in 1.000 t

The Scandinavian countries' share remains fairly constant as depicted in Table 6-21. Due to Denmark's lower GDP growth premises in Case B, its traffic volume will not grow as strongly as total Scandinavian – Continental traffic. Sweden exhibits the strongest gains induced by a trade growth of chemical products and combined traffic and can therefore raise its share to 76 %.

	2011		2022		2025		2030		2035		Growth 2011-2035 p.a.
	Volume	**Share**	**Volume**	**Share**	**Volume**	**Share**	**Volume**	**Share**	**Volume**	**Share**	
Denmark	3.888	14%	5.383	13%	5.585	13%	5.834	13%	6.082	12%	1,9%
Norway	2.742	10%	3.566	9%	3.837	9%	4.111	9%	4.385	9%	2,0%
Sweden	21.230	74%	30.097	75%	31.728	75%	34.435	75%	37.142	76%	2,4%
Finland	913	3%	1.162	3%	1.237	3%	1.386	3%	1.535	3%	2,2%
Sum	**28.774**	**100%**	**40.207**	**100%**	**42.387**	**100%**	**45.766**	**100%**	**49.144**	**100%**	**2,3%**

Table 6-21: Forecasted Case B traffic volume between Scandinavia and Continental Europe for 2022, 2025, 2030 and 2035 by Scandinavian Countries in 1.000 t

Under Case B assumptions, as set forth in Table 6-22, the modal split of rail transportation is expected to increase slightly to 22,1 %, whilst in Case A a share of 21,0 % is predicted for 2035. The diverging modal split is due to the modification of the operating costs in Case B, assuming constant rail transport costs and increasing lorry costs (in 2035: -1 % variable costs, +15 % fixed costs compared to 2011).

		2011	2022 before opening	2022 after opening	2025	2030	2035	Growth 2011-2035 p.a.
road	tons(1.000)	22.610	31.479	31.314	32.995	35.651	38.306	2,2%
	tons share	78,6%	78,3%	77,9%	77,8%	77,9%	77,9%	0,0%
rail	tons(1.000)	6.164	8.728	8.892	9.393	10.116	10.838	2,4%
	tons share	21,4%	21,7%	22,1%	22,2%	22,1%	22,1%	0,1%
total	tons(1.000)	28.774	40.207	40.206	42.388	45.766	49.144	2,3%
	tons share	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	0,0%

Table 6-22: Projected Road and Rail Transport between Scandinavia and Continental Europe by vehicles and tons from 2011 to 2035

Through the opening of the FBFL, the modal shift is reinforced. In the long run, the counteracting effect of higher volumes of manufactured goods shifts more goods towards lorry transportation leading to a slightly decreasing share of rail as of 2025.

6.2.2 Fehmarn Belt Traffic

Road Traffic

Compared with the predicted total traffic developments between Scandinavia and Continental Europe, the road transport volume crossing the Fehmarn Belt is projected to have a higher increase mainly an increase of 84 % between 2011 and 2035 in Case B. Since the average load per lorry is expected to decrease slightly, the transport volume grows slightly more than the volume. The projected development of lorry traffic and traffic volume in tons across the Fehmarn Belt according to the calculated scenarios is depicted in Figure 6-2 and Figure 6-3 respectively.

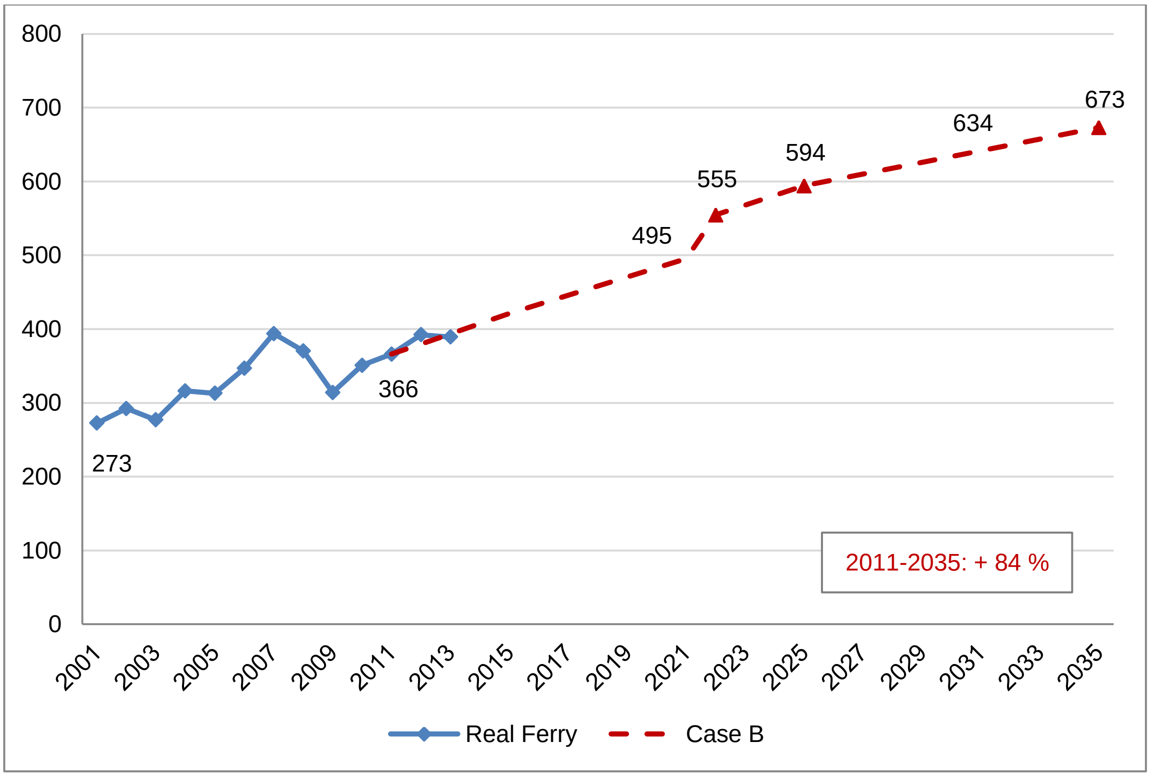


Figure 6-2: Forecasted Case B values for the number of lorries in 1.000 per year crossing the Fehmarn Belt

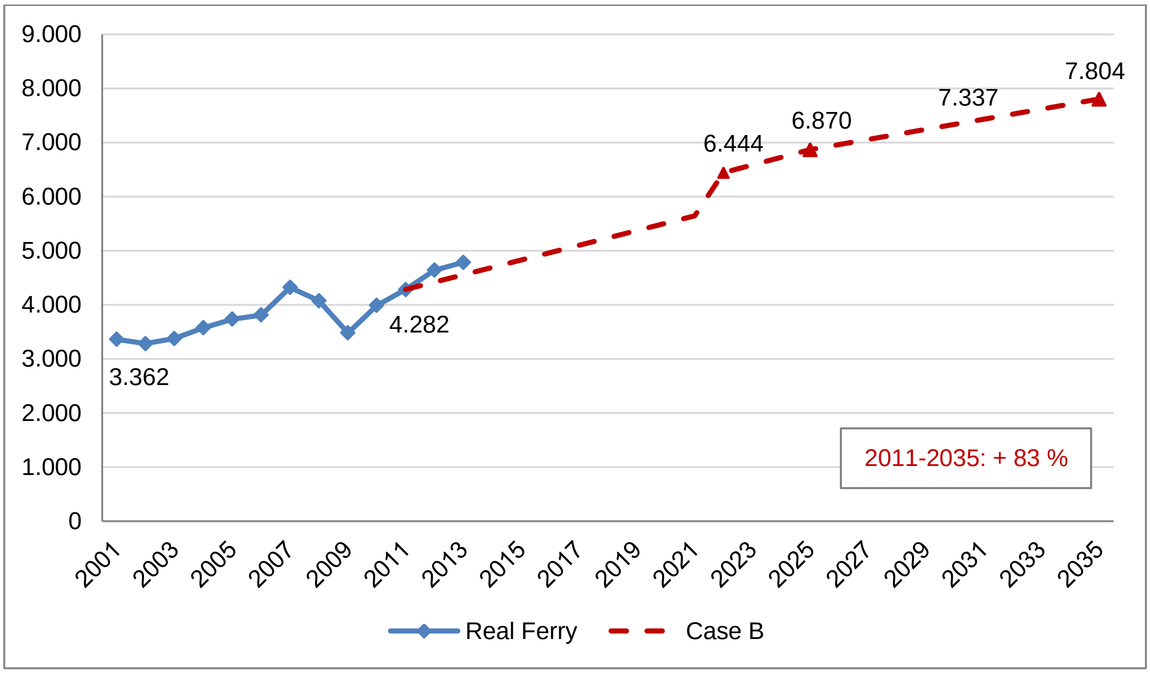


Figure 6-3: Forecasted Case B values for the road freight tonnage in 1.000 t per year crossing the Fehmarn Belt

The opening of the Fehmarn Belt Fixed Link generates a potential growth by 52.000 lorries, but due to the anticipated adjustment process to the new infrastructure supply for road transport, we assume that 10 % of the actually shifted lorries remain on their previous routes in the first year of operation. Hence, instead of 52.000 lorries, 47.000 lorries are shifted towards the new built link in 2022. Thus, the expected number of lorries will rise from 508.000 to 555.000 lorries in 2022. Table 6-23 shows the projection for the FBFL without ramp-up effect.

	2011	2022 before opening	2022 (without ramp-up) after opening	2025	2030	2035
Road freight	366	508	560	594	634	673

Table 6-23: Number of lorries across the Fehmarn Belt in 1.000 (without ramp-up effect in 2022) in Case B

The projected route shifts with ramp-up effect are illustrated in Table 6-24 and Figure 6-4. The ports of Lübeck/ Travemünde (approximately -21.000 vehicles) and Rostock (-20.000 vehicles) will lose the highest amount of lorries to the Fehmarn Belt Fixed Link. Due to the described overall modal shift to rail, the total number of lorries across all links in the Baltic Sea region is projected to decline slightly.

	without FBFL	with FBFL	change
Puttgarden-Rødby	508	555	47
Lübeck-Helsinki	68	68	0
Travemünde-Trelleborg	319	308	-11
Travemünde-Malmö	289	279	-10
Landb. Flensburg-Padborg	69	66	-3
Kiel-Göteborg	100	98	-2
Kiel-Oslo	44	43	-1
Rostock-Gedser	139	131	-8
Rostock-Trelleborg	407	395	-12
Rostock-Helsinki	18	18	0
Sassnitz-Ronne	2	2	0
Sassnitz-Trelleborg	17	16	-1
Swinoujscie-Ystad	73	71	-2
Swinoujscie-Trelleborg	43	42	-1
Great Belt	27	25	-2
Total	**2.123**	**2.117**	**-6**

Table 6-24: Projected Case B Lorry Traffic in 1.000 vehicles per year in 2022 before and after the opening of the Fehmarn Belt Fixed Link by Transport Routes

The effects on Great Belt and Öresund can be seen in Table 6-25.

	2022 be-fore open-ing of FBFL	2022 after opening of FBFL	2025	2030	2035
Öresund	483	493	519	553	586
Great Belt	27	25	26	28	30

Table 6-25: Number of lorries in 1.000 vehicles per year via Öresund and Great Belt in Denmark: (volume only includes traffic between Continental Europe and East Den-mark/Sweden/Norway/ Finland) - Case B

That means Öresund would profit from FBFL by around 10 thousand lorries/year, whereas Great Belt would lose around two thousand lorries/year.

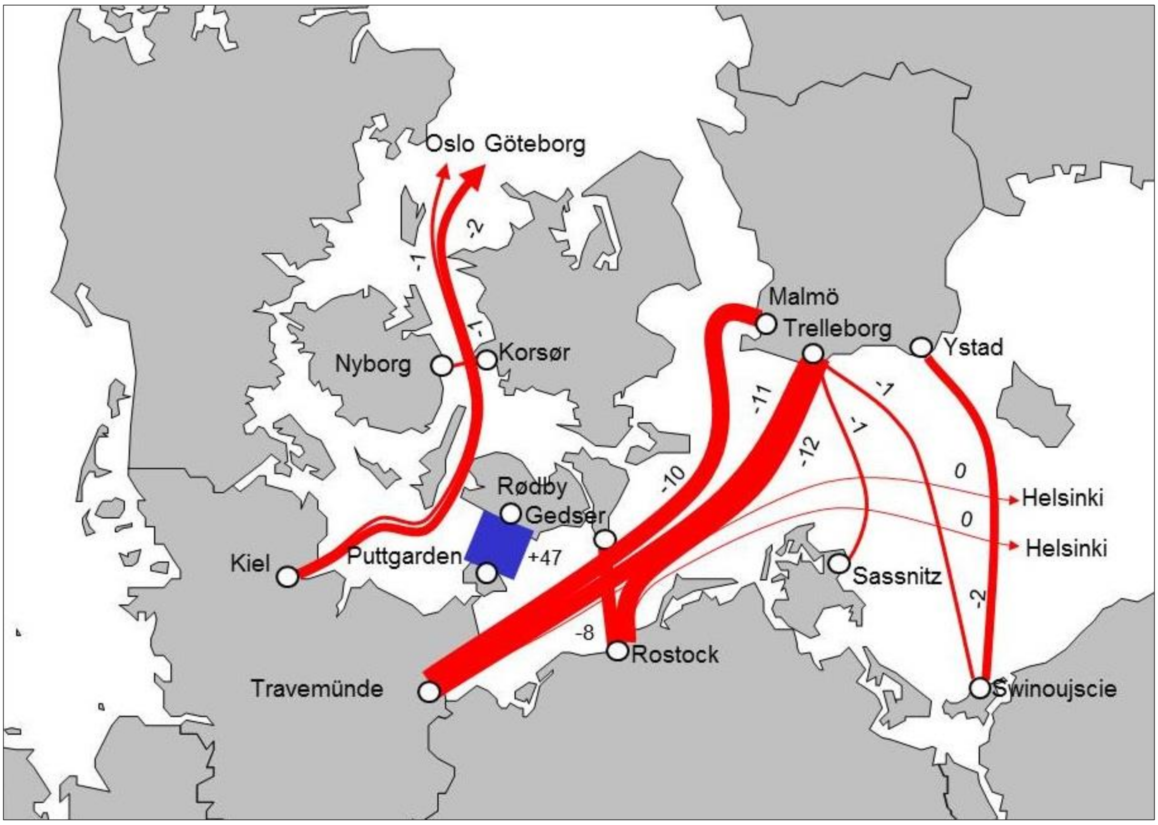


Figure 6-4: Shifts of Case B lorry traffic in 1.000 vehicles per year as response to the opening of the Fehmarn Belt Fixed Link in 2022

Rail Traffic

The rail transport volume across the Fehmarn Belt is expected to increase by 81 % until 2035 in Case B (basis is the rail transport volume over Great Belt before the opening of the FBFL). As illustrated in Figure 6-5, a transport volume of 10,1 million. t is projected for 2035.

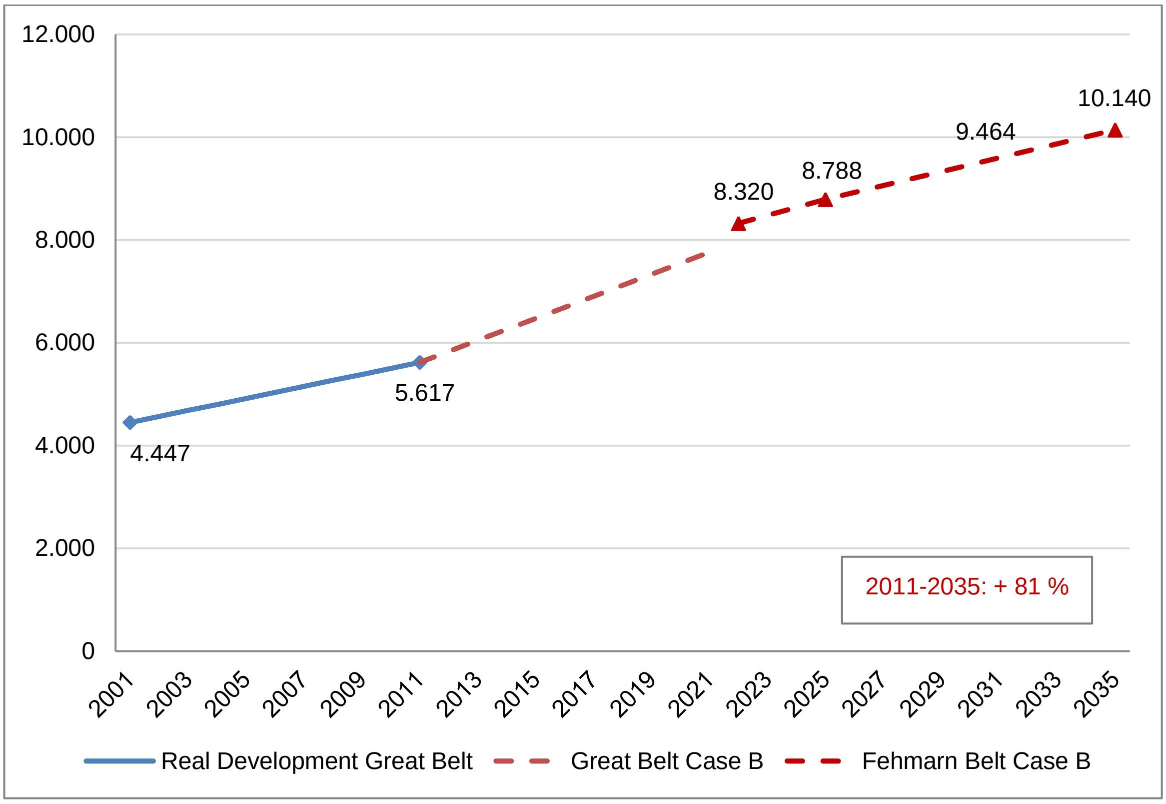


Figure 6-5: Forecasted Case B values for the rail freight volume in 1.000 t per year crossing the Fehmarn Belt

After the opening of the Fehmarn Belt Fixed Link in 2022, transit freight trains from Continental Europe to East Denmark, Sweden, Norway and Finland are presumed to use the FBFL instead of the Great Belt Fixed Link. Thus, 8 million tons of rail haulage are shifted from the Great Belt to the Fehmarn Belt, the ferries calling on Trelleborg will cede 180.000 tons to the FBFL. Furthermore, a modal shift as a result of the ramp-up-effect for road transportation and the stronger improvement for rail transportation through the new link in the amount of 165.000 tons is observed in 2022. The shifts are depicted in Table 6-26 and Figure 6-6.

	without FBFL	with FBFL	change
Fehmarnbelt Fixed Link	0	8.320	8.320
Great Belt Fixed Link	7.973	0	-7.973
Rostock-Trelleborg	328	248	-80
Sassnitz-Trelleborg	427	325	-102
Total	**8.728**	**8.893**	**165**

Table 6-26: Projected Case B Rail Traffic in 1.000 tons in 2022 before and after the opening of the Fehmarn Belt Fixed Link by Transport Routes

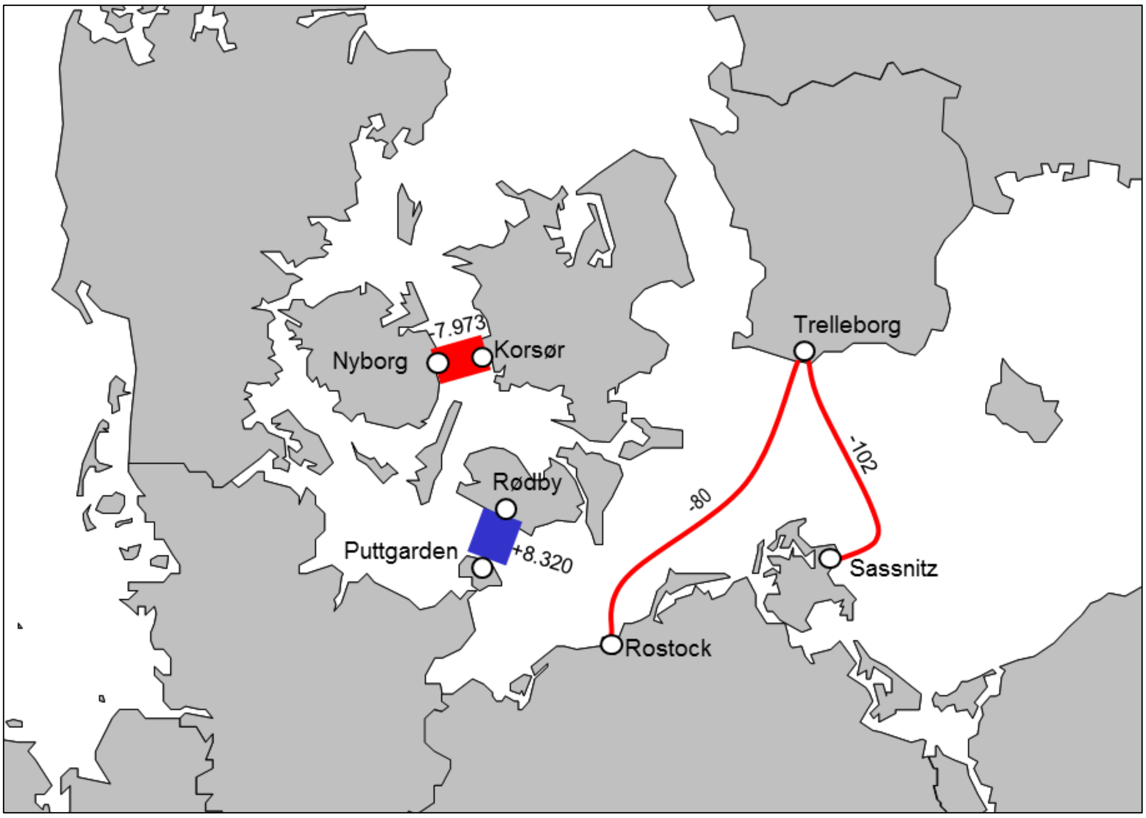


Figure 6-6: Case B shifts of wagon traffic in 1.000 tons per year as response to the opening of the Fehmarn Belt Fixed Link in 2022

6.2.3 Daily freight train number across the FBFL

Besides the forecasted transport volume, the number of freight trains for the FBFL depends on a number of further assumptions regarding e.g. the number of wagons per train, wagon load, operation days, which depends on different production processes. These production processes differ greatly in terms of different time periods as well as between the train operators.

Since it was not possible to simulate a full train operation process within this study, it was decided to calculate with two different rail freight production scenarios. The first scenario is based on the assumptions used in the German 'Bedarfsplan'[53], and the second scenario is based on the

53 Bedarfsplan (2010) assumptions: average wagon load: 18,6 t, number of wagons per train: 26, operation days per year: 253.

assumptions elaborated by the Danish Ministry of Transport and the German Ministry of Transport and agreed upon by the 'Joint Committee'.[54]

Since FTC 2014 Case B is the main planning scenario, a calculation of the number of freight trains per day with the two production scenarios is set forth in Table 6-27. The values refer to the period approximately three, seven and thirteen years after the opening of the FBFL and thereby provide an estimate for the train number across the FBFL in the long term.

By applying the same methodology as in the 'Bedarfsplan' calculation for the purpose of comparability, the projected rail transport volume of about 9,5 Mio t in 2030 would correspond to approximately 77 freight trains per day. Under the Joint Committee assumptions, 70 freight trains per day will cross the FBFL in 2030.

	Forecast year	**Traffic volume via Fixed Link (Mill. t/a)**	**Trains per day**
Bedarfsplan assumptions	2025	8,8	72
	2030	9,5	77
	2035	10,1	83
Joint Committee	2025	8,8	65
	2030	9,5	70
	2035	10,1	74

Table 6-27: Comparison of the number of trains based on 'Bedarfsplan' and Joint Committee assumptions

6.3 Total vehicle traffic on FBFL in Case B

The forecasts of passenger and freight traffic have been made on **yearly basis**. In the following table they are summarized in term of vehicles using the FBFL (resp. before its opening the ferry line Rødby - Puttgarden), giving also the ADT (average daily traffic) traffic figures which normally are basis for road counts.

[54] The Joint Committee is responsible for monitoring and promoting the implementation of the state treaty between Denmark and Germany. Joint Committee assumptions: average wagon load: 17,8 t, number of wagons per train: 30, operation days per year: 255.

	2011	2022 without FBFL	2022 with FBFL[2)]	2025	2030	2035
pass. cars[1)]	4.285	5.395	7.904	9.362	10.321	11.107
buses	84	74	93	99	100	101
lorries	1.003	1.392	1.521	1.627	1.737	1.844
total mot. vehicles	**5.372**	**6.861**	**9.518**	**11.088**	**12.158**	**13.052**

1) incl. motorcycles
2) incl. ramp-up-effects

Table 6-28: Average Daily Traffic (ADT) on Fehmarnbelt, Case B

The average daily traffic would grow from nearly 5,4 thousand vehicles per day in 2011 to nearly 6,9 thousand in 2022 (without FBFL). Due to the traffic jump of 54 % the figure would grow to more than 11,1 until 2025. In 2035 the figure would be at 13,05 thousand.

Due to the fact that for passenger traffic the traffic jump is higher than in the freight traffic, whereas for the latter the modal split effect to rail is higher, the share of lorries on the total number of vehicles on Fehmarn Belt is going down from 18,7 % to 14,1 %.

The direct effect of the FBFL ('traffic jump') is shown in Table 6-29.

	Before opening of FBFL in 2022	After opening of FBFL in 2022[1)]	Increase in %
Cars	5.395	8.951	66 %
Busses	74	93	26 %
Lorries	1.392	1.534	10 %
Total	**6.860**	**10.578**	**54 %**

1) excluding ramp-up-effect which are included in Table 6-28

Table 6-29: Traffic jump caused by the FBFL (ADT) - Case B

By the FBFL vehicle traffic on Fehmarn Belt would increase by 54 %, related to the year 2022. The effects for passenger car traffic are at 66 %, for lorries the effects are smaller (10 %).

The reason for the traffic jump is mainly traffic pulled from other routes, ferries-routes as well as the Great Belt fixed link connection. The latter provides today for passenger car drivers a cheaper and a more flexible and even, in spite of the detour of nearly 140 km, an equally fast connection on most relations, compared to the Rødby - Puttgarden ferry, when taking waiting time and time to embark and disembark the ships into consideration. Apart from route choice effects another reason for the traffic jump is new traffic due to the increased accessibility in consequence of a travel time reduction of around one hour.

7 COMPARISON OF THE RESULTS TO THE FTC 2002 STUDY

7.1 Passenger Traffic

Comparing the forecast of the market development in the study area (see Table 7-1 and Table 7-2), the total traffic volume is 44,6 million in Case A and 47,4 million in for 2025 compared to 36 million in the study of 2002 for 2015. The difference is exclusively related to air traffic which due to the longer forecast period and the dynamic development in the period from 2001 to 2011 is much higher in the FTC forecasts of 2014 than before. For all other modes traffic is lower in 2025 (forecast of 2014) than in 2015 (forecast of 2002).

This is to a big extent a **base year effect**. However, this overview should not give the impression that the relevant market for FBFL is considerably smaller now. Fact is not only that long distance traffic (for example between Scandinavia and the Mediterranean) has grown over-proportionally: Due to Low-Cost-traffic there was also a modal shift from car traffic and to a minor share from bus and rail traffic on very long distances. These modes are less attractive due to higher costs (fuel, toll roads in many countries) and due to low air fares. Traffic flows in lower distance classes and so being of higher importance for the FBFL have not stagnated as could be assumed in the first view for Table 7-1. Land based modes mainly lost market shares on longer distances.

Mode	1000 passengers/year		
	FTC 2002 (2015)	FTC 2014 CASE A (2025)	FTC 2014 CASE B (2025)
Rail	1.423	1.338	1.155
Car	12.427	11.235	11.582
Bus	2.938	2.518	2.442
Air	17.361	28.510	31.299
ferry walk-on	1.850	965	958
Total	**35.999**	**44.566**	**47.436**

Table 7-1: Comparison of FTC 2002 (forecast year 2015[55]) with FTC 2014 forecast (forecast year 2025) for the total market

55 Base Case B

FBFL traffic for 2025 in the forecasts on hand is higher (by about 15 % in terms of passengers and 17 % and 20% in terms of cars for Cases A and B respectively) than that for 2015 from the FTC 2002 study (Table 7-2).

	FTC 2002 [1)] 2015	**FTC 2014 CASE A 2025**	**FTC 2014 CASE B 2025**
Passengers (1000/year)	**9.642**	**11.100**	**11.134**
Thereof			
passenger in cars	6.809	8.396	8.656
passengers in bus	1.638	1.374	1.332
passengers in rail	1.386	1.330	1.146
Vehicles (1000/year)			
cars (incl. motorcy-cles)	2.842	3.314	3.417
Buses	47	37	36

1) Base Case B

Table 7-2: FBFL traffic: comparison between the FTC 2002 and FTC 2014 studies

In Figure 7-1, giving also the (dotted) trend forecast of the FTC 2002 study, it is shown that the forecasts are 'shifted' for several years due to the later opening year of the FBFL. But the level of traffic is comparable.

In the FTC 2002 study the traffic jump for passenger traffic caused by the FBFL was lower (around 49 %, compared to 65 % in Case A and 66 % in Case B of the study on hand). The reason is clearly the fact that the Rødby - Puttgarden ferry line has **lost market shares** (at least from about 2007 as can be seen on the blue line in Figure 7-1 and as has been analysed in chapter 2.1.3), namely **towards the Great Belt** connection. In the case of the FBFL this traffic would 'return' to the Rødby - Puttgarden axis. This effect, the drawback to Great Belt traffic to the FBFL, is considerable and had been regarded lower in the FTC 2002 study because then due to a lower discount of the Great Belt toll compared to the Rødby - Puttgarden ferry, the diverted traffic to the Great Belt was much smaller.[56]

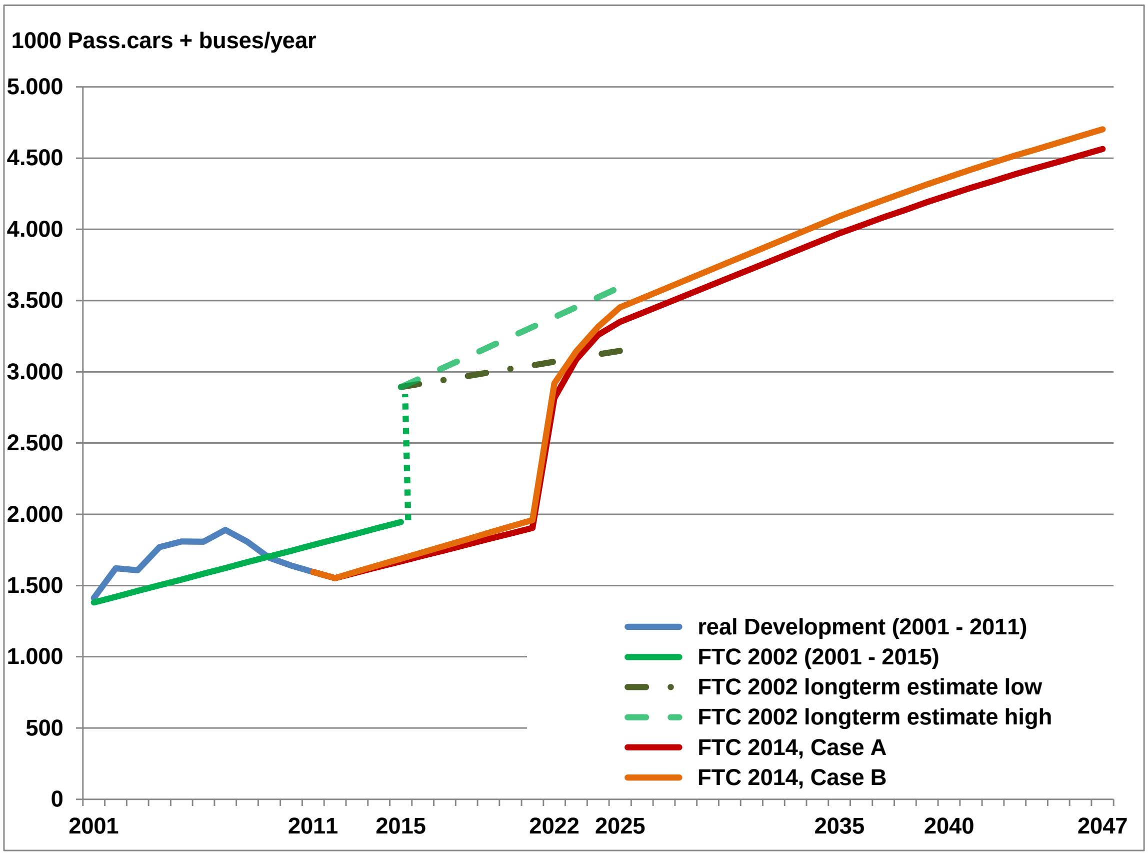


Figure 7-1: Comparison of the FTC 2014 results for the FBFL to the FTC 2002 study[57]

7.2 Freight Traffic

As outlined in chapter 2.2.1, the figures of the road and rail traffic volume across the Fehmarn Belt in 2013 lie substantially behind the projected values from 2002. Mainly due to this, the expected Case A traffic amount in 2025 does not exceed the previously forecasted Base Case B values for 2015 as set forth in Table 7-3. Only the number of lorries crossing the Fehmarn Belt is expected to evolve almost as dynamically as predicted in the last study (see Table 7-4).

56 See chapter 6.1.3: Related to 2022 more than 718 thousand passenger vehicles are diverted from Great Belt to FBFL. This is more than 50 % of the traffic jump. In the FTC 2002 study it was less than 100 thousand vehicles

57 Base Case B

	2014 Case A	2014 Case B	FTC 2002 BC B
	2025	2025	2015
Road	6.622	6.870	7.206[58]
Rail	7.584	8.788	7.983

Table 7-3: Comparison of Projected Fehmarn Belt Traffic Volumes in 1.000 t

In contrast to the FTC 2002 study, higher growth rates are projected for road haulage compared to rail transportation, which is in line with the recent developments of the Continental-Scandinavian traffic patterns. Due to lower GDP assumptions, Case A shows lower growth rates in general. Including the shifts after the opening of the FBFL in 2022, the rail transport volume is projected to grow on average by 2,2 % to 3,3 % p.a. until 2025, whilst the previously expected growth ranged from 4,3 % to 6,6 %[59] p.a. Hence, growth rates in the present study consider the lower dynamics of Continental European – Scandinavian rail transportation observed in the last years.

	2014 Case A	2014 Case B	FTC 2002 BC B
	2011-2025	2011-2025	2001-2015
Road	3,2 %	3,4 %	3,5 %
Rail	2,2 %	3,2 %	4,3 %

Table 7-4: Comparison of Projected Fehmarn Belt Traffic Volume Ave. Growth Rates p.a.

The 2014 forecast values for Fehmarn Belt lorry traffic and the 2025 long term trend projections of the last study are depicted in Figure 7-2 and Figure 7-3. The figures illustrate, that the projected number of lorries approximates former Base Case B[60], whereas the road transport volume in tons is expected to be considerably lower than in the 2002 forecasts.

58 The main reason for this overestimation is a statistical failure in the basis data. In the FTC 2002 study the transport volume for 2001 was depicted with 4,4 million tons against the real value of 3,4 million tons.

59 6,6 % were predicted in the FTC 2002 Base Case A forecasts.

60 For both cases, trend projections in low and high scenarios were made. The pictured data refer to the mean value of high and low scenario of Base Case B.

The deviation of the forecast accuracy between the number of lorries and traffic volume in the FTC 2002 study can be put down to a data error of an average charge of 15,6 t per lorry in the base year (see footnote 54).

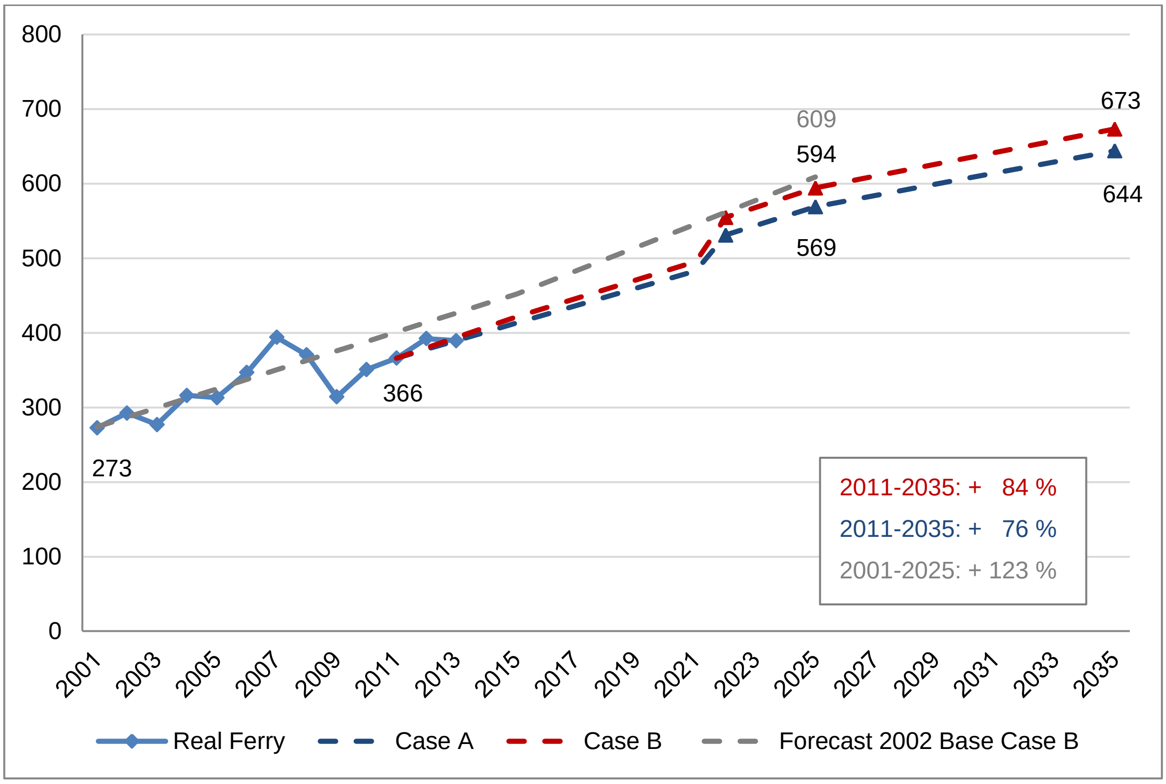


Figure 7-2: Comparison of FTC study 2014 and 2002 results for the number of lorries in 1.000 per year crossing the Fehmarn Belt

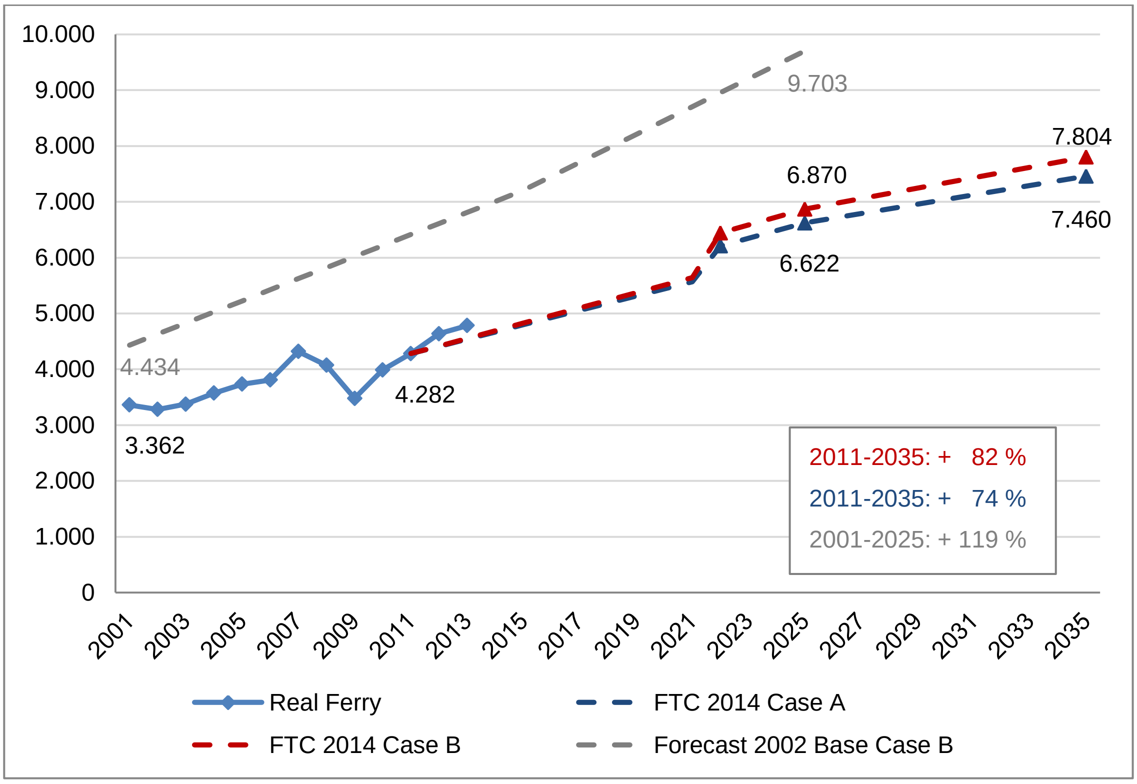


Figure 7-3: Comparison of FTC study 2014 and FTC study 2002 results for the road transport volume in 1.000 t per year crossing the Fehmarn Belt

As set forth in Figure 7-4, the updated forecasts take the modest development of rail transport since 2001 into account and thus predict considerably lower values for the rail traffic volume across the FBFL.

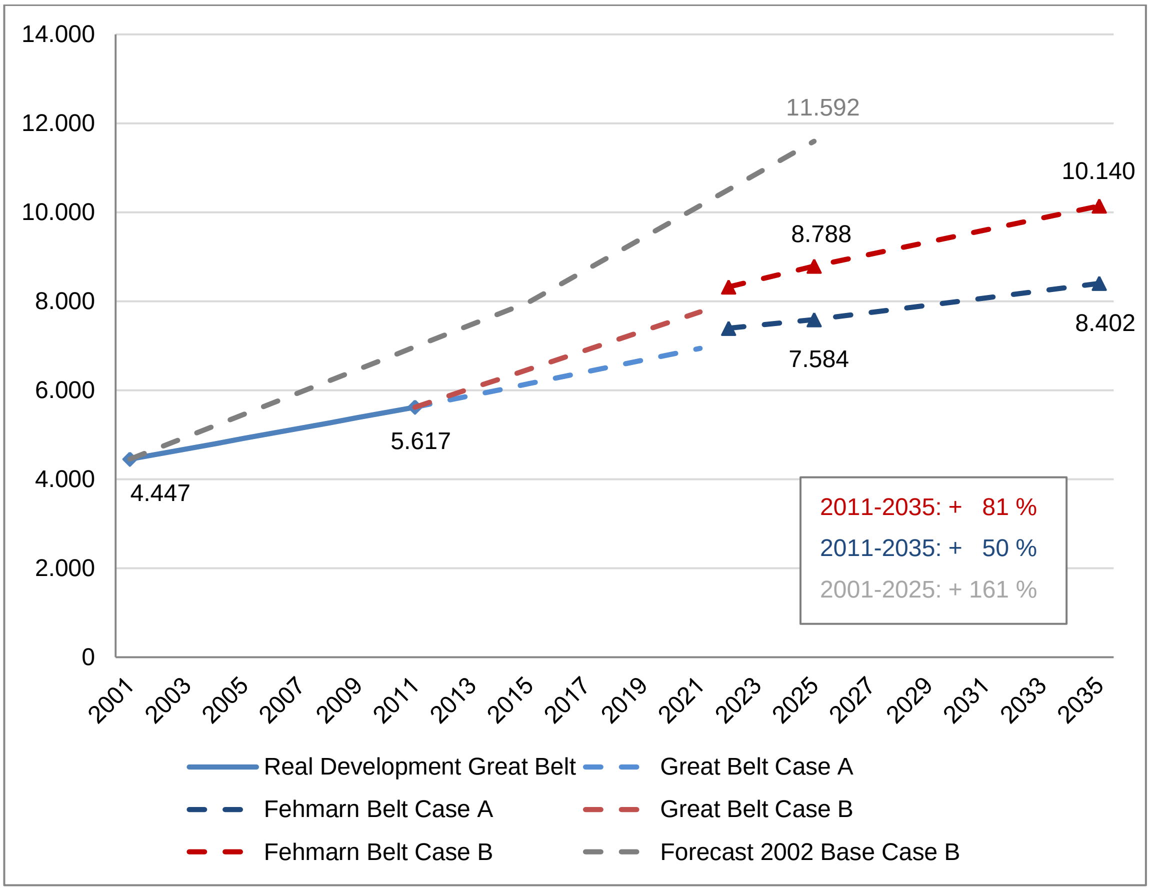


Figure 7-4: Comparison of FTC study 2014 and FTC study 2002 results for the rail transport volume in 1.000 t per year crossing the Great Belt (until 2022) and the Fehmarn Belt (as of 2022)

7.3 Summary and total vehicles

For 2025 the comparison with the FTC 2002 study (plus the extrapolation 2012) is shown for passenger traffic in Table 7-5 and for freight traffic in Table 7-6.

Passenger Traffic	2025 RESULTS				
Year of the study	FTC 2002[1)]		2012 (extrapolation of FTC 2002)	FTC 2014 (New Study)	
Passengers (1000/year)	LOW	HIGH		Case A	Case B
passenger in cars	7 418	8 492	9 205	8 396	8 656
passengers in bus	1 683	1 841		1 374	1 332
passengers in rail	1 405	1 432	1 564	1 330	1 146
Total passengers	10 506	11 765	10 769	11 100	11 134
Vehicles (1000/year)					
cars (incl. motorcycles)	3 097	3 538	3 579	3 314	3 417
buses	51	56	34	37	36

1) Base Case B

Table 7-5: Comparison of the FTC 2014 results with former studies - passenger traffic - 2025 results

Figures for freight traffic are lower than in the FTC 2002 study.

Freight Traffic	2025 RESULTS				
Year of the study	FTC 2002[1)]		2012 (extrapolation of FTC 2002)	FTC 2014 (New Study)	
Volume (1000 t/year)	LOW	HIGH		Case A	Case B
road	8 718	10 684	n/a	6 628	6 870
rail	10 461	12 722	11 478	7 584	8 788
Vehicles (1000/year)					
lorries	547	670	663	569	594

1) Base Case B

Table 7-6: Comparison of the FTC 2014 results with former studies - freight traffic - 2025 results

The total number of road vehicles (average daily traffic) and trains in the forecast is shown in Table 7-7.

Vehicle Type	2022		2025		2030		2035		for comparison FTC 2002 Case B (2015)
	Case A	**Case B**	**Case A**	**Case B**	**Case A**	**Case B**	**Case A**	**Case B**	
passenger cars (ADT)	7.619	7.904	9.079	9.362	10.014	10.321	10.778	11.107	7.786
buses (ADT)	96	93	101	99	103	100	104	101	129
lorries (ADT)	1.356	1.521	1.559	1.627	1.663	1.737	1.764	1.844	1.238
total road vehicles (ADT)	**9.071**	**9.518**	**10.739**	**11.088**	**11.780**	**12.158**	**12.646**	**13.052**	**9.153**
passenger trains/day	32	32	34	36	36	38	38	40	40
freight trains/day*	**54**	**61**	**56**	**65**	**59**	**70**	**62**	**74**	**59**
total trains/ day*	**86**	**93**	**90**	**101**	**95**	**108**	**100**	**114**	**99**

* For the purpose of comparison, the methodology for the calculation of the daily freight train numbers is based on a decision between the Danish Ministry of Transport and German Ministry of Transport(06 December 2012,(further details: see chapter 6.2.3). Thus, the FTC 2002 daily train number differs from the FTC 2002 publication (p. 120).

Table 7-7: Vehicles/trains on FBFL in the FTC 2014 study (for comparison FTC 2002)

There will be around 4,0 million road vehicles crossing the FBFL in 2025 in both cases, that is about 10.700 and 11.100 vehicles in the average daily traffic (ADT). The share of heavy vehicles (lorries and buses) would be between 15 % and 16 %. In 2035 4,6 million (in Case A) and 4,8 million (in Case B) vehicles would cross the FBFL (12.600 and 13.100 ADT) at a share for heavy vehicles of 15,2 % and 15,3 % in the 2 cases respectively. Vehicle traffic 2022 would be roughly as high as expected in the 2002 study for 2015.

The number of trains per day using the FBFL in the year 2025 would be 90 (Case A) resp. 101 (Case B), thereof 56 resp. 65 freight trains. Until 2035 the number of trains would grow to 100 (Case A) resp. 114 (Case B). The number of freight trains is in the same level of magnitude as expected in the FTC 2002 study.

8 EFFECTS OF A PARALLEL FEHMARN BELT FERRY ON THE FBFL-TRAFFIC (PARALLEL-FERRY-CASES)

8.1 General

Some critics of the Fehmarnbelt Fixed Link (FBFL) project put forward the idea that even after opening of the FBFL there would be a competing ferry line thus reducing the traffic and the economy of the FBFL. Due to the possibility to adjust the offer to demand rather flexible they believe that such a parallel ferry could be feasible. Therefore it was sensible to test with the FTC-model the effects of such a ferry service parallel to the Fehmarn Belt Fixed Link.

The scenario is based on Case B of the FTC 2014 study. Two sub-variants have been calculated:

PFA: One of the existing four ships on the line Rødby - Puttgarden stays in service -> departure every 2 hours on each side

PFB: Two of the existing four ships on the line Rødby - Puttgarden stay in service -> departure every hours on each side

For the 'Parallel-Ferry-Cases' the results are presented in the same forecast years as for the main study.

8.2 Scenario Assumptions

In **variant PFA** the ferry service is assumed to decrease its departures to 84 turns per week. The vessels thus depart **every two hours**, which means, that one of the four ships, operating today between Rødby and Puttgarden, would stay in service. In **variant PFB** there are two ships, permitting 168 departures per week resp. an h**ourly service**. In both variants the **cruising time** would be **45 minutes** as today.

For the continued ferry service in both variants, **a fare of 200 EUR for lorries and 49 € for passenger cars** is considered, which means a **discounted price** by 25 % compared to the FBFL charging 267 EUR for lorries and 65 € for cars. The parallel ferry thereby is intended to provide an attractive alternative to the tunnel for cost-sensitive transports.

8.3 Results Variant PFA (two-hourly service)

8.3.1 Passenger Traffic

A parallel ferry between Rødby and Puttgarden would not only influence the traffic on the FBFL but also the overall north-south-traffic (Table 8-1).

Mode	1000 passengers/year					
	2011	2022 (without Fixed Link	2022 (with Fixed Link)	2025	2030	2035
Rail	0	0	-8	-8	-5	-4
Car	0	0	87	83	79	71
Air	0	0	0	0	0	0
Bus	0	0	0	0	0	0
Ferry Walk On	0	0	304	301	298	291
Total	**0**	**0**	**383**	**376**	**372**	**358**

Table 8-1: Differences in the traffic between Scandinavia and Europe[61] in the scenario, **variant PFA** with a parallel ferry to the FBFL and the Base Case B

The reason for that is mainly **walk-on traffic**, which completely stops when the ferry would be closed down as assumed in the Case A and B. With a parallel ferry this, however in the long term stagnating market segment still would be served.

Apart from a minor modal shift from rail additionally some car journeys would be stimulated by a lower price on the ferry compared to the FBFL resp. compared to the ferry before opening of the FBFL.

Total traffic between Scandinavia and Europe would increase by about 0,4 million passengers or 0,6 %. The totals are shown in Table 8-2 (for comparison with the base case see above Table

[61] Traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side

6-1). The effects are decreasing because due to growing GDP the price differences between FBFL and ferry would have lower effects in the long run.

Mode	1000 passengers/year					
	2011	2022 (without Fixed Link	2022 (with Fixed Link)	2025	2030	2035
Rail	460	629	1.141	1.147	1.086	1.034
Car	8.970	10.769	11.174	11.665	12.607	13.373
Air	17.226	27.996	27.733	31.299	38.496	44.384
Bus	2.320	2.392	2.361	2.442	2.526	2.594
Ferry Walk On	1.512	1.413	1.278	1.259	1.247	1.232
Total	**30.488**	**43.199**	**43.687**	**47.812**	**55.962**	**62.617**

Table 8-2: Total passengers between Scandinavia and Europe[62] in the scenario with a parallel ferry to the FBFL, **variant PFA**

The main effect however would be a traffic shift from the FBFL to the parallel ferry, which is shown in Table 8-3.

[62] Traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side

	2022 with Fixed Link	2025	2030	2035
Passengers (1000/year)	**-859**	**-978**	**-1.052**	**-1.112**
Thereof				
passenger in cars	-737	-849	-919	-974
passengers in bus	-114	-121	-128	-134
passengers in rail	-8	-8	-5	-4
ferry walk-on	0	0	0	0
Vehicles (1000/year)				
cars (incl. motorcycles)	-284	-328	-354	-370
Buses	-3	-3	-4	-4

Table 8-3: Difference of FBFL traffic between the Parallel-Ferry-Case, **variant PFA** compared to Case B

The effect would be a decrease of 284 thousand cars and 3 thousand buses on the FBFL compared to Case B in 2022, rising to 370 thousand cars and 4 thousand buses until 2035. That means a traffic loss of about 10 % in 2022 and 9 % in 2035 compared to Case B, because the Value of Time is increasing, thus increasing the advantage of the FBFL compared to the ferry. The remaining traffic on the FBFL is shown in Table 8-4.

	2022	2025	2030	2035
Passengers (1000/year)	**8.883**	**10.156**	**10.957**	**11.612**
Thereof				
passenger in cars	6.592	7.807	8.654	9.350
passengers in bus	1.158	1.211	1.224	1.235
passengers in rail	1.133	1.138	1.078	1.027
ferry walk-on	0	0	0	0
Vehicles (1000/year)				
cars (incl. motorcy-cles)	2.601	3.089	3.413	3.684
Buses	31	33	33	33

Table 8-4: Total passenger traffic **on the FBFL** in the 'Parallel-Ferry-Case', **variant PFA**

The ferry (see Table 8-5) would be attractive for travelers with a low VoT and a need for a short break during the journey. It is **mainly holiday traffic** apart from some **weekend trips**. Not only the low overall traffic volume but the fact that this would be concentrated mainly in the holiday seasons and some weekends, which makes it very doubtful that operating a parallel ferry, including the provision of landside infrastructure, will be economically feasibility.

	2011	2022 without Fixed Link	2022 with Fixed Link	2025	2030	2035
Passengers (1000/year)	**6.028**	**6.990**	**1.242**	**1.354**	**1.424**	**1.470**
Thereof						
passenger in cars	3.973	5.002	824	932	998	1.045
passengers in bus	1.142	1.014	114	121	128	134
passengers in rail	394	557	0	0	0	0
ferry walk-on	519	417	304	301	298	291
Vehicles (1000/year)						
cars (incl. motorcy-cles)	1.564	1.969	319	361	386	398
Buses	31	27	3	3	4	4

Table 8-5: Total passenger vehicle-traffic **on the ferry line** between Rødby and Puttgarden in the 'Parallel-Ferry-Case', **variant PFA**

8.3.2 Freight Transport

Compared to Case B in the FTC 2014 study, where no parallel ferry service was assumed, a parallel ferry service will impact the number of lorries using the FBFL per year by a reduction of about 12 %. Through the ferry service, 592.000 instead of 673.000 lorries are expected on the FBFL in 2035, 100.000 lorries would take the parallel ferry.

As a result of the supply improvement through the parallel ferry, traffic shifts from other ferries are also expected. Thus, the total number of lorries across the Fehmarn Belt per year is increased in contrast to Case B. Whilst 673.000 lorries cross the Fehmarn Belt in Case B, an amount of 692.000 lorries is projected for the PFA Case in 2035 (592.000 lorries via the tunnel and 100.000 lorries via the ferries). The vast majority of the transports favor the time saving tunnel, about 14 % of the total Fehmarn Belt crossing traffic in variant PFA selects the ferry service.

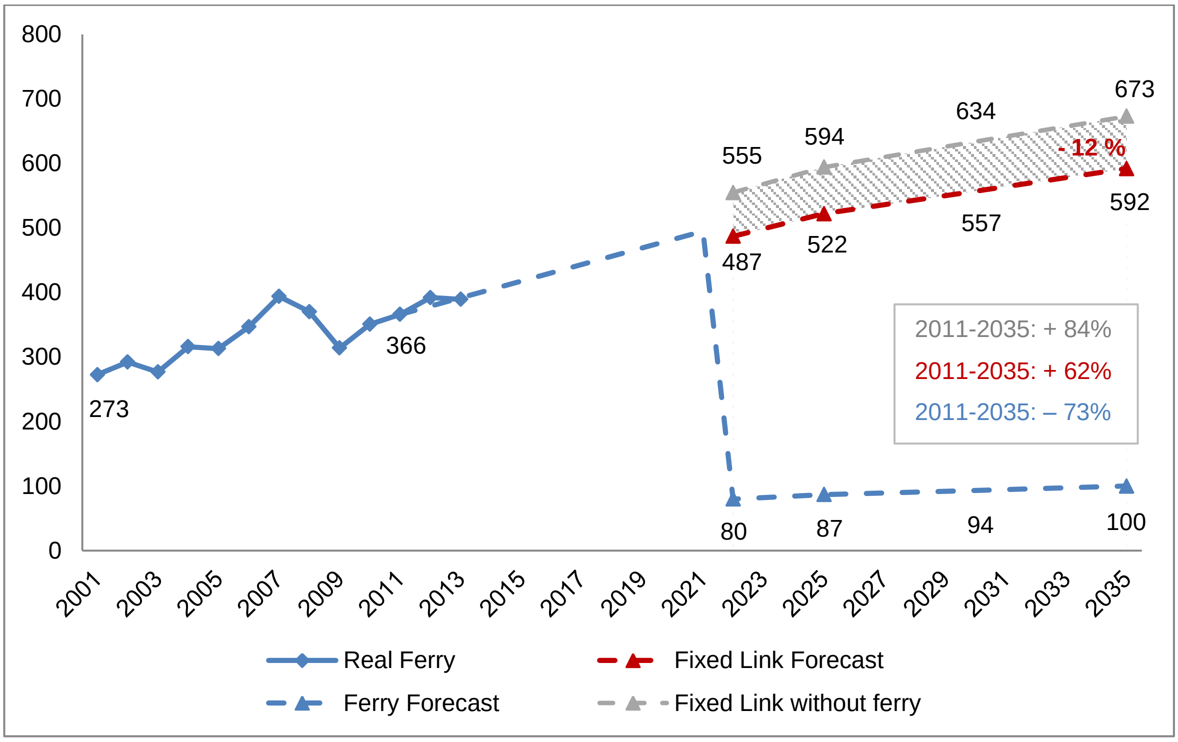


Figure 8-1: Parallel-Ferry-Case **variant PFA** Fehmarnbelt Fixed Link and ferry forecast compared to Case B (without ferry) – number of lorries in 1.000 per year

As set forth in Table 8-6, the reduction of the road transport volume in tons amounts to 12 % compared to Case B. The rail figures show marginal differences to the case without parallel ferry service, a slight decrease in the modal split can be observed owing to the supply improvement of road transportation. The number of trains in the year 2035 is thus estimated to decrease slightly from 17.260 to 17.252.

	2011	2022 after opening		2025		2030		2035	
	Base year	Case B	PFA	Case B	PFA	Case B	PFA	Case B	PFA
Transport volume in 1.000 lorries/trains									
Road freight	366	555	487	594	522	634	557	673	592
Rail freight	10,175*	14,085	14,079	14,900	14,894	16,080	16,073	17,260	17,252
Transport volume in 1.000 t									
Road freight	4.282	6.444	5.697	6.870	6.075	7.337	6.488	7.804	6.900
Rail freight	5.617*	8.320	8.317	8.788	8.785	9.464	9.461	10.140	10.137
Total	9.899	14.764	14.014	15.658	14.860	16.801	15.949	17.944	17.037

*Great Belt

Table 8-6: Comparison of projected transport volume over the Fehmarn Belt Fixed Link in Parallel-Ferry-Case **variant PFA** and Case B

Considering the fairly equal rail volume and the lower road transport volume, the total transport volume over the FBFL is anticipated to decline by about 5 % compared to the case without ferry. In 2025, the FBFL cedes about 72.000 lorries to the ferry service. Apart from that, other ferry connections also lose traffic volume to the parallel ferry service. As depicted in Table 8-7, the highest shifts in the number of lorries are expected from the ferries calling on Travemünde and Rostock.

	Volume		Change	
	Case B	PFA	absolute	relative
FBFL	594.154	522.305	-71.849	-12,1%
Ferry Puttgarden-Rødby	0	85.043	85.043	
Lübeck-Helsinki	71.598	71.433	-165	-0,2%
Travemuende-Trelleborg	334.523	331.631	-2.892	-0,9%
Travemuende-Malmoe	303.016	300.423	-2.593	-0,9%
Landb. Flensburg-Padborg	71.466	70.803	-663	-0,9%
Kiel-Goeteborg	108.507	107.901	-606	-0,6%
Kiel-Oslo	48.969	48.730	-239	-0,5%
Rostock-Gedser	134.942	133.156	-1.786	-1,3%
Rostock-Trelleborg	408.499	405.411	-3.088	-0,8%
Rostock-Helsinki	18.625	18.580	-45	-0,2%
Sassnitz-Ronne	2.089	2.073	-16	-0,8%
Sassnitz-Trelleborg	17.006	16.878	-128	-0,8%
Swinoujscie-Trelleborg	44.031	43.724	-307	-0,7%
Swinoujscie-Ystad	74.671	74.148	-523	-0,7%

Table 8-7: Route shifts in the number of lorries between Parallel-Ferry-Case **variant PFA** and Case B in 2025

8.4 Results Variant PFB (hourly service)

8.4.1 Passenger Traffic

The effect of this variant on the FBFL and also on the overall north-south-traffic is shown in Table 8-8.

Mode	1000 passengers/year					
	2011	2022 (without Fixed Link	2022 (with Fixed Link)	2025	2030	2035
Rail	0	0	-12	-12	-9	-7
Car	0	0	108	103	98	89
Air	0	0	0	0	0	0
Bus	0	0	0	0	0	0
Ferry Walk On	0	0	399	394	388	379
Total	**0**	**0**	**495**	**485**	**477**	**461**

Table 8-8: Differences in the traffic between Scandinavia and Europe[63] in the scenario, **variant PFB** with a parallel ferry to the FBFL and the Base Case B

There is an increase of overall traffic, mainly due to walk-on traffic, which stops when the ferry would be closed down as assumed in the Case A and B. With a parallel ferry this, however in the long term stagnating, market segment still would be served. At an hourly service this traffic would be nearly as high as in the 'without case' (without Fixed Link, see Table 8-9).

Apart from a minor modal shift from rail additionally some car journeys would be stimulated by a lower price on the ferry compared to the FBFL resp. compared to the ferry before opening of the FBFL.

In variant PFB, total traffic between Scandinavia and Europe would increase by about 0,5 million passengers or 1 %. The totals are shown in Table 8-9.

63 Traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side

Mode	1000 passengers/year					
	2011	2022 (without Fixed Link	2022 (with Fixed Link)	2025	2030	2035
Rail	460	629	1.137	1.143	1.082	1.031
Car	8.970	10.769	11.195	11.685	12.626	13.391
Air	17.226	27.996	27.733	31.299	38.496	44.384
Bus	2.320	2.392	2.361	2.442	2.526	2.594
Ferry Walk On	1.512	1.413	1.373	1.352	1.337	1.320
Total	**30.488**	**43.199**	**43.799**	**47.921**	**56.067**	**62.720**

Table 8-9: Total passengers between Scandinavia and Europe[64] in the scenario with a parallel ferry to the FBFL, **variant PFB**

[64] Traffic between Denmark east, Sweden, Norway, Finland on the one side, Germany and the rest of Europe (without Baltic States and CIS) on the other side

The main effect however would be a traffic shift from the FBFL to the parallel ferry, which is shown in Table 8-10.

	2022 with Fixed Link	2025	2030	2035
Passengers (1000/year)	**-1.187**	**-1.323**	**-1.410**	**-1.473**
Thereof				
passenger in cars	-1.031	-1.159	-1.240	-1.297
passengers in bus	-144	-152	-161	-169
passengers in rail	-12	-12	-9	-7
ferry walk-on	0	0	0	0
Vehicles (1000/year)				
cars (incl. motorcy-cles)	-397	-448	-477	-492
Buses	-4	-4	-5	-5

Table 8-10: Difference of FBFL traffic between the Parallel-Ferry-Case, **variant PFB** compared to Case B

The effect would be a decrease of 397 thousand cars and 4 thousand buses on the FBFL compared to Case B in 2022, rising to 492 thousand cars and 5 thousand buses until 2035. That means a traffic loss of about 14 % in 2022 and, due to rising Values of Time, 12 % in 2035 compared to Case B. The remaining traffic on the FBFL is shown in Table 8-11.

	2022	2025	2030	2035
Passengers (1000/year)	**8.555**	**9.811**	**10.599**	**11.251**
Thereof				
passenger in cars	6.298	7.497	8.333	9.027
passengers in bus	1.128	1.180	1.191	1.200
passengers in rail	1.129	1.134	1.074	1.024
ferry walk-on	0	0	0	0
Vehicles (1000/year)				
cars (incl. motorcy-cles)	2.488	2.969	3.290	3.562
Buses	30	32	31,55	32

Table 8-11: Total passenger traffic **on the FBFL** in the 'Parallel-Ferry-Case', **variant PFB**

The ferry (see Table 8-12) would also in this variant mainly be attractive for travelers with a low VoT and a need for a (short, not really relaxing) break during the journey. It is mainly holiday traffic and weekend trips. The occupancy of the ferry would be quite unevenly distributed over the time.

	2011	2022 without Fixed Link	2022 with Fixed Link	2025	2030	2035
Passengers (1000/year)	**6.028**	**6.990**	**1.682**	**1.808**	**1.887**	**1.934**
Thereof						
passenger in cars	3.973	5.002	1.139	1.262	1.338	1.386
passengers in bus	1.142	1.014	144	152	161	169
passengers in rail	394	557	0	0	0	0
ferry walk-on	519	417	399	394	388	379
Vehicles (1000/year)						
cars (incl. motorcy-cles)	1.564	1.969	432	481	509	520
Buses	31	27	4	4	5	5

Table 8-12: Total passenger vehicle-traffic **on the ferry line** between Rødby and Puttgarden in the 'Parallel-Ferry-Case', **variant PFB**

8.4.2 Freight Transport

The assumed hourly parallel ferry service Rødby – Puttgarden would lead to a decline of lorries on the FBFL of about 15 % compared to Case B. As depicted in Figure 8-2, in PFB approximately 570.000 lorries are anticipated to use the FBFL in 2035, whilst about 123.000 lorries are projected to take the hourly ferry service.

Hence, the total amount of vehicles which take the route over the Fehmarn Belt would increase from 673.000 to 693.000 lorries due to route shifts from other ferries through the expansion of transport supply. Almost 18 % of the total freight vehicles crossing the Fehmarn Belt are expected to choose the less expensive but more time-consuming ferry connection.

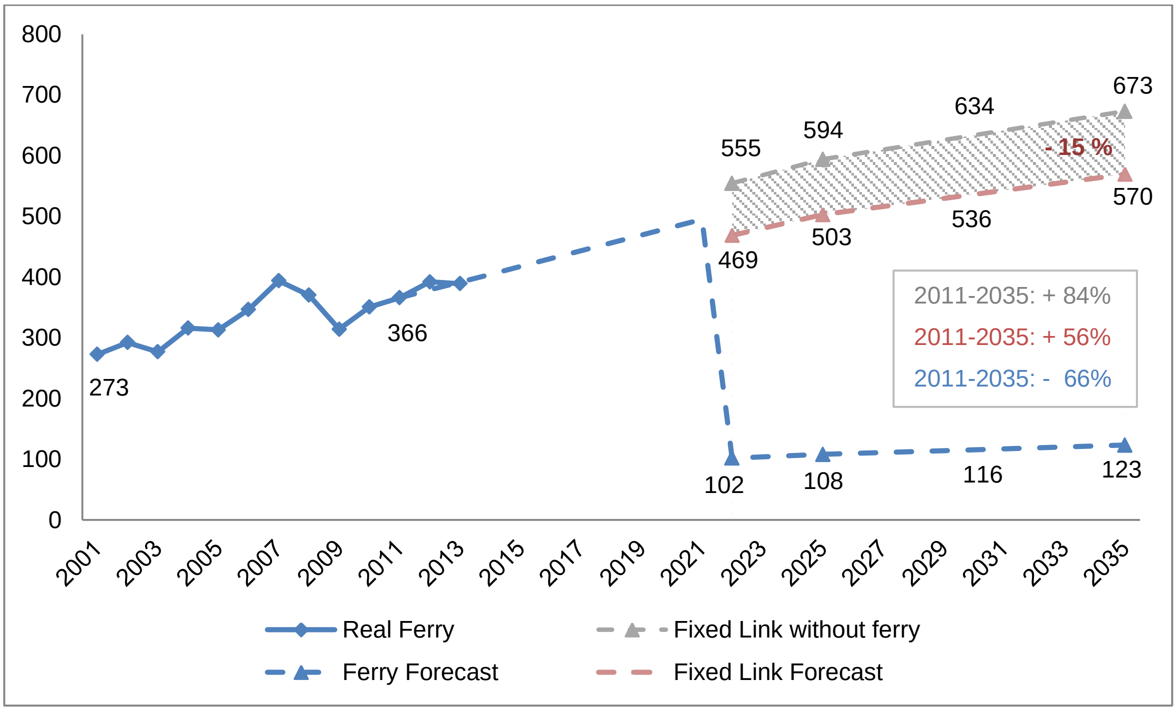


Figure 8-2: Parallel-Ferry-Case **variant PFB** Fehmarnbelt Fixed Link and ferry forecast compared to Case B (without ferry) – number of lorries in 1.000 per year

As set forth in Table 8-13, also the road transport volume in tons over the FBFL is anticipated to decline by about 15 % compared to Case B. A further effect of the supply improvement of road transportation is a slight decrease of rail traffic leading to a marginal lower train number of 17.249 instead of 17.260 in 2035.

As a result of the hourly parallel ferry, the total amount of transported goods via the FBFL will decline from 17,9 million t to 16,8 million t in 2035, which corresponds to a drop by 6,4 %.

	2011	2022 after opening		2025		2030		2035	
	Base year	Case B	PFB	Case B	PFB	Case B	PFB	Case B	PFB
Transport volume in 1.000 lorries/trains									
Road freight	366	555	469	594	503	634	536	673	570
Rail freight	10,175*	14,085	14,076	14,900	14,891	16,080	16,070	17,260	17,249
Transport volume in 1.000 t									
Road freight	4.282	6.444	5.495	6.870	5.861	7.337	6.259	7.804	6.656
Rail freight	5.617*	8.320	8.316	8.788	8.783	9.464	9.459	10.140	10.135
Total	9.899	14.764	13.811	15.658	14.644	16.801	15.718	17.944	16.791

*Great Belt

Table 8-13: Comparison of projected transport volume over the Fehmarn Belt Fixed Link in Parallel-Ferry-Case **variant PFB** and Case B

In addition other ferry lines contribute to the transport volume of the parallel ferry service Puttgarden-Rødby. The highest relative losses are experienced by the ferry line Rostock – Gedser as well as the Travemünde ferries.

	Volume		Change	
	Case B	PFB	absolute	relative
FBFL	594.154	502.990	-91.164	-15,3%
Ferry Puttgarden-Rødby	0	108.189	108.189	
Lübeck-Helsinki	71.598	71.385	-213	-0,3%
Travemuende-Trelleborg	334.523	330.795	-3.728	-1,1%
Travemuende-Malmoe	303.016	299.674	-3.342	-1,1%
Landb. Flensburg-Padborg	71.466	70.612	-854	-1,2%
Kiel-Goeteborg	108.507	107.725	-782	-0,7%
Kiel-Oslo	48.969	48.660	-309	-0,6%
Rostock-Gedser	134.942	132.643	-2.299	-1,7%
Rostock-Trelleborg	408.499	404.518	-3.981	-1,0%
Rostock-Helsinki	18.625	18.567	-58	-0,3%
Sassnitz-Ronne	2.089	2.069	-20	-1,0%
Sassnitz-Trelleborg	17.006	16.841	-165	-1,0%
Swinoujscie-Trelleborg	44.031	43.636	-395	-0,9%
Swinoujscie-Ystad	74.671	73.997	-674	-0,9%

Table 8-14: Route shifts in the number of lorries between Parallel-Ferry-Case **variant PFB** and Case B in 2025

In comparison to the two-hourly ferry service, only minor changes are achieved through the double ferry input of variant PFB: In 2025, the amount of lorries using the ferry would increase from 85.000 to 108.000 per year.

8.5 Conclusion

The parallel ferry would be used by around 0,4 million vehicles in 2022 and by around 0,5 million vehicles in 2035 or 10 % and 9 % of the passenger traffic concerning a two hourly service (variant PFA, see Table 8-15). In the case with an hourly service (variant PFB) the ferry would be used by around 0,54 million vehicles in 2022 and 0,65 million in 2035 or 14 % and 12 % of the passenger traffic. Especially for passenger traffic the seasonality of this traffic would be strong, i.e. the traffic would be concentrated on the summer and on some weekends. That means ships would be occupied rather differently. This reduces the economic feasibility of the line apart from the low overall load:

- an of average of 46 vehicles/boat-trip in 2022 and 57 in 2035 in PFA with an two-hourly service.
- In the case with an hourly service (PFB) average occupancy would be even much lower: 31 vehicles per boat-trip (2022) and 37 in 2035.

For the freight transport the conclusion is, that with a 2 hour parallel ferry service the reduction of the road transport volume in tons amounts to 12 % and for a one hour ferry service the reduction for the road transport volume in tons amounts to 15 % compared to Case B in 2022.

Based on the conclusions regarding economic feasibility of parallel ferry service, the base case scenarios are assuming that there will not be a parallel ferry services operating next to the FBFL.

Apart from that in the cases calculated the revenues per vehicle would be 25 % lower, compared to the existing ferry.

	Vehicles (1000/year)			
	2022 with Fixed Link	**2025**	**2030**	**2035**
Variant PFA (two hourly service)				
Cars (incl. motorcycles)	319	361	386	398
Buses	3	3	4	4
Lorries	80	87	94	100
Total PFA	**402**	**451**	**484**	**502**
Variant PFB (hourly service)				
Cars (incl. motorcycles)	432	481	509	520
Buses	4	4	5	5
Lorries	102	108	116	123
Total PFB	**538**	**593**	**630**	**648**

Table 8-15: Vehicles on the ferry-line in the 'Parallel-Ferry-Cases' variant PFA and PFB

The only relevant reason for the parallel ferries would be the price advantage (assumption: -25 %) compared to the FBFL. Without this discount the numbers shown inTable 8-15 would be reduced substantially to nearly zero.

9 CONCLUSIONS AND FINDINGS

Passenger traffic on the Rødby - Puttgarden axis will grow considerably, from about 1,9 (Case A) and 2,0 (Case B) million vehicles (passenger car and bus) before opening of the FBFL, a figure which almost was reached ahead in 2007, to nearly 3,4/3,5 (Case A/B) million after opening and ramp-up of the project (see Figure 9-1). After that a steady growth to 4,0/4,1 (Case A/B) million vehicles in 2035 is expected. The extrapolation to 2047 would give 4,6/4,7(Case A/B) million vehicles, 25 years after opening.

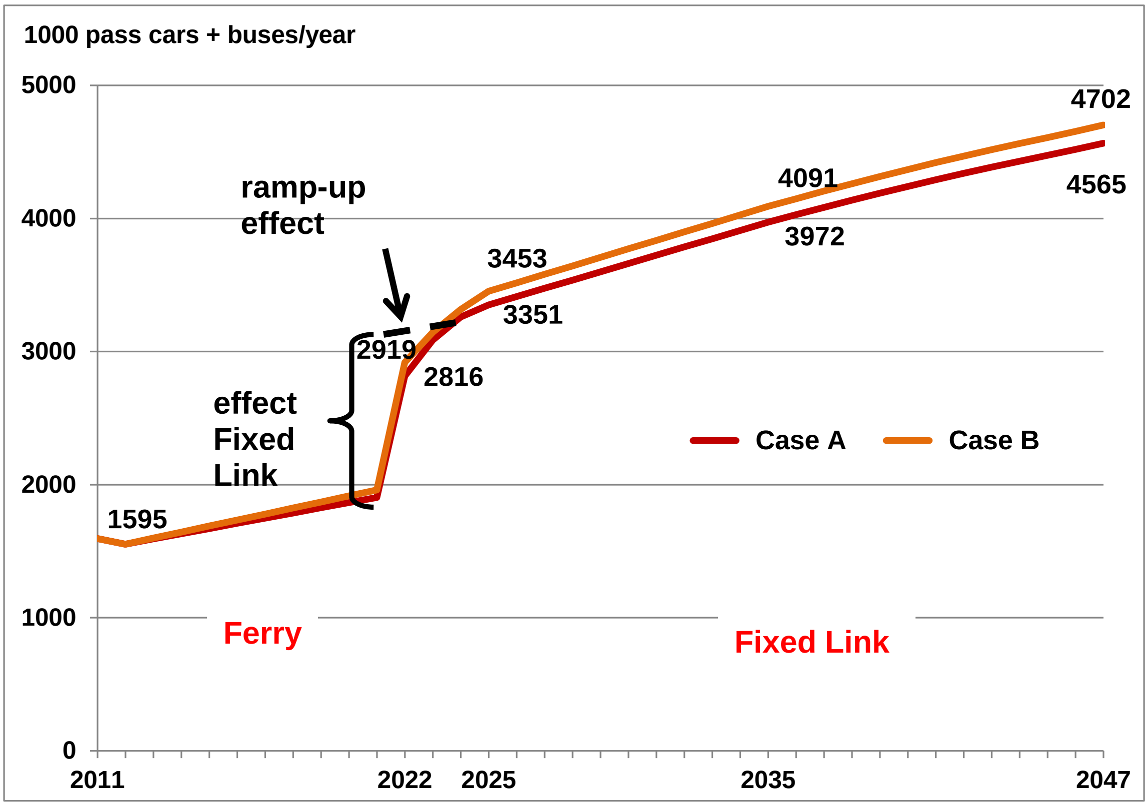


Figure 9-1: Forecast time series for passenger vehicle traffic over Fehmarn Belt

Considering the delay with the project and the development since the base year of the FTC 2002 study, the forecast on hand is widely compatible to this older forecast (see Figure 9-2).

The only major difference is a higher traffic jump due to the FBFL project in the 2014 study compared to 2002. This is mainly caused by the competition of the Great Belt in the base year resp. since the FTC 2002 study. The decrease of traffic on Fehmarn Belt from around 2005/2007 (see the blue line in Figure 9-2) has to do with an increasing market share of Great Belt especially since toll rates have been reduces while Rødby-Puttgarden fares increased considerably. By FBFL this 'lost' traffic will be re-directed to Fehmarn Belt, causing a major traffic jump than in the FTC 2003 forecast.

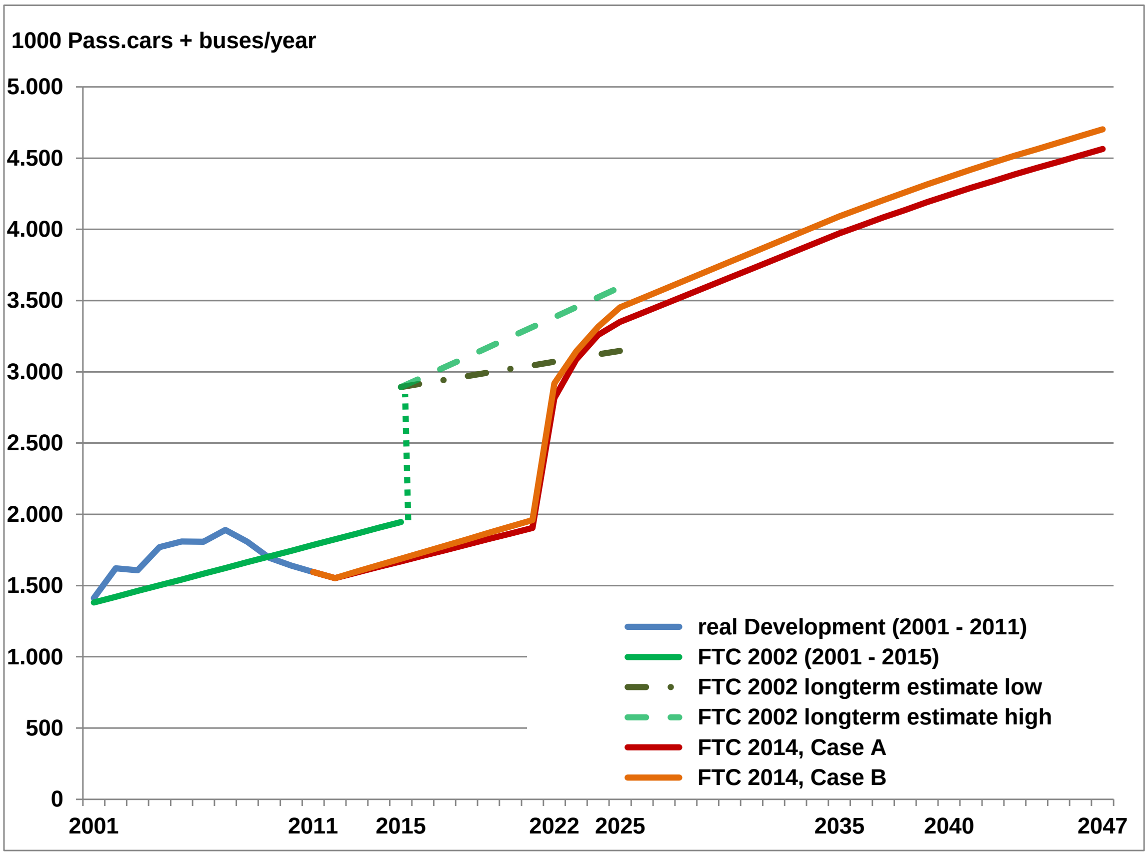


Figure 9-2: Forecast time series for passenger vehicle traffic over Fehmarn Belt, comparison with FTC 2002 study

More details can be seen in Table 9-1, including even a comparison with the 2012 extrapolation of the FTC 2002 study.

Passenger Traffic	2025 RESULTS				
Year of the study	**FTC 2002**		**2012 (extrapolation of FTC 2002)**	**FTC 2014 (New Study)**	
Passengers (1000/year)	**LOW**	**HIGH**		**Case A**	**Case B**
passenger in cars	7.418	8.492	9.205	8.396	8.656
passengers in bus	1.683	1.841		1.374	1.332
passengers in rail	1.405	1.432	1.564	1.330	1.146
Total passengers	10.506	11.765	10.769	11.100	11.134
Vehicles (1000/year)					
cars (incl. motorcy-cles)	3.097	3.538	3.579	3.314	3.417
buses	51	56	34	37	36

Table 9-1: Comparison of the FTC 2014 results (all scenarios) with former studies - passenger traffic

With regard to freight transport, we expect a dynamic development of the Fehmarn Belt crossing transport volume which is reinforced significantly through the FBFL. After the opening of the Fehmarn Belt Fixed Link in 2022, a freight transport volume of 13,6 million t to 14,8 million t is projected across the Fehmarn Belt. Due to the expected route shifts as response to the new built link, the traffic volume increase will amount to 37 % to 49 % between 2011 and 2022.

	2011	2022 after opening		2025		2030		2035		annual growth 2011-2035		annual growth 2025-2035	
	base year	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B
Road freight	4.282	6.212	6.444	6.622	6.870	7.041	7.337	7.460	7.804	2,3%	2,5%	1,2%	1,3%
Rail freight	5.617*	7.390	8.320	7.584	8.788	7.993	9.464	8.402	10.140	1,7%	2,5%	1,0%	1,4%
Total	**9.899**	**13.602**	**14.764**	**14.206**	**15.658**	**15.034**	**16.801**	**15.862**	**17.944**	**2,0%**	**2,5%**	**1,1%**	**1,4%**

* Traffic over Great Belt

Table 9-2: Freight transport volume across the Fehmarn Belt in 1.000 t per year

According to the expected road transport volume developments, the number of lorries using the Fehmarn Belt Fixed Link is estimated to range from 644.000 to 673.000 vehicles in 2035. Including the traffic shifts, a growth of 76 % to 84 % is projected for road transportation from 2011 to 2035. 10 % to 13 % of the lorry traffic growth across the Fehmarn Belt can be attributed to the traffic jump after the opening of the FBFL. Rail transportation however, is expected to develop less dynamically by 50 % to 81 % to an amount of 19,8 million t to 21,0 million t in 2035, as shown in Figure 9-4.

In the long term, freight traffic volumes over the Fehmarn Belt are projected to almost double compared to 2011 quantities, the number of lorries crossing the Fehmarn Belt Fixed Link is estimated to develop with similar dynamics.

For the period after the opening of the Fixed Link until 2035, a solid growth of 1,2- 1,3 % p.a. for lorry traffic is projected in Case A and Case B from 2025 to until 2035. From 2035 to 2047 the growth is expected to be 1,1 % per year. According to the linear extrapolation, 25 years after the opening of the Fehmarn Belt Fixed Link, 734.000 to 768.000 lorries per year are expected to use the link.

Whilst the of rail volume across the FBFL is estimated to grow by 1,0 % (Case A) to 1,4 % p.a. (Case B) between 2025 and 2035, it is projected to increase by 0,9 % to 1,2 % p.a. from 2035 to 2047. Thus, a rail freight volume of 9,4 million t to 11,8 million t is reached in the long term.

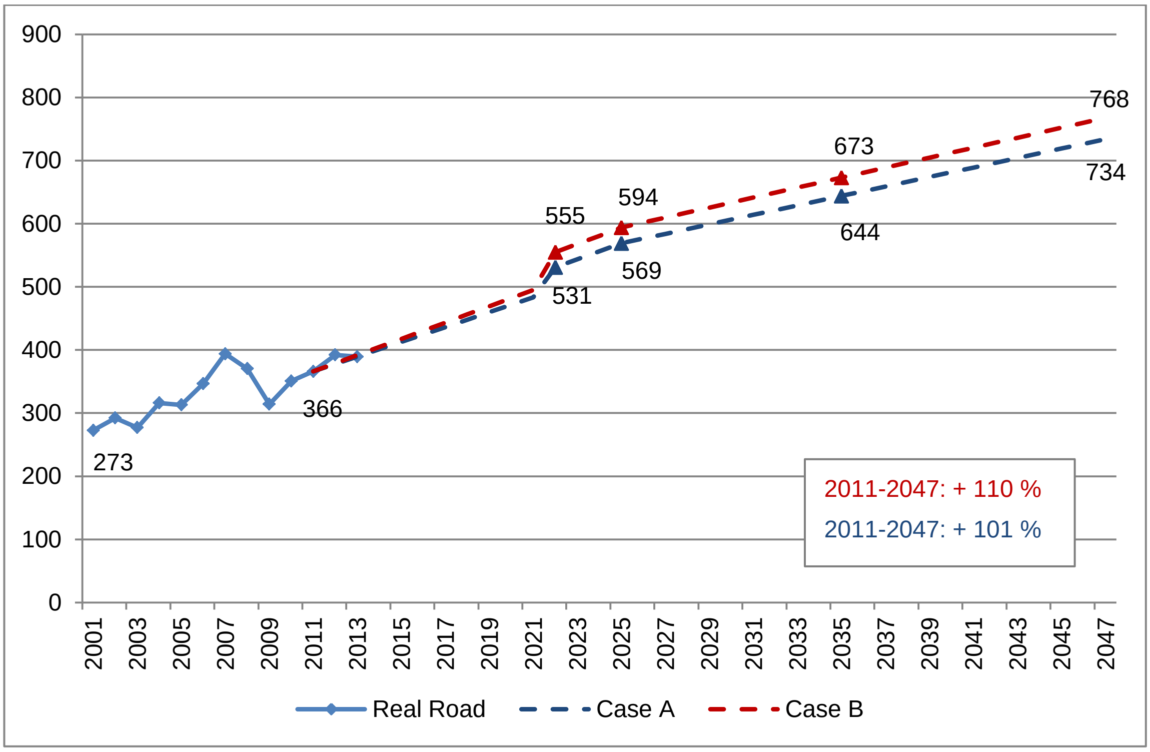


Figure 9-3: Trend Projections of lorry number in 1.000 vehicles per year crossing the Fehmarn Belt Fixed Link for Case A and Case B until 2047

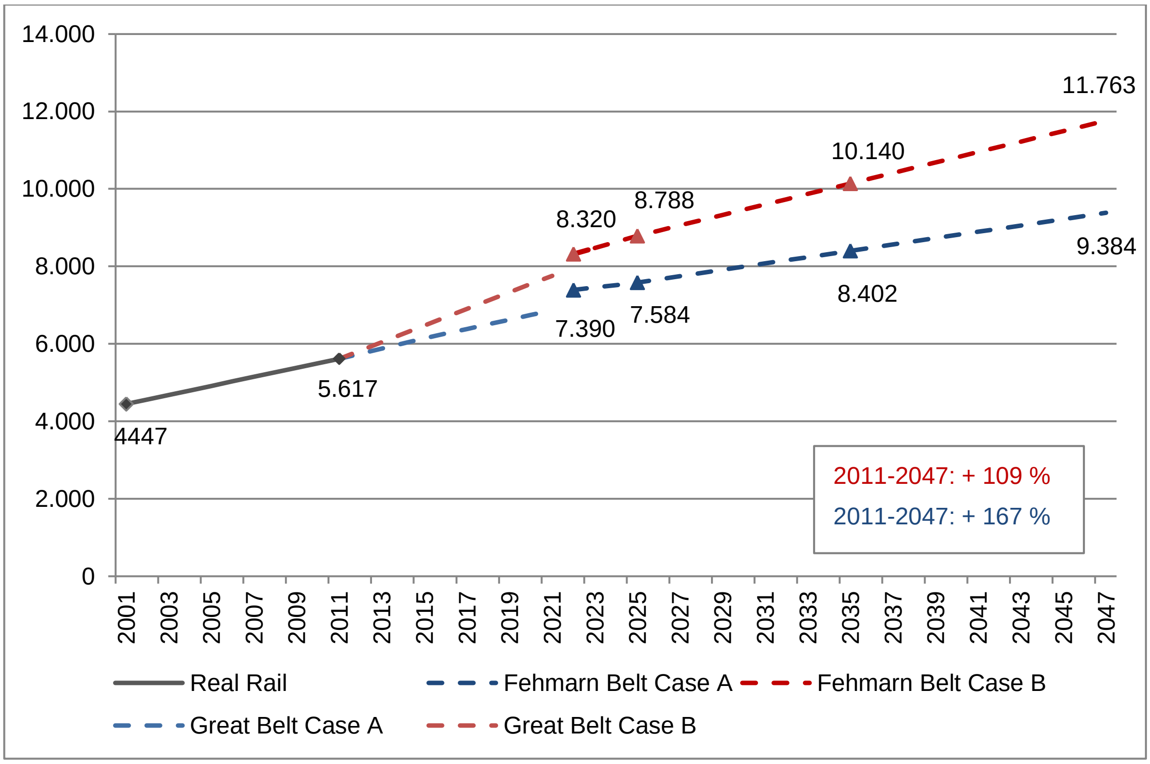


Figure 9-4: Trend Projections of rail volume in 1.000 t per year crossing the Fehmarn Belt Fixed Link (before opening: Great Belt) for Case A and Case B until 2047

A detailed comparison to former studies is given in Table 9-3.

Freight Traffic	**2025 RESULTS**				
Year of the study	**FTC 2002**		**2012 (extrapolation of FTC 2002)**	**FTC 2014 (New Study)**	
Volume (1000 t/year)	**LOW**	**HIGH**		**Case A**	**Case B**
road	8 718	10 684	n/a	6 622	6 870
rail	10 461	12 722	11 478	7 584	8 788
Vehicles (1000/year)					
lorries	547	670	663	569	594

Table 9-3: Comparison of the FTC 2014 results (all scenarios) with former studies - freight traffic

The total number of road vehicles and trains in the forecast is shown in Table 9-4.

Vehicle Type	2022		2025		2030		2035		for comparison FTC 2002 Case B (2015)
	Case A	Case B	Case A	Case B	Case A	Case B	Case A	Case B	
passenger cars (ADT)	7.619	7.904	9.076	9.362	10.014	10.321	10.778	11.107	7.786
buses (ADT)	96	93	101	99	103	100	104	101	129
lorries (ADT)	1.356	1.521	1.559	1.627	1.663	1.737	1.764	1.844	1.238
total road vehicles (ADT)	**9.071**	**9.518**	**10.739**	**11.088**	**11.780**	**12.158**	**12.646**	**13.052**	**9.153**
passenger trains/day	32	32	34	36	36	38	38	40	40
freight trains day*	**54**	**61**	**56**	**65**	**59**	**70**	**62**	**74**	**59**
total trains/ day*	**86**	**93**	**90**	**101**	**95**	**108**	**100**	**114**	**99**

* For the purpose of comparison, the methodology for the calculation of the daily freight train numbers is based on a decision between the Danish Ministry of Transport and German Ministry of Transport (06 December 2012,(further details: see chapter 6.2.3). Thus, the FTC 2002 daily train number differs from the FTC 2002 publication (p. 120).

Table 9-4: Vehicles/trains on FBFL in FTC 2014 study (for comparison FTC 2002 results)

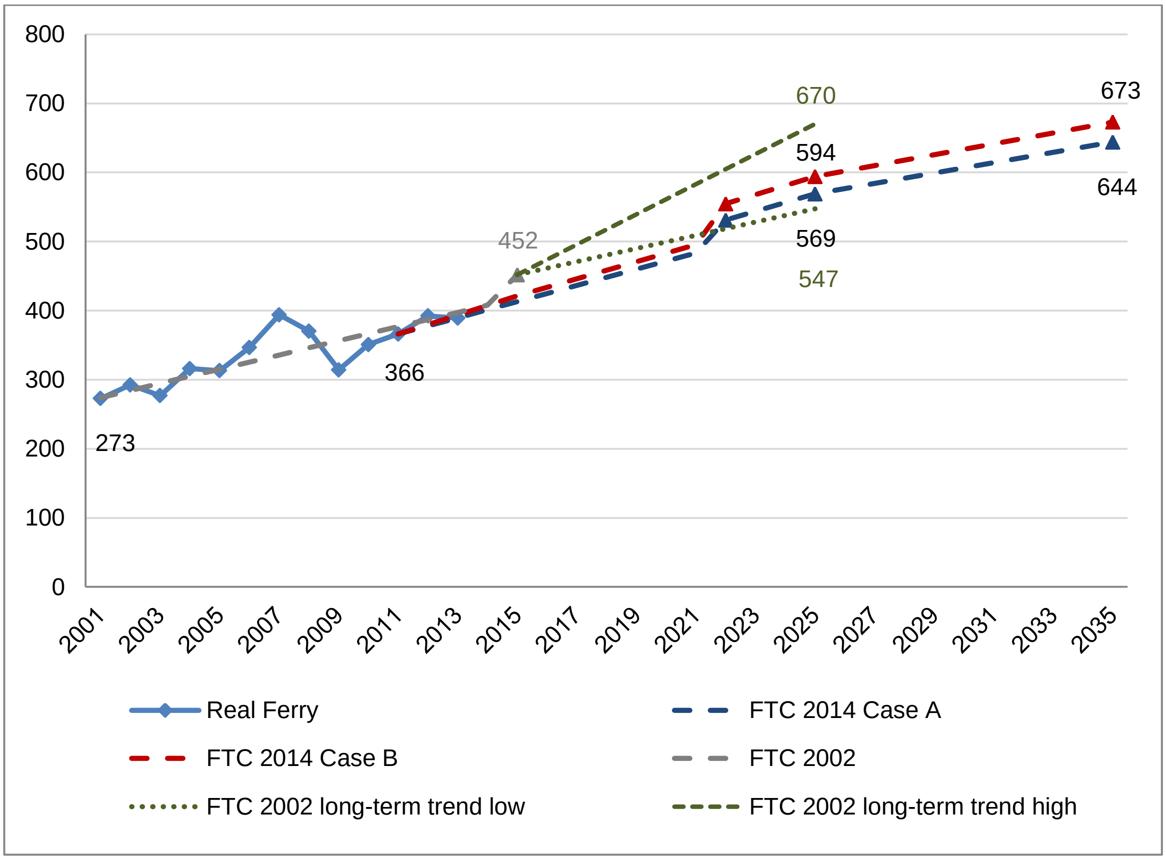


Figure 9-5: Comparison of FTC study 2014 and 2002 Base Case B results for the number of lorries in 1.000 per year crossing the Fehmarn Belt

There will be around 4,0 million road vehicles crossing the FBFL in 2025 in both cases, that is about 10.700 and 11.100 vehicles in the average daily traffic (ADT). The share of heavy vehicles (lorries and buses) would be between 15% and 16%. In 2035 4,6 million (in Case A) and 4,8 million (in Case B) vehicles would cross the FBFL (12.600 and 13.100 ADT) at a share for heavy vehicles of 15,2% and 15,3% in the 2 cases respectively. Vehicle traffic 2022 would be as high as expected in the 2002 study for 2015.

The number of trains per day using the FBFL would grow from 90 to 101 in 2025, thereof 56 to 65 freight trains, to 100 to 114 in 2035 (thereof 62 to 74 freight trains).