Traffic forecast
for the Fehmarnbelt Fixed Link
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0. Summary of the basis and main conclusions of the traffic forecast

It appears from the government’s legislative programme for the parliamentary year 2014/15 that a construction act for the Fehmarnbelt Fixed Link will be presented in February 2015. In the light of this, an updated forecast has been prepared for the traffic trends for the Fehmarnbelt Fixed Link.

This report summarises the various forecasts and analyses of traffic trends prepared by consultants in connection with this. All analyses will be published with a view to ensuring a fully transparent basis for the forecast, cf. www.femern.dk.

0.1. Basis for the traffic forecast

This report is based on the following data and knowledge base:

1. The forecast traffic trends for the Fehmarnbelt Fixed Link are based on what is termed the FTC model, which has been tailored to describe the traffic trends in the Fehmarnbelt corridor. Calculated on two different scenarios.

2. The forecast for the traffic trends between Scandinavia and Continental Europe and specifically in the Fehmarnbelt corridor was prepared based on the Trans-Tools trans-European traffic network model.

3. Analysis of the relationships between economic growth and traffic growth.

The forecast “Fehmarnbelt Forecast 2014” was prepared by German Intraplan and BVU, while the Trans-Tools forecast report was prepared by Danish Tetraplan based on the Trans-Tools model, which is the model used for traffic planning by the European Commission. The FTC model and Trans-Tools model represents the best available traffic models for describing traffic trends on a Fehmarnbelt Fixed Link and the trends in the cross-border traffic in the EU when the forecast was being prepared.

The FTC model was designed specifically to describe the traffic on the Fehmarnbelt Fixed Link and has been approved by the Danish and German authorities. In 2003, the model formed the basis for the joint report from the two countries’ Ministries of Transport on the traffic and economic assumptions for the Fehmarnbelt Fixed Link. The model has now been substantially updated.

The model contains key factors for traffic trends in relation to the Fixed Link. This applies to macro-economic parameters such as economic growth, population growth and development in consumer spending, car ownership etc. and factors such as the users’ choice of route (including ferry services) and transport mode. The analysis covers both the total market in the corridor and specifically for the Fehmarnbelt Fixed Link.

The FTC model has been prepared with two different scenarios based on two different sets of assumptions about the future trends. One scenario is based on the assumptions used by the Danish Ministry of Transport about factors such as transport prices, socio-economic factors and the infrastructure’s development. These assumptions will also be predominantly used in the Danish national traffic model.

The other scenario is based on the assumptions used in the German Bundesverkehrswegeplan (BVWP) (federal transport infrastructure plan), which is the German government’s official transport plan.

The FTC model’s main scenario is Danish based.
In order to shed more light on and further assess future traffic trends, Tetraplan has prepared a traffic forecast based on the Trans-Tools model. It was designed to describe traffic trends in prioritised European traffic corridors, including the Fehmarnbelt corridor. The Trans-Tools model is used by the European Commission to describe future traffic trends and trends in the distribution between the various transport modes.

In relation to work on the forecast, the historical traffic trends around the Fehmarnbelt are analysed in chapter 2. The analysis gives a historical perspective of the traffic trends, and analyses the trends and relationships between the social economy and traffic growth in the past half century.

The assumptions for some of the most important macro-economic parameters in the traffic forecasts are also separately illustrated by a research team from CBS based on reports from e.g. the Economic Council and the OECD. The report analyses economic growth, international trade and trends in consumer spending.

By involving various sources and models to understand the drivers behind the traffic trends between Scandinavia and Continental Europe, the intention is to draw a broad-based picture of the traffic trends, and in the light of this, create the fairest basis for expectations regarding the future traffic trends for the Fehmarnbelt Fixed Link.

Uncertainty is linked to the assessment and forecasts in the field of transport. As regards the selection of analyses and assumptions, an effort has been made to ensure that the material is as transparent as possible. A number of sensitivity calculations have also been included in the financial analysis concerning the consequences for the project’s economy if central parameters in the traffic forecast develop differently than expected. The sensitivity calculations include e.g. the consequences of continued ferry services and different traffic growth scenarios.

Comments and questions regarding the traffic forecasts can be submitted to the following email address: femernprognose2014@femern.dk
0.2. The main results of the traffic forecast

The main scenario in the report “Fehmarnbelt Forecast 2014”, which was based on the FTC model, shows the following:

- The number of passenger cars is expected to be approx. 5,400 per day before the opening, increasing to approx. 9,400 in the fourth year after opening. The annual growth after the first four years following the opening is projected to be approx. 2 per cent, declining to 1.5 per cent in 2035. In 2047, the growth is expected to have declined to 1 per cent. After 2047, i.e. 25 years after the Fixed Link opens, as a precautionary measure, Femern A/S is assuming zero growth.

- For lorries, the annual growth after the first four years following opening is estimated to be approx. 1.3 per cent, declining to 1.2 per cent in 2035. Subsequently, growth will decline to 1.1 per cent per year up to 2047, after which traffic is assumed to remain constant.

- The number of goods trains expected to use the Fixed Link in 2022 will be 61 freight trains per day, increasing to 74 freight trains per day in 2035. For passenger trains, the number of passengers will double when the link opens.

- A traffic jump of 54 per cent is estimated for road traffic. The traffic jump will occur partly through transfer from other transport routes, and partly through the creation of new traffic through increased availability and shorter travel times. For precautionary reasons, the traffic jump is being phased in during the first three years. In other words, it is estimated that the traffic jump will be fully phased in during the fourth year of operation.

- Growth in traffic on the Fehmarnbelt Fixed link will be at relatively the same level as expected in the original forecasts from 2003. Slightly lower average annual growth is expected and a slightly higher traffic jump compared with the forecast from 2003.

Both the Trans-Tools model and the FTC model are based on a number of assumptions about the factors driving the traffic trends. The “Fehmarnbelt Forecast 2014” report describes the model results and the underlying assumptions in more detail.

The relationship between economic growth and traffic growth is described in the analysis prepared by CBS. It reviews the overall national and international economic forecasts for the future development in GDP, international trade and consumer spending. These three macro-economic variables play an important role for traffic across the Fehmarnbelt, e.g. because the Fehmarnbelt Fixed Link is an international corridor where traffic is driven by international trade and leisure traffic.

The report from CBS shows the following:

- In the years leading up to the financial crisis, growth in GDP in Denmark followed economic trends but has remained at average growth of 2.2 per cent per year. Short-term forecasts indicate growth of between 1.1 and 1.6 per cent in 2014 and up to 2.2 per cent in 2015 and 2016. CBS has included two long-term forecasts, one of 2.5 per cent (The Economic Council’s forecast for 2016-2020) and another for 2.1 per cent. (The OECD’s forecast for 2030-2060).

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International trade dropped dramatically in Denmark as well as abroad when the financial crisis occurred. However, short-term and long-term forecasts for Denmark show that the growth in trade is increasing once again. As a result, the most recent forecasts from the Economic Council predict that the trade to GDP ratio will rise to 2:1 again this year, and will remain at this level until 2020.

Consumption relating to holidays and leisure is a luxury and is therefore volatile and follows the economic fluctuations in society. Short-term forecasts for overall consumer spending in Denmark predict growth of between 1.3 and 1.6 per cent in 2014, between 1.6 and 2.8 per cent in 2015 and between 2 and 3.2 per cent in 2016. The only long-term forecast for consumption (TEC 2014) forecasts annual growth of 3.2 per cent in consumption up to 2020. Consumption relating to holidays and leisure is also expected to have the same growth.

It is essential for understanding the Fehmarnbelt Fixed Link that traffic will be driven not only by general economic growth in the individual countries and local area close to the Fixed Link, but also by international trade, which is expected to grow more rapidly than general economic growth. General economic growth is significant in terms of, for example, car ownership and transport patterns but also for the population’s consumption relating to holidays and leisure, which is expected to increase as part of the overall consumption when incomes rise. This should be viewed in relation to the fact that holiday and leisure traffic is also an important part of the traffic in the corridor.

The Fehmarnbelt corridor has been characterised by high average traffic growth for many years. Chapter 2 reviews the historical traffic trends on the Rødby-Puttgarden ferry route, where average annual growth of 3.4 per cent in road traffic has been recorded over the past 40 years. Historically, the Rødby-Puttgarden route has been dominated by passenger traffic, including holiday and leisure travellers, but since the 1970s, lorry traffic on the route has risen significantly. This now comprises 20 per cent of the total traffic on the route.

Table 0.1 provides an overview of the forecast’s results for the total daily traffic on the Fehmarnbelt Fixed Link measured in the number of vehicles and trains in 2022, 2025, 2035 and 2047, respectively. This forecast is used as the main scenario for the financial analysis for the Fehmarnbelt project.
Table 0.1: Expected daily traffic on the Fehmarnbelt Fixed Link, main scenario in the Fehmarnbelt Forecast 2014

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>2022*</th>
<th>2025</th>
<th>2035</th>
<th>2047</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger cars</td>
<td>7,904</td>
<td>9,362</td>
<td>11,107</td>
<td>12,775</td>
</tr>
<tr>
<td>Coaches</td>
<td>93</td>
<td>99</td>
<td>101</td>
<td>107</td>
</tr>
<tr>
<td>Lorries</td>
<td>1,521</td>
<td>1,627</td>
<td>1,844</td>
<td>2,104</td>
</tr>
<tr>
<td><strong>Total number of road vehicles</strong></td>
<td><strong>9,518</strong></td>
<td><strong>11,088</strong></td>
<td><strong>13,052</strong></td>
<td><strong>14,986</strong></td>
</tr>
<tr>
<td>Passenger trains</td>
<td>32</td>
<td>36</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Freight trains**</td>
<td>61</td>
<td>65</td>
<td>74</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total number of trains</strong></td>
<td><strong>93</strong></td>
<td><strong>101</strong></td>
<td><strong>114</strong></td>
<td>-</td>
</tr>
</tbody>
</table>


*Note: Includes a phasing-in period (ramp-up) of three years with an expected full phase-in during the fourth year after the opening

**Note: The traffic forecast’s current estimations regarding train traffic extend only up to 2035

Figure 0.1 shows the forecast for passenger traffic on the road link in the FTC analysis’s main scenario and the German sensitivity scenario compared with the forecast in the original FTC analysis from 2003. The figure indicates that both the main scenario and the sensitivity scenario are within the estimates in the original traffic forecast from 2003.
Figure 0.1: Forecast for passenger cars and coaches for the Fehmarnbelt Fixed Link


Note: The two scenarios in the FTC analysis are compared with the actual traffic trends (Rødby-Puttgarden ferry 2001-2011) as well as the original FTC forecast.

Figure 0.2 below shows the forecast for lorry traffic for the Fehmarnbelt Fixed Link. For the period 2001-2011, the actual trends for Rødby-Puttgarden are shown, followed by the FBF forecast’s main scenario for the period 2011-2047. The number of lorries crossing the Fehmarnbelt will increase. The figure shows an increase from 379,000 in 2011 to 555,000 in 2022. Long term, the number of lorries on the Fehmarnbelt Fixed Link is expected to increase to 768,000 in 2047.
Figure 0.2: The forecast for lorry traffic for the Fehmarnbelt Fixed Link

The Trans-Tools forecast shows annual growth of 4.0 per cent in the cross-border road traffic in the Fehmarnbelt corridor for passenger vehicles and 3.4 per cent for lorries for the period between 2005 and 2030 on the establishment of a fixed link across the Fehmarnbelt within this period. The Trans-Tools model is based on an calculated traffic level in 2005, and the forecast deals exclusively with the traffic level in the final year 2030 and not the individual intermediate years. Establishment of a Fehmarnbelt Fixed Link is therefore included in the Trans-Tools forecast but is distributed in linear fashion across the entire analysis period and is therefore not linked to a specific year.

The Trans-Tools forecast supports that the establishment of a fixed rail link across Fehmarnbelt will result in a re-organisation of freight transport via the railway. In future, freight transport on the railway is expected to occur to a significant extent on the Fehmarnbelt Fixed Link rather than on the route across the Great Belt, where pressure will therefore be reduced. The Trans-Tools forecast also indicates a significant increase in the volume of goods transported by rail between Scandinavia and Continental Europe in the years up to 2030.

Table 0.2: Key figures for the trends in traffic growth for the Fehmarnbelt corridor from 2005 to 2030

<table>
<thead>
<tr>
<th>Average annual growth</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger cars and coaches</td>
<td>4.0%</td>
</tr>
<tr>
<td>Lorries</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

Source: “Forudsætninger og resultater fra TENConnect2 – Forventet trafikudvikling i Femern-korridoren” (Assumptions and results from TENConnect2 – Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014, pages 7-8
1. Introduction

As a part of the original basis for decision-making used for studies on the establishment of a Fehmarnbelt Fixed Link, the then Danish Ministry of Transport and the German Bundesministerium für Verkehr, Bau- und Wohnungswesen prepared a joint traffic forecast for traffic trends on the establishment of a Fehmarnbelt Fixed Link.

The traffic forecast – the FTC forecast – was published in 2003 in the report “Fehmarnbelt Forecast 2002, Final Report, April 2003”. Since then, the FTC forecast from 2003 has been the official reference source for the expected traffic trends with the establishment of a Fehmarnbelt Fixed Link, and the forecast has been used as the starting point for the financial analyses of a forthcoming Fehmarnbelt Fixed Link.

Femern A/S has had a new and updated traffic forecast prepared based on a fully updated version of the FTC model in advance of the forthcoming Construction Act. The updated traffic forecast from 2014 therefore replaces the traffic forecast from 2003. This chapter presents the objective and background for the overall analytical and geographical frameworks etc. for the traffic forecast.

1.1. Objective and background

The Fehmarnbelt Fixed Link will connect eastern Denmark to the German mainland and will thereby bring Scandinavia and Continental Europe closer together. According to plan, the Fehmarnbelt Fixed Link will be designed as an 18 km long immersed tunnel that will reduce travel time across the Fehmarnbelt from the current 45-minute ferry trip plus waiting time and disembarkation to an approximate ten-minute car journey. The preparation phase began in 2009 when the Danish Parliament passed the Planning Act for the Fehmarnbelt Fixed Link, while the construction work is expected to begin in 2015.

The objective of the new traffic forecast is to provide an updated, transparent and model-based traffic projection for the Fehmarnbelt Fixed Link based on the best available traffic models for describing the future traffic trends across national borders and for the Fehmarnbelt Fixed Link specifically. The traffic forecast documents partly the expected traffic demand for the Fixed Link and partly changes in the traffic patterns caused by a fixed link across the Fehmarnbelt. The traffic forecast is therefore a core part of the foundation for the Construction Act on the establishment of a fixed link across the Fehmarnbelt that the government is expected to present in February 2015. The traffic forecast forms the basis for a new updated financial analysis of the profitability of a fixed link across the Fehmarnbelt.

Updating the traffic forecast is therefore also intended to reveal whether the original expectations from 2003 concerning traffic growth on a Fehmarnbelt Fixed Link can be maintained or should be adjusted based on updated data on traffic trends.

1.2. Procedure and data source

This traffic forecast is based on a full update of the original FTC model from 2003, which forms the basis for the original traffic forecast “Fehmarnbelt Forecast 2002, Final Report, April 2003”. The model is based on a broader and more up-to-date data source containing data for the development of a number
of core parameters up to the present date. The comprehensive source is intended to pave the way for the most detailed presentation possible.

Main model:

- The updated FTC forecast is based on the most recently available assumptions for economic and demographic development as well as assumptions concerning the trends in transport costs, choice of transport mode etc. The forecast presents the main scenario for traffic trends for a Fehmarnbelt Fixed Link and also accommodates a sensitivity scenario that is based on a number of estimates for the economic development and trends in transport costs used in a German context. At the same time, sensitivity scenarios have been prepared that study the impact a parallel ferry service across the Fehmarnbelt will have on traffic on the Fixed Link.

Additional sources:

- The Trans-Tools model is a common European traffic model designed to project the expected traffic in selected European corridors and regions in 2030. The model is considered one of the most advanced traffic models for calculating traffic trends across national borders in Europe and is used by the European Commission, inter alia. However, the model contains a number of uncertainties in relation to the more specific forecast based on the FTC model.

- “Sammenhængen mellem økonomisk vækst og trafikvækst – en undersøgelse af mulige ændringer i fremtiden”, (The relationship between economic growth and traffic growth – a study of possible changes in the future), October 2014 report prepared by the Centre for Economic and Business Research at Copenhagen Business School on behalf of Femern A/S.

- Chapter 2 contains a historical review of the traffic trends across the Fehmarnbelt. In the light of the historical data from Statistics Denmark and others.

It has been necessary to use traffic models that at the time of preparing the traffic forecast were specifically suited to estimating the transnational traffic between Scandinavia and Continental Europe and the specific trends for the Fehmarnbelt Fixed Link. In the long term, the national traffic model will be able to describe and analyse this development, but as the relevant part of the model has not yet been completed, it is therefore estimated that it cannot be used at the present time as the basis for a traffic forecast for the Fehmarnbelt link. Femern A/S intends to use the national traffic model when the relevant part of the model has been completed and verified.

Traffic forecasting is not an exact science. Therefore, different projections of traffic trends do not necessarily share the same analytical approach, data and assumptions. Therefore the models’ specific results deviate from each other. However, in this context, the analyses’ differences can be considered a strength. By involving various sources and models to understand the drivers behind the traffic trends between Scandinavia and Continental Europe, it is the intention to draw a broad picture of the traffic trends, and in the light of this, create a true and fair basis for the expectations for the future traffic trends for the Fehmarnbelt Fixed Link.

1.3. Geographic limitations

The following geographical traffic corridors will be used in the traffic forecast:
• **The traffic between Scandinavia and Continental Europe:** Vehicles/freight/passengers passing between Scandinavia and Continental Europe via the Danish-German border to the West via the Fehmarnbelt and via the Swedish ferry routes to the East.

• **The Fehmarnbelt corridor:** Vehicles/freight/passengers passing between Scandinavia and Continental Europe via the Fehmarnbelt (the Rødby-Puttgarden ferry service and the Fixed Link) as well as the Gedser-Rostock ferry service and the Swedish ferry services to Travemünde and Rostock. The traffic in the Fehmarnbelt corridor is therefore part of the total traffic between Scandinavia and Continental Europe.

• **Fehmarnbelt:** Vehicles/freight/passengers passing between Scandinavia and Continental Europe via the Rødby-Puttgarden ferry crossing and after 2021 via the Fehmarnbelt Fixed Link. The traffic across the Fehmarnbelt is therefore part of the total traffic in the Fehmarnbelt corridor and between Scandinavia and Continental Europe.

**1.4. The TEN-T network in the EU**

The Trans-European Transport Network (TEN-T) is the overall transport network in the EU whose main objective is to ensure the development of the trans-European transport network to strengthen the internal market by facilitating the transport of goods across borders and geographical obstacles and thereby increase economic and social cohesion while reducing the pressure on the environment. TEN-T is therefore also intended to transfer more freight from road to rail to reduce energy consumption while also reducing the traffic pressure on local roads and in cities.

Freight traffic on the railway will be noticeably improved. From 2022, freight passing between Scandinavia and Europe will not have to travel via the Great Belt. The distance for freight traffic on the railway will be significantly reduced. At the same time, the railway’s capacity will be considerably expanded, which will produce far faster freight traffic than today. The Fehmarnbelt link will be part of the backbone in the north/south-bound railway corridor in the EU’s internal market and will move freight from the road network to the railway network.

Germany, not least northern Germany, is one of the largest and most important export markets for the Nordic countries, Norway, Sweden, Finland and Denmark. With the faster freight link, the business community in these countries will have an attractive logistics opportunity that can provide the basis for new international growth and employment.

At the same time, the Fehmarnbelt link can contribute to improving passenger transport in Europe, including the railway.

The Fehmarnbelt link will therefore be a new and important part of this overall European transport network and will realise the central North-South axis between Scandinavia and Continental Europe via the shortest distance. Therefore, the Fehmarnbelt link, together with a new Brenner tunnel between Austria and Italy, is one of the two EU infrastructure projects in the EU with the highest priority.

It is also an advantage and future-proofing of the traffic volume for the link that it will be a central part of the overall traffic network, which will be continuously expanded and maintained in the decades to come.
In the light of this, the Fehmarnbelt link will receive financial support from the EU. In connection with the establishment of the landworks and immersed tunnel, the Fehmarnbelt link is entitled to co-financing from the EU of up to 40 per cent of the construction costs for the railway link and up to 10 per cent for the road link.

Figure 1.1: Map of TEN-T: Nine corridors


Between 2007 and 2015, the European Commission has granted over DKK 1.5 billion to the preparatory project activities and construction works. The Fehmarnbelt link has therefore achieved the highest possible EU support for both the preparatory landworks and for the planning phase.
2. **Traffic trends for the Fehmarnbelt over the past 40 years**

2.1. **Introduction and main conclusions**

This chapter reviews the historical traffic trends on the Fehmarnbelt.

The Fehmarnbelt Fixed Link will be built close to the existing ferry service between Rødby and Puttgarden. As a basis for traffic expectations on the Fixed Link, it is therefore natural to consider the historical traffic trends between Rødby and Puttgarden. This chapter also touches on the total traffic trends in the region (the western Baltic) and in Denmark in general. Finally, the historical experience from the Great Belt and Øresund will be presented where the opening of the fixed links has resulted in changes in regional traffic patterns.

Over the past 40 years, overall road traffic across the Fehmarnbelt has grown by an average of 3.4 per cent per year. Passenger car traffic, which historically speaking has accounted for the majority of the traffic across the Fehmarnbelt, has increased by an average of 3.0 per cent per year, while lorry traffic has increased by an average of 5.6 per cent per year.

From a historical perspective, there has been a close relationship between traffic trends throughout Denmark and trends in economic growth. Between 1970 and 2011, total road use\(^3\) increased by an average of 1.8 per cent per year, while the GDP per inhabitant grew by 1.9 per cent per year.\(^4\)

Traffic growth across national borders is typically higher than the growth in GDP. This is linked to the fact that international trade has been increasing over the past many decades. With average annual traffic growth of 3.4 per cent, historically, traffic across Rødby-Puttgarden has grown significantly faster than GDP and road use in Denmark as a whole.

**KEY FIGURES IN HISTORICAL DEVELOPMENT**

- Road traffic (passenger cars, coaches and lorries) across the Fehmarnbelt for the period 1973-2013 grew by an average of 3.4 per cent per year.
- Passenger car traffic across the Fehmarnbelt grew by an average of 3 per cent per year in the same period.
- Lorry traffic has grown by an average of 5.6 per cent per year over the period. Consequently, over the years, lorries are accounting for a greater proportion of the total traffic across the belt. Today they account for 20 per cent.
- The Rødby-Puttgarden service has a market share of 44 per cent of the total traffic in the western Baltic.

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\(^3\) Road use means the distance driven by vehicles on the road and reflects the total number of kilometres driven in Denmark as a whole.

2.2. The historical Rødby-Puttgarden traffic trends

The ferry link between Rødby and Puttgarden opened in 1963 as the “Fugleflugtslinie” (literally: bird flight line) which was a central component of an overall plan to create a more direct transport route between Scandinavia and the European continent. Historically, the route has had a strong position in the competition for customers in the western Baltic and is now the largest ferry service in the region. In 2013, Rødby-Puttgarden had a market share of 44 per cent of the total number of vehicles transported on the ferries between southern Scandinavia and the northern part of continental Europe.5

Jutland is another important corridor through Denmark for the transport of freight and people between Scandinavia and the continent. When estimated in terms of the number of vehicles, the border in Jutland is the largest link between Scandinavia and Germany. More than 18 million vehicles (passenger cars, lorries and coaches) cross the Danish-German border per year. This corresponds to an average of almost 50,000 vehicles a day.

In the future, both the Fehmarnbelt link and the Jutland corridor will be central corridors for land-based transport. They supplement each other and together contribute towards Denmark and the rest of Scandinavia having central transport links to and from the continent.

Figure 2.1: Map of the corridor through Denmark

![Map of the corridor through Denmark](image)


Historically, there has been a large increase in transport demand between Scandinavia and Europe, which has resulted in a constant need for the development of infrastructure in terms of rail, road, airports and ports.

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6Source: Data supplied by the Danish Road Directorate number of vehicles in 2013
Up to 2035, i.e. in the next 20 years, a 45 per cent rise in the economy (GDP) is expected in the countries surrounding the western Baltic. GDP in Norway, Sweden, Denmark, Poland and Germany will therefore grow by 50 per cent in two decades. For the whole EU-27, a similar picture is apparent. Up to 2030, GDP in Europe is expected to grow by 30 per cent.

Based on historical development, cross-border trade can be expected to grow faster than growth in the individual countries’ GDP. This expectation underlines the need to expand the infrastructure in the future.

In other words, there will be an ever growing need to service the increased traffic resulting from the growing economies. At the same time, the expansion of the infrastructure will help to create the prerequisites for further growth. There will, therefore, be a need to develop the total capacity of the infrastructure across the Baltic Sea, i.e. the Swedish Polish/German corridor and the three corridors down through both eastern and western Denmark. Moreover, there will also be a need for development and continuing investment in roads, railways, airports and ports to ensure cohesion and flexible transport in this part of Europe.

In the light of this, the Fixed Link across the Fehmarnbelt should be considered part of the continued expansion of the total network.
Figure 2.2: Total expected GDP growth for Denmark, Sweden, Norway, Poland and Germany as well as the EU-27 from 2010 to 2035


2.2.1. Overall trends in traffic development for Rødby-Puttgarden

Figure 2.3 below shows the historical traffic development for passenger cars, coaches and lorries for Rødby-Puttgarden from 1963 to 2013. It is evident from the figure that traffic has grown significantly since the route opened and until the present day. Over the past 40 years⁸ – between 1973 and 2013 – total road traffic on the route grew by an average of 3.4 per cent per year. The overall trends with increasing traffic volumes have been interrupted by periods of declining traffic. Historically, the route has been characterised by periods of low traffic growth being replaced by new periods of high traffic growth and a relatively higher traffic level compared with previously.

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⁷ The calculation of the total development in GDP for Denmark, Norway, Poland, Sweden and Germany was based on data from the OECD Database, dataset: Economic Outlook No 95 - May 2014 - Long-term baseline projections. The starting point was the estimated growth in absolute figures for the five countries. The growth was subsequently converted to index figures. The projection of GDP for EU-27 is based on data from the report The Global Economy in 2030: Trends and Strategies for Europe page 79, prepared by the Centre for European Policy Studies (CEPS). For EU-27, the expected growth in GDP in sub-periods is used to extrapolate data from 2010.

⁸ In the estimation of the average annual traffic growth, the first ten years from 1963-1973 have been removed to provide a true and fair picture of traffic developments.
Traffic volumes fell in the years after the financial crisis began in 2008. The same applies to other ferry services and fixed links, but traffic on Rødby-Puttgarden has fallen more than on other routes in the area. This could be linked to toll developments over the period. Freight traffic on the route between Rødby and Puttgarden began to stabilise again and grew from 2009 onwards. In 2013, the number of lorries using the Rødby-Puttgarden ferry service was higher than before the financial crisis. Passenger car traffic has begun to stabilise and in the first months of 2014, traffic grew compared with the same months the year before.\(^9\) In 2013, daily traffic on the route comprised 5,361 vehicles, i.e. 1,067 lorries, 4,216 passenger cars and 79 coaches.

### 2.2.2. Traffic composition for Rødby-Puttgarden

Rødby-Puttgarden traffic comprises business travellers, holidaymakers and freight traffic distributed across passenger cars, coaches, walk-on passengers, passenger trains, vans and lorries. There is no freight traffic on the Rødby-Puttgarden railway today. Passenger cars comprise by far the majority of traffic on the Rødby-Puttgarden ferry service while lorry traffic comprises about 20 per cent of traffic and coaches 1 per cent.

However, the historical trends show lorries and thereby freight traffic comprising an increasing share of the traffic on the route. The lorries’ share of the traffic has therefore grown significantly over the years. In 1973, lorry traffic comprised 8 per cent of the total traffic on the route while in 2013 it grew to 20 per cent.

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\(^9\)Prepared on the basis of extracts from Shippax’ “Cruise and Ferry database” and Statistics Denmark’s “statistics bank, table: SKIB32”
cent. As the tolls for lorries are somewhat higher than the tolls for passenger cars, lorries currently comprise an important source of revenue. Revenue from lorries comprises significantly more than 20 per cent. See section 2.2.5 for more information on freight trends at Rødby-Puttgarden.

Figure 2.4 shows the composition of Rødby-Puttgarden traffic distributed across passenger cars, lorries and coaches in 1973 and 2013, respectively.

**Figure 2.4: Traffic composition for Rødby-Puttgarden in 1973 (left) and 2013 (right)**

![Traffic composition diagrams for 1973 and 2013](source)


### 2.2.3. Development in passenger traffic

Altogether, the Rødby-Puttgarden ferry carries an average of 16,000 passengers across the Fehmarnbelt every day. Over the past 40 years, passenger traffic has grown by an average of 3.0 per cent per year. The number of passenger cars has therefore more than quadrupled over the period.

The long-term growth trends in passenger traffic on the route have been driven by a number of factors. Generally increased prosperity in Denmark, Germany and Sweden has, in part, generated a growing number of cars and new travel patterns in the three countries. Figure 2.5 below shows the development in consumer spending in the three countries indexed with 2000 as the index year.
Figure 2.5: Household consumption in Denmark, Sweden and Germany (Index estimation, constant prices, index year = 2000)

Car ownership in the three countries has been increasing. In 1991, there were 310 cars per 1,000 inhabitants in Denmark, 393 in Germany and 421 in Sweden. In 2008, the number of cars per 1,000 inhabitants rose to 468 in Denmark, 504 in Germany and 462 in Sweden.¹⁰

In addition to the economic development and trends in car ownership, the establishment of new infrastructure in the corridor has helped to drive traffic growth between Rødby-Puttgarden. When the Øresund link opened, Sweden’s access to Denmark was significantly improved and Sweden thereby gained faster access to the European continent. In the years immediately following the opening of the Øresund link in 2000, Rødby-Puttgarden experienced higher growth. Similarly, it is expected that the opening of a fixed link across the Fehmarnbelt will have a positive effect on traffic on the Øresund link. Forecasts show that the Fehmarnbelt Fixed Link will contribute an extra 1,000 passengers a day to the Øresund link in 2025.¹¹

Major infrastructure expansion projects are set to take place in Europe. The European Commission has an ambitious project to improve connections within Europe through a cohesive transport network – the TEN-T network. The Fixed Link is a part of the European TEN-T network, the link is the part of the

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¹⁰ Source: Eurostat, table: “Final consumption expenditure of households” extracted on 18 June 2014

¹¹ Source: Øresundsbron, “Øresundsbron og regionen 2013” (The Øresund bridge and the region 2013)
north/south-bound corridor connecting Scandinavia with the Mediterranean. In this corridor, the infrastructure is being expanded and transport bottlenecks removed.

In the report “Fehmarnbelt Forecast 2014” the travel objective for passengers on the Rødby-Puttgarden ferry was estimated in 2011. Here it appears that e.g. 19 per cent of passengers had a business or commuting objective and that 23 per cent were holidaymakers. Furthermore, approximately 20 per cent of the traffic in 2013 comprised lorries.12

2.2.4. Trends in coaches, trains and other passengers on Rødby-Puttgarden

In addition to passenger cars, the Rødby-Puttgarden ferries carried an average of 79 coaches a day across the belt in 2013. In addition, there are the walk-on passengers and passengers on the international trains between Germany and Denmark. Every day, an average of almost 1,000 train passengers from all over Europe board the ferry.13

The number of train passengers across the Fehmarnbelt has remained largely constant over the past 13 years. Figure 2.6 below shows the relatively stable development in the number of train passengers on Rødby-Puttgarden from 2000 to 2013.

Figure 2.6: Trends in the number of train passengers on Rødby-Puttgarden, 2000-2013

Source: Data supplied by DSB 1 July 2014

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12“Fehmarnbelt Forecast 2014”, Intraplan and BVU
13Data supplied by DSB 1 July 2014
This trend is different to the trend across Øresund in particular, where the number of train passengers has grown significantly over the same period. On the Øresund link, rail passenger traffic has doubled over the last 10 years and set a new record in 2013 with almost 11.5 million passengers. This corresponds to 31,600 rail passengers a day by train across the Øresund. Also on the Great Belt link, the number of train passengers has risen in the past 13 years.

Figure 2.7 shows the trend in rail passengers on Rødby-Puttgarden compared with the number of rail passengers across the Great Belt, from 1996, when the railway section opened, to 2013 and across the Øresund from 2000, when the Øresund link opened, to 2013.

*Figure 2.7: Trend in the number of rail passengers on Rødby-Puttgarden, the Great Belt and Øresund, 1996-2013*

Source: Statistics Denmark, table: Bane 21 (Line 21)

Note: No data is available for Rødby-Puttgarden from before 2000

### 2.2.5. Trends in freight traffic on Rødby-Puttgarden

Although passenger traffic continues to comprise the majority of Rødby-Puttgarden traffic, lorry traffic has increased in importance on the route. In the past 40 years, the number of lorries has risen by an average of 5.6 per cent annually, which corresponds to the fact that the number of lorries transported across the Fehmarnbelt has increased ninefold since 1973, cf. figure 2.8. In the first nine months of 2014, lorry traffic rose by 6 per cent compared with the same period last year.

The trend in freight traffic has been driven by increased international work distribution and increasing trade between the European countries. Since opening, the ferry service between Rødby and Puttgarden has been a central trade route between Scandinavia and Continental Europe.
Trade between Denmark and Sweden on the one side and Germany on the other has been increasing over the past 22 years. Germany is now the largest trade partner for both Denmark and Sweden while Scandinavia as a whole is Germany’s eighth-largest trading partner.

**Figure 2.8: Trend in the number of lorries and their share of the total traffic on Rødby-Puttgarden, 1963-2013**

![Graph showing trend in the number of lorries and their share of the total traffic on Rødby-Puttgarden, 1963-2013.]


In addition to the German, Danish and Swedish freight traffic on the route, Rødby-Puttgarden is another important link for international freight transport in a wider sense. According to a study completed by Terraplan in 2010, much of the freight traffic on the route is transit traffic between Sweden and the rest of Europe.

### 2.3. Traffic trends in the western Baltic

The link between Røaby and Puttgarden is part of a larger network of ferry routes in the western Baltic linking central cities and ports in Sweden, Denmark, Germany and Poland. Passenger cars and coach traffic on the ferries throughout the entire corridor comprised 61 per cent of the total road traffic in 2013, while lorry traffic comprised 39 per cent. Jutland is the main artery between Scandinavia and Germany, and if the national border is included, a daily average of 62,000 vehicles drives between southern Scandinavia and Germany. 80 per cent of these 62,000 vehicles drive across the border in Jutland.
Historically, traffic in the western Baltic has been increasing. Freight traffic in the corridor is largely international and characterised by international trade. The ferry routes in the western Baltic serve the markets with which the Scandinavian countries trade most in central Europe. International trade between countries has been increasing, and this indicates that the trend will continue. This increases the need for good traffic links so that the goods can be transported between the trading countries.

Continued European integration and EU expansion to the East has increased the importance of the Fehmarnbelt as a transport corridor. Today, 12,000 vehicles are transported across the western Baltic every day. They sail between various cities and ports in southern Scandinavia (Denmark and Sweden) and northern Continental Europe (Germany and Poland). The commercial ferry routes in the western Baltic and their traffic volumes are listed in table 2.1.
Table 2.1: Average number of vehicles a day on the ferry routes in the western Baltic, 2013

<table>
<thead>
<tr>
<th>Route</th>
<th>Passenger cars</th>
<th>Lorries</th>
<th>Coaches</th>
<th>Vehicles in total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rødby-Puttgarden</td>
<td>4,216</td>
<td>1,067</td>
<td>79</td>
<td>5,361</td>
</tr>
<tr>
<td>Ystad-Swinoujscie</td>
<td>510</td>
<td>536</td>
<td>3</td>
<td>1,049</td>
</tr>
<tr>
<td>Trelleborg-Rostock</td>
<td>280</td>
<td>676</td>
<td>4</td>
<td>960</td>
</tr>
<tr>
<td>Gedser-Rostock</td>
<td>678</td>
<td>250</td>
<td>32</td>
<td>956</td>
</tr>
<tr>
<td>Trelleborg-Travemünde</td>
<td>135</td>
<td>569</td>
<td>4</td>
<td>708</td>
</tr>
<tr>
<td>Malmö-Travemünde</td>
<td>63</td>
<td>626</td>
<td>0</td>
<td>689</td>
</tr>
<tr>
<td>Trelleborg-Sassnitz</td>
<td>470</td>
<td>74</td>
<td>3</td>
<td>547</td>
</tr>
<tr>
<td>Karlskrona-Gdynia</td>
<td>255</td>
<td>282</td>
<td>3</td>
<td>540</td>
</tr>
<tr>
<td>Gothenburg-Kiel</td>
<td>264</td>
<td>221</td>
<td>4</td>
<td>489</td>
</tr>
<tr>
<td>Swinoujscie-Trelleborg</td>
<td>24</td>
<td>323</td>
<td>0</td>
<td>348</td>
</tr>
<tr>
<td>Oslo-Kiel</td>
<td>204</td>
<td>96</td>
<td>3</td>
<td>303</td>
</tr>
<tr>
<td>Nynäshamn-Gdansk</td>
<td>111</td>
<td>25</td>
<td>1</td>
<td>138</td>
</tr>
</tbody>
</table>

Source: Prepared on the basis of extracts from Shippax’ “Cruise and Ferry database” and Statistics Denmark’s table: SKIB32

The Rødby-Puttgarden route is by far the largest of the ferry routes in the corridor, as shown in table 2.1. In 2013, Rødby-Puttgarden had a market share of 44 per cent of the total number of vehicles throughout the western Baltic. In 2013, the Danish-German ferry routes, Gedser-Rostock and Rødby-Puttgarden, had a market share totalling 52 per cent of the total traffic and a total of 67 per cent of the total passenger car transport on the ferry routes in the western Baltic. The Swedish ferry routes carry freight to a greater extent, with a higher proportion of lorries, but the proportion of lorries on the Rødby-Puttgarden route has grown significantly over the past 40 years.

Figure 2.10 Market distribution between the existing ferry routes in the western Baltic in 2013

Source: Prepared on the basis of extracts from Shippax’ “Cruise and Ferry database” and Statistics Denmark’s table: SKIB32
The western Baltic is a central European trade route, and an average of approx.
5,000 lorries a day are transported through the western Baltic. The ferry routes are characterised by international freight traffic from all over Europe.

As a transport corridor, the western Baltic is, however, surpassed by the border in Jutland, which, measured in the number of vehicles, is by far the largest link between Scandinavia and Germany. More than 18 million vehicles\textsuperscript{14} (passenger cars, lorries, coaches) cross the Danish-German border annually corresponding to almost 50,000 vehicles a day.

The opening of the Great Belt link, which connected eastern Denmark to mainland Europe, meant that the Jutland corridor became a more significant transport corridor. The same applied when the Øresund link connected Sweden by land with Denmark. Today, railway traffic in transit between Scandinavia and Continental Europe drives an extra 160 kilometres across the Great Belt instead of driving directly across the Fehmarnbelt.

The opening of the Fixed Link across the Fehmarnbelt can be expected to change market shares in relation to the traffic situation on the ferries in the western Baltic today. There is a potential for transferring freight by lorry from the Swedish-German routes to the Danish-German links as well as an opportunity for transferring freight from lorries between Sweden and Germany/Poland to the railway that runs via Denmark.

As chapter 3 will show, in relation to this potential, growth rates in Danish imports and exports are expected to increase in the years to come.

2.4. The relationship between traffic and economics

Historically, traffic trends in Denmark have been closely related to economic development measured in growth in GDP.\textsuperscript{15} Viewed over the whole period from 1970 to 2011, the GDP per inhabitant grew by an average of 1.9 per cent per year while road use\textsuperscript{16} in the same period grew by an average of 1.8 per cent per year.\textsuperscript{17}

2.4.1. Trends in road traffic in Denmark

Figure 2.11 shows the trend in road use (number of kilometres driven) for all vehicles compared with the trend in the Danish GDP in fixed prices. As can be seen, road use and GDP have developed somewhat in parallel. Historically, there has been a direct relationship between traffic and socio-economic growth.

\textsuperscript{14}Data sent from the Danish Road Directorate

\textsuperscript{15}The relationship is documented, inter alia, in the Danish Ministry of Transport’s memo “BNP og trafikvækst – centrale udviklingsstendenser” (GDP and traffic growth – central development trends) prepared by COWI, 2013, and in the memo “Sammenhængen mellem økonomisk vækst og trafikvækst – en undersøgelse af mulige ændringer i fremtiden” (The relationship between economic growth and traffic growth – a study of possible changes in the future) which was prepared by CEBR at CBS, 2014.

\textsuperscript{16}Road use means vehicle kilometres and reflects the trend in the number of kilometres driven in total in Denmark

\textsuperscript{17}“BNP og trafikvækst – centrale udviklingsstendenser”, (GDP and traffic growth – central development trends) COWI for the Danish Ministry of Transport, 2013
The relationship between economic and traffic growth can also be identified when considering traffic trends across the Fehmarnbelt in particular. As the Fehmarnbelt is an international transport corridor, Danish economic development as well as prosperity in the other countries surrounding the Belt are of importance in terms of traffic trends. Figure 2.11 shows the indexed economic development in Denmark, Sweden and Germany respectively, compared with the traffic trend for the Rødbj-Puttgarden crossing from 1973 to 2013.

**Figure 2.11: Economic development in Denmark, Sweden and Germany as well as traffic trends for Rødby-Puttgarden (Index estimation, constant prices, index year 2000 = 100)**

![Image](image-url)

Source: Prepared on the basis of extracts from Eurostat table: Gross domestic product at constant prices (index 2000=100), Shippax “Cruise and Ferry database”

While the Danish GDP has increased by an average of 1.6 per cent per year over the past 40 years, the Swedish economy has grown by an average of 2.1 per cent per year over the same period. Since reunification, Germany’s GDP has grown by an average of 1.3 per cent per year. As is evident from the indexed development shown above, traffic growth across the Fehmarnbelt since 2000 was higher than the growth in GDP in the three countries.

Another important factor in terms of the traffic trends across the Fehmarnbelt is the development in international trade. The Fixed Link across the Fehmarnbelt will be largely a link for freight transport. When a great deal of trade occurs between countries, more goods need to be transported and freight traffic therefore increases.

Historically, global trade has grown more than GDP. There has been an increase in global trade, which is approximately twice the rate of the growth in global GDP. The average annual growth in global trade
was 5.3 per cent over the past 20 years before the financial crisis.\textsuperscript{18} For Denmark, international trade for various periods has been more than twice the rate of the growth in GDP.

See chapter 3 for a more detailed assessment of the outlook for long-term economic development following the financial crisis.

\textit{2.4.2. Trends in railway traffic}

Trends in railway traffic are related to a lesser extent to GDP development and depend more on the development of Danish infrastructure. The establishment of the fixed links across the Great Belt and Øresund has significantly boosted passenger transport on the railway. As described earlier, the number of train passengers across the Øresund has increased tenfold since the opening of the Øresund fixed link and the Great Belt link has also resulted in the Danes taking more domestic journeys by train.\textsuperscript{19}

Danish rail freight has declined significantly since the discontinuation of DSB Gods in 2000. However, in recent years, the volume of rail freight has increased once again driven primarily by transit goods crossing Denmark en route to Sweden and Continental Europe. Developments in rail freight traffic in Denmark thus reflect to a greater extent the economic and infrastructural factors in Sweden and Germany in particular.\textsuperscript{20}

\textsuperscript{18}``Sammenhæng mellem økonomisk vækst og trafikvækst'' (The relationship between economic growth and traffic growth), CEBR 2014

\textsuperscript{19}Statistics Denmark, statistics bank, table: Bane21 (Line 21), data supplied by Øresundsbron

\textsuperscript{20}``BNP og trafikvækst – centrale udviklingstendenser'', (GDP and traffic growth – central development trends) COWI for the Danish Ministry of Transport, 2013
As is shown in the chart, national and international freight traffic on the railways in Denmark has fallen since the turn of the millennium. During the same period, transit traffic by rail freight has risen significantly.

2.5. The effect of fixed links: experience from the Great Belt and Øresund

Experience from the opening of the fixed links across the Great Belt and Øresund in 1998 and 2000 respectively show that traffic volumes grow considerably when a bridge or tunnel replace a ferry crossing. In the first years following the opening of the Øresund fixed link, total traffic across Øresund increased by over 60 per cent\(^1\), while the opening of the Great Belt link resulted in a 127 per cent increase in traffic across the Great Belt.\(^2\)

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\(^1\)“Positive erfaringer fra Øresund” (Positive experience from the Øresund), memo from the Danish Ministry of Transport, 2006

\(^2\)“Positive erfaringer fra Storebælt” (Positive experience from the Great Belt), memo from the Danish Ministry of Transport, 2006
These ‘traffic jumps’ are related to the new opportunities offered by the Fixed Link in the form of shorter travel times, increased availability, smoother traffic flow and increased flexibility. At the same time, the fixed links have demonstrated their importance to economic development in the region.\(^\text{23}\)

Traffic jumps are defined partly as new traffic arising from the establishment of new infrastructure and partly as a result of traffic switching from other transport routes due to improved availability and travel times. New traffic is generated when new travel opportunities, such as those provided by fixed links, encourage people who would not otherwise have travelled – not even by other transport modes or via other transport routes – to travel. Fixed links also typically change traffic patterns and have the potential to change the choice of route and transport mode, also termed the modal split. Modal split is a term for how traffic volumes (passengers and freight) are divided according to different transport modes, i.e. the proportion of the car traffic as opposed to the proportion of train traffic etc. In the remainder of the report, this is termed choice of transport mode.

Before the Great Belt link opened in June 1998, over 8,000 vehicles crossed the Great Belt every day. Immediately after the opening, traffic rose to approximately 18,500 vehicles a day. This corresponds to a traffic jump of 127 per cent. The average daily traffic is now almost 30,000 vehicles. Some of the 127 per cent is traffic transferred from the ferry routes farther away than the ferry route Korsør-Nyborg, from the link or from air traffic. At the same time, the Great Belt link resulted in changes to Danish travel patterns. Domestic journeys by car, coach and train rose and more people used public transport. However, the number of domestic flights almost halved during the period 1996-2007.

The opening of the Øresund link in 2000 resulted in a traffic jump of over 60 per cent when traffic, including the Elsinore-Helsingborg crossing, is included in the calculation. After a rather cautious start, actual traffic on the Øresund link is now higher than the level expected in the traffic forecast prepared before the Øresund link opened. The slightly slower start has been fully compensated for and now over 18,000 vehicles cross the link on a daily basis.\(^\text{24}\)

At the same time, the Øresund link considerably strengthened freight traffic on the railway. Between 2001 and 2009, the volume of rail freight increased by an average of 5 per cent per year. This means that total rail freight transport has almost doubled since 2001. Freight traffic across the Great Belt was strengthened by the opening of the Øresund link. When the Øresund link opened in 2000, transit freight trains were able to operate directly between Sweden and Germany. 80 per cent of the freight transported across the Great Belt comprises transit goods.\(^\text{25}\) Today, transit goods by rail are forced to make a 160 km detour across the Great Belt instead of taking the direct route across the Fehmarnbelt. Freight trains may not use the Rødby-Puttgarden ferry crossing.

\(^{23}\)“Effekter af faste forbindelser – casestudier fra Storebælt og Øresund” (Effects of fixed links – case studies from the Great Belt and Øresund), Andresen Analyse, 2013

\(^{24}\)Prepared based on extracts from Shippax’ “Cruise and Ferry database”

\(^{25}\)“Ex post samfundsøkonomisk analyse af Storebæltsforbindelsen, Transportministeriet og Sund & Bælt 2014” (Ex post socio-economic analysis of the Great Belt link, the Danish Ministry of Transport and Sound and Bell 2014)
A socio-economic analysis of the Great Belt demonstrates its economic benefits. Over a period of 50 years, the Great Belt link will yield Danish society DKK 379 billion. The investment in the Great Belt link will thus provide a socio-economic return of 14 per cent per year.26

Figure 2.13 below shows traffic developments on the Great Belt and Øresund from 1996 (before the fixed links opened) compared with traffic developments between Rødby-Puttgarden. As shown, the fixed links across the Great Belt and Øresund have generated significant traffic growth on these routes, while traffic across Rødby-Puttgarden shows a more modest trend. By 2013, traffic across the Great Belt had increased almost fourfold while traffic across the Øresund had seen a threefold increase compared with the year before the opening of the two fixed links.

**Figure 2.13: Traffic trends for the Great Belt, Øresund and Rødby-Puttgarden, 1996-2013**

Source: Prepared on the basis of extracts from Shippax’ “Cruise and Ferry database” and Statistics Denmark’s statistics bank, table: SKIB32

*Note: The comparison shows traffic trends for the Great Belt link (before 1998 ferry services between Halskov and Korsør-Nyborg), the Øresund link (before 2000 ferry services between Elsinore and Helsingborg, and Dragør-Limhamn) and Rødby-Puttgarden.

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26 "Ex post samfundsøkonomisk analyse af Storebæltsforbindelsen, Transportministeriet og Sund & Bælt 2014" (Ex post socio-economic analysis of the Great Belt link, the Danish Ministry of Transport and Sound and Belt 2014)
To a large extent, the Fehmarnbelt link stands as an international transport corridor that is increasingly characterised by business traffic between Sweden, Norway and eastern Denmark and Continental Europe. International trade between Scandinavia and Continental Europe can, therefore, be expected to impact on traffic across the Fehmarnbelt link.

Moreover, the trend in rail traffic on the existing fixed links indicates untapped potential in the transport corridor across the Fehmarnbelt. The opening of the fixed links across the Øresund and Great Belt over the past ten years has resulted in significant increases in both passenger and freight traffic on the railway, including transit goods between Sweden and Germany. On the railway across the Fehmarnbelt, passenger trends have remained largely unchanged however.

2.6. Summary: Trends in traffic development

- Between 1973 and 2013, road traffic on the ferry service between Rødby and Puttgarden grew by an average of 3.4 per cent per year. Rødby-Puttgarden traffic thereby increased significantly more than traffic in Denmark generally, where annual road use grew by 1.8 per cent from 1970-2011.

- The percentage of lorries on the ferry service increased from 9 per cent in 1973 to 20 per cent in 2013. The growing lorry traffic on the route shows that the transport corridor across the Fehmarnbelt is increasingly becoming a corridor for the business community.

- An important exception, however, is rail traffic on the route. Here, developments have been characterised by rather low passenger growth while no freight at all is transported on the railway. The modest development in Rødby-Puttgarden train traffic stands in marked contrast to train traffic in the rest of Denmark. In particular, the link across Øresund has generated significant growth in rail traffic and has resulted in an additional boost for the transportation of transit goods through Denmark.

- Rødby-Puttgarden is part of the larger traffic corridor in the western Baltic, which has also experienced increasing traffic over the years. Growth in traffic has been driven by the economic development in the countries around the Fehmarnbelt and by increased international trade.

- The Rødby-Puttgarden crossing now has a market share of 44 per cent of the total vehicular traffic in the western Baltic. The high market share, combined with traffic growth over the past 40 years, shows that the geographical position of the Fehmarnbelt crossing makes it highly competitive as regards other transport routes in the western Baltic.
3. Expectations for economic development following the financial crisis

3.1. Introduction and main conclusions

3.1.1. Introduction

GDP growth is a reflection of general economic growth in society and is the driving force for trade and consumer spending, which are both important for traffic. In the overall forecast for traffic trends for the forthcoming Fehmarnbelt link, the prospects for future economic growth in Denmark and in the other countries around the Fehmarnbelt corridor should, therefore, be determined. As the Fehmarnbelt link is an international transport corridor for both freight and passengers, trends in international trade in the countries around the Fehmarnbelt corridor are also expected to have a major impact on traffic. In addition, developments in consumer spending will have an impact on traffic on the link due to the relationship between consumer spending and travel habits.

This chapter sets out expectations for developments in economic growth, measured in GDP, in international trade and in consumer spending in Denmark and the other countries around the Fehmarnbelt corridor from the Ministry of Economic and Business Affairs in Denmark, the OECD and the Economic Council. GDP growth, international trade and consumer spending are the three macro-economic variables expected to be the most important macro-economic drivers for traffic trends between Scandinavia and Continental Europe and therefore for traffic trends for a Fehmarnbelt Fixed Link.

Reference is made to the report “Sammenhæng mellem økonomisk vækst og trafikvækst” (Relationship between economic growth and traffic growth), CEBR at CBS, October 2014.

3.1.2. Main conclusions

• Historically, there has been a link between economic growth and traffic trends. The Centre for Economic and Business Research at Copenhagen Business School states in the report “Sammenhængen mellem økonomisk vækst og trafikvækst – en undersøgelse af mulige ændringer i fremtiden” (Relationship between economic growth and traffic growth – a study of possible changes in the future), 2014, that historically there has been a close empirical relationship between overall economic growth (measured in GDP) and traffic growth. COWI reached the same conclusion in the report “BNP og trafikvækst – centrale udviklingstendenser” (GDP and traffic growth – central development trends), 2013. In the short term, there can, of course, be deviations from this link.

• Both the OECD and the Economic Council conclude that the global economy is about to recover after the financial and economic crises in 2008. After a number of years of low or negative growth, both institutions now expect that economic activity in Denmark and the other relevant countries will return to a form of normality with positive economic growth.

• There are few forecasts for long-term development in the economy. The OECD’s forecasts for long-term economic growth up to 2030 and 2060 show the prospect of new global economic growth albeit at a slightly lower level than before the financial crisis. The OECD’s forecast shows a return to economic trend growth in Denmark, Sweden and Germany.

• In its latest analysis of market conditions in the Danish economy, TEC estimates that Denmark’s GDP will grow up to 2020. The Council estimates a growth rate of 1.4 per cent in 2014, 2.0 per cent in 2015 and 2.5 per cent per year for the period 2016-2020.
• TEC also expects growth rates for the development in Danish imports and exports as well as consumer spending in Denmark to increase up to 2020 as a result of increased prosperity.

• Expectations for renewed growth are also evident in the most recent version of Denmark’s Convergence Programme. Here, the Danish Ministry of Economic and Business Affairs concludes, based on figures from Statistics Denmark, that Denmark’s economy is entering a new growth period. The Ministry expects Danish GDP to grow by approx. 1.5 per cent in 2014 and almost 2 per cent in 2015. For the period 2016-2020, average annual growth of 2.0 per cent is expected. In addition, the Convergence Programme estimates that Danish trade with other countries will grow considerably as the Eurozone economy improves. Consumer spending is also expected to grow up to 2020.

• The OECD’s long-term forecasts as well as the government’s and TEC’s 2020 forecasts together indicate that the most important macro-economic drivers for traffic across a Fehmarnbelt fixed link are a return to the trend observed before 2008.

3.2. Expectations for economic growth

The OECD’s forecasts for long-term economic development indicate that after a substantial fall in growth during and after the financial crisis, the global economy will return to stable growth up to 2030. However, it is expected that the growth trend will be at a slightly lower level, because of lower growth in the work force than previously.

<table>
<thead>
<tr>
<th>Table 3.1: The OECD’s forecasts for GDP development 2011-2030 and 2030-2060</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong></td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Sweden</td>
</tr>
<tr>
<td>OECD</td>
</tr>
<tr>
<td>The world</td>
</tr>
</tbody>
</table>

Source: “Sammenhæng mellem økonomisk vækst og trafikvækst” (Relationship between economic growth and traffic growth), CEBR, October 2014

The OECD’s forecast shows a long-term growth trend in GDP in Denmark, Germany, Sweden and Norway up to 2030, as shown in table 3.1.

In Denmark, the government states in its Convergence Programme for 2014 that the Danish economy is once again improving. In the light of figures from Statistics Denmark, the Ministry of Economic and Business Affairs in Denmark (MEBAD) has estimated GDP growth of about 1.5 per cent in 2014 and almost 2.0 per cent in 2015. For the period 2016-2020 average annual growth of 2.0 per cent is expected.
Table 3.2: Forecasts Denmark’s GDP development

<table>
<thead>
<tr>
<th>Country</th>
<th>2014</th>
<th>2015</th>
<th>2016-2020 (average annual growth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEC</td>
<td>1.4%</td>
<td>2.0%</td>
<td>2.5%</td>
</tr>
<tr>
<td>MEBAD</td>
<td>1.5%</td>
<td>2.0%</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

Source: Denmark’s Convergence Programme 2014, the Ministry of Economic and Business Affairs, April 2014, page 63 as well as “Sammenhæng mellem økonomisk vækst og trafikvækst” (Relationship between economic growth and traffic growth), CEBR, October 2014

This conclusion is supported by TEC, which in its assessment of Denmark’s economic climate from the spring of 2014 concludes that after some years of stagnation, the Danish economy will now experience new GDP growth. For 2014, TEC estimates growth of around 1.4 per cent, and growth is expected to increase in the coming years to around 2.0 per cent in 2015 and up to 2.4 per cent in 2016. In the slightly longer term, TEC expects average annual growth in Denmark’s GDP to be 2.5 per cent for the period 2016-2020.

As mentioned above, economic growth was, among other things, driven by developments in the size of the workforce. The overall demographic trend in the western world is that the workforce will not grow at the same rate as previously.

According to Statistics Denmark, growth in the Danish workforce will decline until approximately 2033, but will then rise again until around 2040 when growth in the workforce will be higher than it is now.27

3.3. Expectations for developments in international trade up to 2020

In the twenty years prior to the onset of the financial crisis, global trade grew by an average of 5.3 per cent per year. Global trade has, therefore, grown at a rate that is approximately twice the rate of growth in global GDP. However, the financial crisis meant that international trade took an unexpectedly major dive in 2008 and 2009.

However, the forecasts for global trade from a range of leading economic institutions all point to an increase in international trade in 2014 and 2015.

Table 3.3: The TEC forecast for Denmark’s exports and imports 2016-2020

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>4.8%</td>
<td>5.4%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

Source: “Sammenhæng mellem økonomisk vækst og trafikvækst” (Relationship between economic growth and traffic growth), CEBR, October 2014

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27Workforce projections from Statistics Denmark, 2014. The explanation for the growing workforce in the long-term is mainly immigration.
In its long-term forecast, TEC also expects international trade to recover in the same way as growth in the general economy. In its latest assessment of the economic climate, TEC estimates that Danish exports will see annual growth of 4.8 per cent between 2016 and 2020, and that imports will grow by 5.4 per cent in the same period. This should be viewed in relation to TEC’s expectations for annual growth of 2.5 per cent in GDP. In other words, TEC expects international trade to grow twice as fast as GDP in the slightly longer term.

Similarly, the Ministry of Economic and Business Affairs in Denmark concludes that the gradual economic improvement in the Eurozone will result in increasing Danish trade with other countries. It is estimated in the Convergence Programme that Denmark’s total export of goods and services will grow by an average of 5.75 per cent per year over the period 2016-2020, while imports are expected to grow by almost 6.5 per cent per year over the same period.

3.4. Expectations for developments in consumer spending

The main component of passenger traffic across the Fehmarnbelt consists of holiday and leisure traffic between Scandinavia and Continental Europe. It is therefore interesting to look at the prospects for growth in consumer spending.

TEC’s forecast for Danish consumer spending indicates annual growth of 3.2 per cent during the period 2016-2020.

As prosperity and consumer spending are increasing, the historical trend is for luxury goods such as holidays and leisure travel to comprise a larger proportion of overall consumer spending.

<p>| Table 3.4: Forecast for the development in consumer spending and GDP in Denmark for 2016-2020* |
|---------------------------------|---------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th>Country</th>
<th>Annual growth in consumer spending</th>
<th>Annual growth in GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEBAD</td>
<td>“A good 2%”</td>
<td>2.2%</td>
</tr>
<tr>
<td>TEC</td>
<td>3.2%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

Source: “Sammenhæng mellem økonomisk vækst og trafikvækst” (Relationship between economic growth and traffic growth), CEBR 2014, as well as Denmark’s Convergence Programme 2014*, the Ministry of Economic and Business Affairs in Denmark, April 2014

Note: For the Ministry of Economic and Business Affairs in Denmark, consumer spending covers the period 2015-2020. A specific estimate has not been made.

3.5. Summary: Expectations for economic development following the financial crisis

- Both the OECD and TEC expect stable growth in the economy up to 2020 and the OECD’s forecasts also indicate stable growth trends in the economy up to 2030 and 2060.
- At the same time, TEC expects significant growth in Danish exports and imports up to 2020 and an increase in consumer spending up to 2020. Altogether, this indicates that economic development for

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28 Denmark’s Convergence Programme 2014, the Ministry of Economic and Business Affairs in Denmark, April 2014, page 17
three of the most important drivers for traffic on the Fehmarnbelt Fixed Link is a return to the growth trend observed before 2008 albeit at a slightly lower level than previously.

4. **Forecast based on the EU’s Trans-Tools model**

4.1. **Introduction and main conclusions**

4.1.1. **Introduction**

This chapter presents the expectations for traffic trends in the Fehmarnbelt corridor that emerge from the trans-European traffic model Trans-Tools (TENConnect 2). The Trans-Tools model was developed to predict the inter-regional and cross-border traffic trends in the EU. A number of European universities and research institutes are behind the model. The objective of the Trans-Tools model is to strengthen the political basis for decisions by prioritising and planning the EU’s infrastructure projects in the trans-European transport network, TEN-T, by calculating future traffic volumes in selected European traffic corridors.29

The Trans-Tools forecast is based on the results achieved in the TENConnect 2 project with a focus on describing traffic trends in the following ways:

1. The trend in the overall north/south-bound traffic for passengers and goods between Scandinavia and Continental Europe for the period 2005-2030.

2. The specific trend for passengers and goods traffic in the Fehmarnbelt corridor for the period 2005-2030.

In the Trans-Tools forecast, the Fehmarnbelt corridor is defined as the traffic across the Fehmarnbelt (i.e. the Rødby-Puttgarden ferry route and from 2021, the Fehmarnbelt Fixed Link) as well as the Gedser-Rostock ferry service and the Swedish ferry services to Travemünde and Rostock. Traffic in the Fehmarnbelt corridor is therefore part of the total traffic between Scandinavia and Continental Europe. The results in the Trans-Tools forecast can therefore be used to estimate the changes in traffic volumes in the various transport corridors for overall traffic between Scandinavia and Continental Europe.

4.1.2. **Main results in the Trans-Tools forecast**

The Trans-Tools forecast shows overall that there will be growth in the total traffic between Scandinavia and Continental Europe for the period 2005-2030. The forecast also shows that traffic in the Fehmarnbelt corridor will grow relatively more than the total traffic between Scandinavia and Continental Europe by establishing a fixed link across the Fehmarnbelt.

According to the analysis, road traffic with passenger vehicles between Scandinavia and Continental Europe will experience average growth of 1.2 per cent for the period from 2005 to 2030. For lorries, the analysis shows average annual growth of 1.8 per cent between Scandinavia and Continental Europe in the same period.

29TEN-T is the EU term for the EU prioritised trans-national traffic corridors that are intended to link the EU together and strengthen the internal market across national borders. See also the European Commission’s website: [http://ec.europa.eu/transport/themes/infrastructure/index_en.htm](http://ec.europa.eu/transport/themes/infrastructure/index_en.htm).
Specifically for the Fehmarnbelt corridor, the analysis indicates average annual growth of 4.0 per cent in road traffic for passenger vehicles for the period 2005-2030. For lorries, the forecast shows average annual growth of 3.4 per cent in the Fehmarnbelt corridor over the same period.

The Trans-Tools analysis shows that a relatively large share of the total growth in road traffic between Scandinavia and Continental Europe will occur through the Fehmarnbelt corridor via the establishment of a fixed link across the Fehmarnbelt. The Trans-Tools forecast also shows that the establishment of a Fehmarnbelt Fixed Link will lead to a significant redistribution of rail freight from the Great Belt and the border to a new rail link via the Fehmarnbelt link. The forecast therefore indicates that the Fehmarnbelt link will relieve the pressure on the other transport routes between Scandinavia and Continental Europe. The model is described in more detail in Tetraplan’s report on the subject “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), November 2014.

4.2. About the Trans-Tools model

The Trans-Tools model was designed in 2006 based on a trans-European wish to create an analysis tool for predicting traffic volumes in selected European corridors and regions in 2030. The model describes the interaction between passengers and freight traffic and takes into account a number of variables such as the infrastructure network, economy and environment. The transport mode is included.

The objective of the Trans-Tools model is to contribute to the political basis for decision-making when planning and implementing the trans-European transport network, TEN-T. In Denmark, the Øresund Bridge, Great Belt Bridge, Jutland corridor and Fehmarnbelt link are included in the TEN-T-network as part of connecting the motorways in Denmark with the rest of Europe.

The model covers 55 countries, including EU-27 (the model was established before Croatia joined the EU) and the neighbouring countries such as Norway, Switzerland and Russia. The model is also based on 1441 traffic zones as well as a number of external zones. Altogether, the model covers more than 35,000 road sections and 6,000 railway lines.

A number of European universities and research institutes are behind the Trans-Tools model. The original model was launched in 2006 and has since been updated and improved.30

The Trans-Tools model is now used as a tool by the European Commission and as a reference point for the EU’s traffic forecasts. The European Commission has used the model in the impact analysis that forms the basis for the Commission’s White Paper on transport from 2011.

However, the Trans-Tools model also presents a number of known challenges. Because the model is very ambitious, the calculations and results are difficult to comprehend. The model’s application has therefore been limited, and there are challenges concerning the possibilities for identifying errors and omissions in the model as well as assuring the quality of the calculated results. Finally, the model has sometimes delivered results at a level of detail that has been difficult to explain. However, that is not regarded as unusual for such comprehensive models.

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30Tetraplan’s report “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), November 2014, which is the basis for this chapter, is based on version 2.5 (TT25) from 2011.
4.3. About the Trans-Tools forecast “Forventet trafikudvikling i Femern Bælt-korridoren” (Expected traffic trends in the Fehmarnbelt corridor)

The consulting company Tetraplan has used the Trans-Tools model to prepare the report “Forventet trafikudvikling i Femern Bælt-korridoren, November 2014” (Expected traffic trends in the Fehmarnbelt corridor, November 2014).

The report contains the following forecasts, which were prepared based on data from the Trans-Tools model:

1. Trends in overall north/south-bound traffic for passengers and freight between Scandinavia and Continental Europe for the period 2005-2030

2. Specific trends for passenger and freight traffic in the Fehmarnbelt corridor for the period 2005-2030

4.3.1. Fundamental traffic scenarios in the Trans-Tools model

The Trans-Tools model has three fundamental scenarios for traffic trends in the EU up to 2030:

1. The priority project scenario (PP) describes future traffic trends based on the existing infrastructure in Europe and also includes the consequences for traffic trends through the implementation of other infrastructure projects in Europe that have already been approved at political level but not yet implemented.

2. The COMP scenario describes future traffic trends based on an ideal situation where all projects in the Trans-European Transport Network TEN-T are implemented.

3. The CORE scenario is a combination of the two scenarios.

Of these three, the PP scenario represents the most conservative projection, while the COMP scenario as a starting point will reach the largest growth in traffic trends. In the current traffic forecast, the three scenarios in the Trans-Tools forecast will be dealt with as a reflection of a possible sample space for the expected traffic trends. The sample space thus ranges from the PP scenario with the lowest growth rates for traffic trends to the COMP scenario with the highest growth rates for traffic trends.

Overall, there is no significant difference in the results for the three scenarios as far as traffic trends in the Fehmarnbelt corridor are concerned. Therefore, in the following review, only the results of the trends from the base year calculation in 2005 to the CORE scenario in 2030 will be presented.

4.3.2. Prerequisites and assumptions in the Trans-Tools model

The Trans-Tools forecast assumes the establishment of a fixed link across the Fehmarnbelt in all three scenarios. Similarly, the three scenarios are based on the same fundamental assumptions about the demographic and economic development, trends in car ownership as well as types of passenger journeys and groups of products for freight transport. The crucial difference in the three scenarios, and thereby

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31 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014, page 7

32 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014, page 12
the reason for the span in the expected traffic trends, relates exclusively to the scenarios for the development of the other transport infrastructure in Europe.

The technical calculations of the Trans-Tools model are based on a number of realised traffic figures for selected European traffic hubs in 2005. On this basis, the model has estimated the traffic figures for other corridors and traffic sections. Consequently, the Trans-Tools model’s starting point for traffic between Scandinavia and Continental Europe is an estimated expression of traffic in 2005. This also means that the traffic jumps on establishing the Fixed Link or other infrastructure projects have not been explicitly estimated in the model.

In some cases, it is evident that the Trans-Tools model’s calculated traffic figures are higher than the actual realised traffic in 2005. This also means that the Trans-Tools model cannot capture the actual realised trends in traffic volumes for the period 2005-2013. Therefore, there will be a tendency for the Trans-Tools model to overestimate traffic trends up to 2014, as it does not take into account the effect of the financial crisis on traffic trends. However, the use of calculated traffic figures is a common method for preparing traffic forecasts and the Trans-Tools model is now the only trans-European model for calculating the trends in traffic volumes across borders and regions of Europe.

4.4. Trends in total traffic volume between Scandinavia and Continental Europe

The Trans-Tools model’s forecast for overall trends in traffic volumes between Scandinavia and Continental Europe as a whole for the period 2005 to 2030 is reviewed below for passenger vehicles, lorries and freight respectively, on the railway with a fixed Fehmarnbelt link.

The Trans-Tools forecast for road traffic shows average annual growth of 1.2 per cent in the number of passenger vehicles between Scandinavia and Continental Europe for the period 2005-2030 with the establishment of a fixed link across the Fehmarnbelt.33

For lorry traffic, the Trans-Tools model predicts annual growth of 1.8 per cent in the number of lorries between Scandinavia and Continental Europe for the period 2005-2030 as a result of the establishment of a fixed link across the Fehmarnbelt.34

The Trans-Tools model estimates average annual growth of 3.5 per cent in rail freight traffic calculated in tonnes between Scandinavia and Continental Europe with the establishment of a fixed link across the Fehmarnbelt.35

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33 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014, page 7
34 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014, page 8
35 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014, page 8
4.5. Trends in total traffic volumes in the Fehmarnbelt corridor

The following section presents expectations for trends in traffic volumes in the Fehmarnbelt corridor. As above, the trend concerning passenger vehicles, lorries and rail freight for the period 2005 to 2030 has been examined.

Table 4.1: Trends in traffic in the Fehmarnbelt corridor from 2005 to 2030

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Annual average growth in 2005-2030</th>
<th>Percentage who used the Fehmarnbelt corridor in 2005</th>
<th>Percentage who will use the Fehmarnbelt corridor in 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger vehicles</td>
<td>4.0%</td>
<td>18.9%</td>
<td>37.4%</td>
</tr>
<tr>
<td>Lorries</td>
<td>3.4%</td>
<td>33.0%</td>
<td>48.1%</td>
</tr>
<tr>
<td>Rail freight</td>
<td>N/A</td>
<td>0</td>
<td>61.4%</td>
</tr>
</tbody>
</table>

Source: “Forventet trafikudvikling i Femern Bælt-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014

For passenger vehicles in the Fehmarnbelt corridor, the Trans-Tools model shows annual growth of 4.0 per cent in traffic for the period 2005-2030 with the establishment of a fixed link.36

The Trans-Tools model therefore shows higher growth than the average growth in total traffic between Scandinavia and Continental Europe. Overall, this means that while approximately 18.9 per cent of passenger vehicles between Scandinavia and Continental Europe used the Fehmarnbelt corridor in 2005, this percentage will increase to 37.4 per cent in 2030.37

The Trans-Tools model thus shows that the Fixed Link across the Fehmarnbelt will change traffic patterns between Scandinavia and Continental Europe. It is to be expected that a large part of the estimated growth in the number of passenger vehicles will occur as traffic on the Fehmarnbelt Fixed Link.38

The Trans-Tools model estimates average annual growth of 3.4 per cent in lorry traffic in the Fehmarnbelt corridor for the period 2005-2030 with the establishment of a fixed link across the Fehmarnbelt.39

The Trans-Tools model therefore anticipates considerable growth in lorry traffic in the Fehmarnbelt corridor. Also for lorry traffic, growth in the Fehmarnbelt corridor is higher than the average growth in total lorry traffic between Scandinavia and Continental Europe. Consequently, whereas approx. 33 per cent

36 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014
37 This estimation was based on figures in “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014
38 As the Trans-Tools model does not specifically view the trends across the Fehmarnbelt, it cannot be ruled out that the growth in the corridor will be driven by the trends in the other transport routes in the Fehmarnbelt corridor
39 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014
of lorry traffic between Scandinavia and Continental Europe used the Fehmarnbelt corridor in 2005, this proportion will increase to 48.1 per cent in 2030.40

As is the case for road traffic comprising passenger vehicles, it is to be expected that a large proportion of the estimated growth in lorry traffic will have an impact on the Fehmarnbelt Fixed Link. However, as a starting point, it cannot be ruled out that some of the growth in lorry traffic could also be related to the other transport routes in the Fehmarnbelt corridor.41

The Trans-Tools model’s expectations for overall growth in the number of lorries between Scandinavia and Continental Europe mean that, despite the expected growth in trends in lorry traffic in the Fehmarnbelt corridor, annual growth of 0.7 per cent in the number of lorries crossing the border between Germany and Denmark will occur up to 2030.

The Trans-Tools model is based on the fact that no rail freight is currently transported via the Fehmarnbelt corridor, but with the establishment of a fixed link, the model predicts that 32,670 tonnes per day will be transported by rail via the Fehmarnbelt corridor in 2030.42 The Trans-Tools forecast therefore shows that 61.4 per cent of the total rail freight traffic between Scandinavia and Continental Europe in 2030 will occur via the Fehmarnbelt corridor and a significant proportion should be expected to travel via the Fixed Link across the Fehmarnbelt.

4.6. Summary: Forecast based on the Trans-Tools model

• The overall conclusion in the Trans-Tools analysis is that there will be general growth in overall traffic volumes between Scandinavia and Continental Europe between 2005 and 2030.

• In the same period, the Fehmarnbelt corridor, defined as the Fehmarnbelt Fixed Link as well as the Gedser-Rostock ferry and the ferries between Sweden and Germany, will experience significantly higher traffic growth. For road traffic comprising passenger vehicles, average annual growth of 4.0 per cent is expected in the Fehmarnbelt corridor from 2005 to 2030. For lorry traffic in the Fehmarnbelt corridor, average growth of 3.4 per cent is expected in the Fehmarnbelt corridor from 2005 to 2030.

• The model estimates that 61.4 per cent of the total rail freight traffic between Scandinavia and Continental Europe in 2030 will occur via the Fixed Link.

• Traffic growth in the Fehmarnbelt corridor is thereby relatively higher than the total traffic growth between Scandinavia and Continental Europe. Therefore, the Fehmarnbelt corridor’s proportion of total traffic between Scandinavia and Continental Europe will rise up to 2030.

40 This estimation was based on figures in the “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014

41 “Forventet trafikudvikling i Femern korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014

42 “Forventet trafikudvikling i Femern-korridoren” (Expected traffic trends in the Fehmarnbelt corridor), Tetraplan, November 2014, page 8
The Trans-Tools forecast shows that a fixed Fehmarnbelt link will take a large proportion of the future traffic growth between Scandinavia and Continental Europe due to the benefits a fixed link offers in terms of time saved and increased flexibility.

For rail freight traffic, the Trans-Tools forecast shows that the coming rail link across the Fehmarnbelt will fundamentally change the distribution of rail freight traffic between Scandinavia and Continental Europe. In this context, the Fehmarnbelt link is expected to drive the growth in rail freight traffic while relieving the pressure on the Danish rail network between eastern and western Denmark.
5. Fehmarnbelt Forecast 2014

5.1. Introduction and main conclusions

5.1.1. Introduction

This chapter presents the results of the updated FTC forecast, which contains estimations of the expected traffic on a fixed link across the Fehmarnbelt.

The updated FTC forecast (Fehmarnbelt Forecast 2014) was prepared by the consulting companies Intraplan Consult GmbH and BVU (Beratergruppe Verkehr + Umwelt GmbH). They also participated in preparing the original FTC forecast from 2003 (FTC 2003). FTC 2003 was prepared for the Danish and German Ministries of Transport and was specifically designed to map traffic demand for a forthcoming fixed link across the Fehmarnbelt. The model was purpose-built, meaning that as far as possible, the FTC model takes into account all relevant factors pertaining to traffic trends for the Fehmarnbelt Fixed Link. In other words, the model includes socio-economic and demographic trends, trends in the choice of transport mode (modal split), driving/resting time regulations and route choices, including the competition with alternative routes in the Fehmarnbelt corridor.

The estimates behind the Fehmarnbelt Forecast 2014 include topical data from the latest ten years’ economic and traffic trends. The model has been technically updated and improved with a more detailed traffic zone structure to take into account various development factors. Similarly, it also contains updated economic and traffic data. The model has been expanded with more forecasting years, and there is more detailed allocation of choice of route. The Fehmarnbelt Forecast 2014 thus represents a broader-based forecast that is more robust in terms of data than FTC 2003. However the model’s basic methodology is largely identical to FTC 2003, “Fehmarnbelt Traffic Demand Study, Final Report”. The same methodology is used by the German Ministry of Transport in its national traffic forecast (Bundesverkehrswegeplan, BVWP).

Updating the FTC forecast takes into account developments that have occurred in society and in the traffic patterns since the last traffic forecast was prepared.

44 Intraplan and BVU explain that the FTC forecasts from 2003 and 2014 are based on the same basic method expansion and improvements in relation to the study corridor (coverage, zone system), traffic data (FTC OD matrix based on further data sources such as studies on ferries, Danish and Swedish traffic statistics, which are not used in BVWP), the traffic supply data (topical ferry prices and road tolls, coverage and details from the ferry service), procedures for modal split and route choice (new segment “ferry walk-on”, which is not included in BVWP), route choice task adapted to the ferry service which, in BVWP is included in a more general way, and calibration (basis: ferry statistics and transport statistics from the Great Belt). For further information about the model, see “Bundesministerium für Verkehr und digitale Infrastruktur, Grundkonzeption für den Bundesverkehrswegeplan 2015”, Berlin 2012, especially chapter 9.1, “Qualitätssicherung der laufenden Arbeiten am BVWP 2014”. The method for the traffic models is also described in detail in “Verkehrsverflechtungsprognose 2030 – Los 3: Erstellung der Prognose der deutschlandweiten Verkehrsverflechtungen unter Berücksichtigung des Luftverkehrs”, chapter 2. Further details are available in “Verkehrsverflechtungsprognose – Los 3: Ergänzender Bericht zur Methodik“, internal, December 2014. See footnote 32 in “Fehmarnbelt Forecast 2013”, Intraplan and BVU, November 2014.
Overall, the Fehmarnbelt Forecast 2014 examines the following:

1. The expected traffic trends between Scandinavia (here defined as eastern Denmark, Sweden, Norway and Finland) and Continental Europe (except the former Soviet Republics, the Baltic countries and eastern Poland).

2. The proportion of traffic expected to go to the Fehmarnbelt Fixed Link compared with other transport routes.

The Fehmarnbelt Forecast 2014 contains two scenarios for the expected traffic trends, case A and case B. Case B is based on the assumptions and growth expectations from the OECD, the Danish Ministry of Transport and the Danish Ministry of Finance and is estimated by Intraplan/BVU to be the most relevant scenario for the ongoing planning process. Case B is therefore treated in the following review as the main scenario. Case A is based on the assumptions based on the German expectations for growth and is presented as a sensitivity scenario.

5.2. About the FTC model

The objective of the FTC model is to project the freight and passenger traffic between Scandinavia and Continental Europe as well as the Fehmarnbelt link specifically. The FTC model focuses partly on traffic development between Denmark (east of the Great Belt), Sweden, Norway and Finland on the one side, and the European continent (excluding the former Soviet Republics, the Baltic countries and eastern Poland) on the other. The forecast also focuses specifically on the percentage of traffic that a fixed link across the Fehmarnbelt is expected to reach.

FTC 2003 was based on the base year 2001 and contained a forecast for 2015 estimated on the two scenarios, a high growth scenario and a low growth scenario for 2025. The Fehmarnbelt Forecast 2014 is based on the base year 2011 and contains a main scenario and a sensitivity scenario for traffic trends. The main scenario is based on the official Danish expectations for socio-economic development and for trends in transport costs. The main scenario is reviewed in the following pages. Unlike FTC 2003, which focuses primarily on a forecast year, namely 2015, the Fehmarnbelt Forecast 2014 is a dynamic model with forecasts for traffic trends in the medium and long term. The Fehmarnbelt Forecast 2014 contains the following forecast years and projections:

- 2022 as the first complete year of operation with a fixed link in two variations:
  - The full effect of the Fixed Link (fully implemented traffic jump) in the first year
  - The effect of the Fixed Link (traffic jump) with three phase-in years (the ramp-up period) and fully implemented traffic jump after four years

- 2022 without a fixed link (in order to be able to isolate the effect of the Fixed Link, i.e. the traffic jump)

- 2025 with a fixed link (first year, when the ramp-up period is expected to be completed, the primary forecast in the medium term)

- 2035 with a fixed link (the primary forecast in the long term)

- 2047 with a fixed link (projection to 2047)

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5.3. Data source for the Fehmarnbelt Forecast 2014

The Fehmarnbelt Forecast 2014 is based on a number of assumptions concerning demographic development, socio-economic development, other infrastructure projects in Europe as well as the trends in transport costs. The most important assumptions are presented in general in the following section and are also further described in the Fehmarnbelt Forecast 2014.

5.3.1. Socio-economic assumptions

The Fehmarnbelt Forecast 2014 is based on the expectations for population development and development in the workforce in Denmark, Sweden, Germany, Norway and Finland, which are available at Eurostat as well as in official statistics banks for the individual countries.

In terms of car ownership, the Fehmarnbelt Forecast 2014 is based on the expectation in the German Bundes-verkehrswegeplan that car ownership will increase by 0.55 per cent per year in Germany and by 0.85 per cent per year in Denmark.\(^{46}\)

The underlying expectations for the economy are, in the main scenario, based on the Ministry of Finance’s expectations for the development in GDP as well as the OECD’s expectations for growth in the surrounding countries. The sensitivity scenario is based on growth expectations from the German Ministry of Finance. Table 5.1 shows the expectations for the development in GDP in the Fehmarnbelt Forecast 2014.

<table>
<thead>
<tr>
<th>GDP</th>
<th>Main scenario</th>
<th>Sensitivity scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Average 2012 – 2030 in per cent per year (1.3 (to 2022), 1.6 (from 2022))</td>
<td>Average 2011 – 2030 in per cent per year (1.3)</td>
</tr>
<tr>
<td>Germany</td>
<td>1.2</td>
<td>1.14</td>
</tr>
<tr>
<td>Sweden</td>
<td>2.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Norway</td>
<td>2.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Finland</td>
<td>2.2</td>
<td>1.3</td>
</tr>
</tbody>
</table>


Note: The forecast’s source for the main scenario is: Danmark - Finansministeriets fremskrivning; øvrige lande OECD (Denmark - The Ministry of Finance’s projections; other countries the OECD). Note that the growth expectations here are based on an OECD forecast from 2012, while the growth forecasts dealt with in chapter 3 are based on updated 2014 forecasts from the OECD and TEC. The differences in OECD 2012 and OECD 2014 are modest, however the expectations for the GDP growth in Germany and Sweden have been adjusted upwards slightly in OECD 2014. The forecast’s source for the sensitivity scenario: DE Federal Ministry of finance, Germany.

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\(^{46}\) “Fehmarnbelt Forecast 2014 – ANNEX”, Intraplan and BVU, November 2014, page 11
As seen in table 5.1, the main scenario is based on an expectation for relatively low economic growth in Germany, moderate growth in Denmark and relatively high growth in Sweden and the other Nordic countries. The underlying reasons for this expectation could be the business composition as well the demographic development in the respective countries. Whereas Germany has a relatively large industrial sector, the Nordic countries have a more developed service sector, which can have an impact on future GDP development. In addition, Germany is characterised by declining population figures and thereby a shrinking workforce, while the workforce is continues to grow in the Nordic countries.\footnote{“Fehmarnbelt Forecast 2014”, Intraplan and BVU, November 2014, page 96}

5.3.2. Assumptions concerning other infrastructure in the region

The Fehmarnbelt Fixed Link will be part of the European infrastructure network and therefore cannot be considered in isolation in the projection of traffic trends. In order to gain the full effect of the link, there must be e.g. adequate capacity on the road and rail network on both sides of the Fehmarnbelt to absorb the traffic. The forecast therefore contains a number of integral assumptions for the other infrastructure in the region.

In broad outline, the following is assumed in the Fehmarnbelt Forecast 2014:

- Existing and decided investments in the European infrastructure up to 2030 will be realised as planned.
- It is also assumed that the ferry link across the Fehmarnbelt will close when the Fehmarnbelt Fixed Link opens (see section 5.6.2 for an analysis of the effect if the Rødby-Puttgarden ferry remains in service after the Fixed Link opens). The assumption concerning the closure of the ferry service is based on a profitability analysis with continued ferry operations.
- Other ferry routes in the corridor will continue to operate as previously (unchanged supply).
5.3.3. Assumptions concerning the transport cost structure

The cost structure on which the forecast is based contains the direct costs related to using the Fixed Link (compared with the costs related to using the current ferry route) and the underlying transport costs, including road tolls and costs related to car ownership. As shown in tables 5.2 and 5.3, the two scenarios vary with respect to the assumed transport costs both for passengers and freight.

<table>
<thead>
<tr>
<th>Table 5.2: Assumptions concerning transport costs for passenger transport</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport mode</strong></td>
</tr>
<tr>
<td>Fehmarnbelt Fixed Link, cars</td>
</tr>
<tr>
<td>Passenger costs, ferry</td>
</tr>
<tr>
<td>Variable user costs, car (without taxes)</td>
</tr>
<tr>
<td>Road tolls, cars</td>
</tr>
<tr>
<td>Road tolls, coaches</td>
</tr>
<tr>
<td>Passenger costs, rail</td>
</tr>
<tr>
<td>Passenger costs, air</td>
</tr>
</tbody>
</table>


Note: Prices converted from euro (EUR) into kroner (DKK) at an exchange rate of 7.45

<table>
<thead>
<tr>
<th>Table 5.3: Assumptions concerning the transport costs for freight transport</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport mode</strong></td>
</tr>
<tr>
<td>Fehmarnbelt Fixed Link, lorries</td>
</tr>
<tr>
<td>Ferries, lorries</td>
</tr>
<tr>
<td>Lorries</td>
</tr>
<tr>
<td>Road tolls</td>
</tr>
<tr>
<td>Conventional rail</td>
</tr>
<tr>
<td>Combined rail</td>
</tr>
</tbody>
</table>

⁴⁸ The estimation stems from “Transportøkonomiske Enhedspriser” (Transport-economic unit prices) for use for socio-economic analyses prepared by DTU Transport at the Technical University of Denmark, and COWI for the Ministry of Transport, version 1.4, November 2013
The main scenario assumes, for example, that the variable costs related to running a passenger car will fall by 2 per cent per year for the period 2011-2035. The background for this is the Ministry of Transport’s analysis of Transport-Economic (TE) unit prices, which indicates that the energy efficiency in the Danish car fleet has considerably improved since 2007. In light of this, the Ministry of Transport expects the technological development of cars, including in relation to fuel economy in particular, to continue in the years ahead, which means that running a car will gradually become cheaper.

The main scenario in the Fehmarnbelt Forecast 2014 therefore assumes a reduction in costs per kilometre driven, which will provide an average annual price reduction of 2.0 per cent for the period 2011-2035. The sensitivity scenario is based on the cost expectations from the German Ministry of Transport. Here there is not the same expectation for a fall in user costs related to passenger cars. However, the German Ministry of Transport assumes a lower price for using the Fehmarnbelt Fixed Link for passenger cars.

5.4. Traffic trends between Scandinavia and Continental Europe

The following section presents the forecast for traffic trends between Scandinavia (eastern Denmark, Sweden, Norway and Finland) and Continental Europe (Germany and western Poland). Passenger traffic and freight traffic are described separately. Later in the chapter, the forecast is presented more specifically for the Fehmarnbelt.

5.4.1. Trends in passenger traffic between Scandinavia and Continental Europe

Passenger traffic between Scandinavia and Continental Europe (the Baltic section) will be characterised by overall growth for the period 2011-2035. Table 5.4 below shows the estimated traffic growth both with and without the establishment of the Fehmarnbelt Fixed Link.
Table 5.4: Trends in passenger traffic between Scandinavia and Continental Europe (1000 passengers/year)

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>2011</th>
<th>2022 (without a fixed link)</th>
<th>2022 (with a fixed link)</th>
<th>2025 (with a fixed link)</th>
<th>2030 (with a fixed link)</th>
<th>2035 (with a fixed link)</th>
<th>Average growth 2025-2035 (in % per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train</td>
<td>460</td>
<td>629</td>
<td>1,149</td>
<td>1,155</td>
<td>1,091</td>
<td>1,038</td>
<td>-1.1</td>
</tr>
<tr>
<td>Car</td>
<td>8,970</td>
<td>10,769</td>
<td>11,087</td>
<td>11,582</td>
<td>12,528</td>
<td>13,302</td>
<td>1.4</td>
</tr>
<tr>
<td>Plane</td>
<td>17,226</td>
<td>27,996</td>
<td>27,733</td>
<td>31,299</td>
<td>38,496</td>
<td>44,384</td>
<td>3.6</td>
</tr>
<tr>
<td>Of this relevant area for the forecast*</td>
<td>1,657</td>
<td>2,244</td>
<td>2,081</td>
<td>2,235</td>
<td>2,488</td>
<td>2,696</td>
<td>1.9</td>
</tr>
<tr>
<td>Coach</td>
<td>2,320</td>
<td>2,392</td>
<td>2,361</td>
<td>2,442</td>
<td>2,526</td>
<td>2,594</td>
<td>0.6</td>
</tr>
<tr>
<td>Ferry, walk-on passen- sengers</td>
<td>1,512</td>
<td>1,413</td>
<td>974</td>
<td>958</td>
<td>949</td>
<td>941</td>
<td>-0.2</td>
</tr>
<tr>
<td>Total</td>
<td>30,488</td>
<td>43,199</td>
<td>43,304</td>
<td>47,436</td>
<td>55,589</td>
<td>62,259</td>
<td>2.8</td>
</tr>
</tbody>
</table>


*Note: Relevant area (core study) for the forecast is eastern Denmark/Sweden and Germany in this case.

The estimates in the main scenario show that passenger traffic between Scandinavia and Continental Europe will double for the period 2011-2035 – from 30.5 million passengers annually to 62.3 million passengers annually, corresponding to 170,685 a day. This equates to average passenger traffic growth of 3.0 per cent per year from 2011 to 2035 across transport modes. Considering the period 2025-2035 in isolation (after the traffic jump and ramp-up effect), average passenger growth is 2.8 per cent per year.

With regard to individual transport modes, air passenger traffic will experience the highest growth rate of an average of 4.0 per cent per year and 3.6 per cent per year for the period 2025-2035. However, the high growth in air traffic should be seen in the context that by far the majority of air traffic relates to journeys of 1,500 km or more, which are only to a lesser extent decisive in relation to traffic on the Fixed Link and ferry routes. This is due not least to the popularity of low-cost flights which, over the past decade, have significantly changed the patterns of the European long-distance transport. As a basis for the forecast, BVU and Intraplan therefore carried out a comprehensive analysis of air traffic both historically and in the future.

Table 5.5 below shows the passenger distribution and choice of transport mode distributed across the transport modes in 2011 for the total north/southbound European traffic and for the traffic between eastern Denmark/Sweden and Germany.

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The first two columns of the table show the total traffic while the long-distance traffic element has been removed in the last two columns. A large difference in the choice of transport mode is evident between the transport modes for long distances and short distances. For shorter distances, cars are the preferred transport mode (56 per cent), while air traffic comprises only 14.9 per cent of traffic. In the overall calculation of traffic, air traffic has the largest share of 56.5 per cent of the passengers.

<table>
<thead>
<tr>
<th>(1000 passengers/year)</th>
<th>Passengers between Northern Europe and Southern Europe</th>
<th>Passengers between eastern Denmark/Sweden and Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport mode</td>
<td>2011</td>
<td>Proportion (%)</td>
</tr>
<tr>
<td>Train</td>
<td>460</td>
<td>1.5</td>
</tr>
<tr>
<td>Car</td>
<td>8,970</td>
<td>29.4</td>
</tr>
<tr>
<td>Plane</td>
<td>17,226</td>
<td>56.5</td>
</tr>
<tr>
<td>Coach</td>
<td>2,320</td>
<td>7.6</td>
</tr>
<tr>
<td>Ferry, walk-on passengers</td>
<td>1,512</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30,488</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


Naturally enough, the Fehmarnbelt Fixed Link will not be able to compete with long-distance air traffic to any great extent. However it will be a competitive alternative to air transport on shorter journeys as this will significantly reduce the travel time between a number of central cities in Europe, e.g. Copenhagen-Hamburg and Copenhagen-Berlin.

As a relatively large proportion of the traffic is long-distance traffic, it is important not only to consider the figures in aggregate.

With the Fehmarnbelt tunnel, travel time between Copenhagen and Hamburg by train will fall by almost a third from 264 minutes via Rødby-Puttgarden to 205 minutes via the Fehmarnbelt link. Consequently, the Fehmarnbelt Fixed Link will not only be a competitive route for car passengers, but also an attractive alternative to air traffic. Time savings on the Fehmarnbelt Fixed Link will therefore prompt changes in travel patterns not only in terms of choice of route but also in terms of transport mode.

On shorter distances, the Fehmarnbelt link will result in a transfer of traffic from air to land-based traffic, including trains, in particular. This choice of transport mode will contribute to the increase in traffic on the Fehmarnbelt link. Table 5.6 shows the effect of opening the Fehmarnbelt link on air traffic between a number of destinations.

### Table 5.6: The effect of the Fehmarnbelt link on air traffic between selected destinations, 2022

<table>
<thead>
<tr>
<th>Flight distance</th>
<th>Number of passengers (in 1,000 passengers)</th>
<th>Proportion of the total air traffic on the distance (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany Eastern Denmark</td>
<td>102</td>
<td>12.1</td>
</tr>
<tr>
<td>Germany Sweden</td>
<td>61</td>
<td>4.4</td>
</tr>
<tr>
<td>Germany Norway</td>
<td>5</td>
<td>0.3</td>
</tr>
<tr>
<td>Germany Finland</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>The rest of Europe Eastern Denmark</td>
<td>54</td>
<td>1.0</td>
</tr>
<tr>
<td>The rest of Europe Sweden</td>
<td>38</td>
<td>0.4</td>
</tr>
<tr>
<td>The rest of Europe Norway</td>
<td>2</td>
<td>0.0</td>
</tr>
<tr>
<td>The rest of Europe Finland</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>263</strong></td>
<td><strong>0.9</strong></td>
</tr>
</tbody>
</table>


Calculations show that the opening the Fehmarnbelt Fixed Link will prompt 12 per cent of air passengers between Germany and eastern Denmark to choose the Fehmarnbelt link rather than fly in 2022. This equates to 102,000 passengers. The same applies to 4.4 per cent of air passengers between Sweden and Germany, equating to 61,000 passengers.

Between eastern Denmark and the rest of Europe, 1.0 per cent of air passengers in 2022 will opt for the Fehmarnbelt link rather than fly, corresponding to 54,000 passengers. Between Sweden and the rest of Europe, 38,000 air passengers will choose the Fixed Link rather than fly, corresponding to 0.4 per cent of total air traffic on this distance. Overall, the opening the Fehmarnbelt Fixed Link will mean that 263,000 passengers will switch from air to a land-based transport mode, mainly rail.

A similar development could be seen in domestic air traffic across the Great Belt in the years following the opening of the Great Belt. This was due to improved accessibility, shorter travel time across the Great Belt, significant reduction in domestic air traffic between eastern and western Denmark and the fact that a number of domestic routes closed as a result of increased competition from the Great Belt Bridge.

The opening of the Great Belt Bridge also resulted in a change to domestic travel patterns and the distribution between the transport modes because it became significantly faster to travel between eastern and western Denmark by either train or car. Overall, the number of passengers on Danish domestic flights fell by almost 40 per cent from 1996 to 2013 following the opening of the Great Belt Bridge.\(^{52}\)

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\(^{52}\) Calculations based on Statistics Denmark’s, statistic bank, Table FLYV32: Departing passengers from large, public-sector, manned airports according to airport, transport type and flight
5.4.2. Trends in freight traffic between Scandinavia and Continental Europe

Freight traffic between Scandinavia and Continental Europe will also reflect growth in the coming years. Table 5.7 shows the development forecasts in total freight traffic between Scandinavia and Continental Europe by road and rail respectively, measured in tonnes.

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>2011</th>
<th>2022 after the Fixed Link opens</th>
<th>2025</th>
<th>203053</th>
<th>2035</th>
<th>Average annual growth 2011-2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road freight</td>
<td>22,610</td>
<td>31,298</td>
<td>32,979</td>
<td>35,634</td>
<td>38,288</td>
<td>2.2%</td>
</tr>
<tr>
<td>Rail freight</td>
<td>6,164</td>
<td>8,909</td>
<td>9,408</td>
<td>10,132</td>
<td>10,856</td>
<td>2.4%</td>
</tr>
<tr>
<td>Total</td>
<td>28,774</td>
<td>40,207</td>
<td>42,387</td>
<td>45,766</td>
<td>49,144</td>
<td>2.3%</td>
</tr>
</tbody>
</table>


According to the Fehmarnbelt Forecast 2014, freight volumes on roads and railways combined will rise from 28.8 million tonnes in 2011 to 40.2 million tonnes in 2022 after the opening of the Fixed Link. In 2025, freight is expected to total 42.4 million tonnes and 49.1 million tonnes in 2035. This corresponds to average annual freight growth of 2.3 per cent for the period 2011-2035.

Table 5.7 also shows the choice of transport mode between road and rail for freight traffic between Scandinavia and Continental Europe. The distribution between rail and road freight is relatively stable throughout the period, while freight volumes will grow.

5.5. Traffic trends across the Fehmarnbelt

As described above, the Fehmarnbelt Forecast 2014 indicates average annual growth of 3.0 per cent in passenger traffic between Scandinavia and Continental Europe for the period 2011-2035 and average annual growth of 2.3 per cent in the freight volumes. The following section focuses specifically on traffic across the Fehmarnbelt i.e. on the Rødby-Puttgarden ferry up to 2021, and subsequently the Fehmarnbelt Fixed Link.

5.5.1. Time saved on the Fehmarnbelt Fixed Link

The Fehmarnbelt Fixed Link will mean that travellers can cross the Fehmarnbelt significantly faster than before. Table 5.8 below shows a calculation of the time consumption on the current ferry service between Rødby and Puttgarden and the coming Fehmarnbelt Fixed Link. The assumptions for the figures are shown in the column on the far right and are set conservatively. For example, the calculations assume a driving speed of 70 kph through the tunnel, which is lower than the actual expected speed in the tunnel. This is a precautionary measure and is a contributory factor to the fact that the calculated time savings are conservative. In addition, the average waiting time at the ferry does not take into account

53 Figures for 2030 are estimated values, based on the forecast figures for 2025 and 2035, respectively
peak hours during the high season when traffic jams can arise. Similarly, check-in and payment time at the tunnel are set high.54

<table>
<thead>
<tr>
<th>Table 5.8: Overview of the average time consumption on the ferry link and the Fehmarnbelt Fixed Link respectively (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average time consumption</strong></td>
</tr>
<tr>
<td><strong>Time component</strong></td>
</tr>
<tr>
<td>Crossing time, ferry</td>
</tr>
<tr>
<td>Time to drive through the tunnel</td>
</tr>
<tr>
<td>Average waiting time, ferry</td>
</tr>
<tr>
<td>Check-in time and embarkation, ferry</td>
</tr>
<tr>
<td>Check-in time at the toll booth, tunnel</td>
</tr>
<tr>
<td>Disembarkation, ferry</td>
</tr>
<tr>
<td>Expansion of southern landworks, four lanes</td>
</tr>
</tbody>
</table>


*Note: The normal speed for four-lane roads in Germany is 120 kph, while the normal speed for Bundesstraßen is 100 kph

With waiting time, check-in, embarkation and disembarkation, crossing the Fehmarnbelt takes an average of 75 minutes by ferry. On the Fehmarnbelt Fixed Link, total transport time will be around 17 minutes, including check-in and payment. The Fehmarnbelt Fixed Link represents a time saving of around one hour. In the model, this is set at 59 minutes. In FTC 2003, the time saving was set at 65 minutes. The reduced time saving is owing to the fact that the ferry crossing today is faster than previously.

The shorter travel time across the Fehmarnbelt reduces the travel time on a number of routes between Scandinavia and Continental Europe. Time savings on the main routes between Copenhagen and Hamburg and Berlin respectively, are shown in table 5.9.

Table 5.9: Travel time and costs, Hamburg-Copenhagen and Berlin-Copenhagen

<table>
<thead>
<tr>
<th>Route</th>
<th>Km</th>
<th>Travel time in minutes</th>
<th>Of which ferry/tunnel (incl. waiting time and check-in), minutes</th>
<th>Travel costs per car, DKK</th>
<th>Of which ferry/fixed link, DKK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamburg – Copenhagen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>via Rødby-Putgarden</td>
<td>334*</td>
<td>264</td>
<td>75</td>
<td>767.4</td>
<td>484.3</td>
</tr>
<tr>
<td>via the Great Belt</td>
<td>474</td>
<td>270</td>
<td>0</td>
<td>669.8</td>
<td>245.9</td>
</tr>
<tr>
<td>via the Fehmarnbelt link</td>
<td>334</td>
<td>205</td>
<td>17</td>
<td>785.2</td>
<td>484.3</td>
</tr>
<tr>
<td>Berlin – Copenhagen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>via Rostock-Gedser</td>
<td>444</td>
<td>430</td>
<td>180</td>
<td>959.6</td>
<td>607.2</td>
</tr>
<tr>
<td>via Rødby-Putgarden</td>
<td>584*</td>
<td>409</td>
<td>75</td>
<td>990.9</td>
<td>484.3</td>
</tr>
<tr>
<td>via the Fehmarnbelt Fixed Link</td>
<td>584</td>
<td>350</td>
<td>17</td>
<td>1008.7</td>
<td>484.3</td>
</tr>
</tbody>
</table>

Source: “Fehmarnbelt Forecast 2014”, Intraplan and BVU, November 2014, pages 100 and 102

*Note: Total distance including the ferry crossing

Travellers between Hamburg and Copenhagen can currently choose between two main routes: via Rødby-Putgarden and via the Great Belt. In the traffic model, the latter is assumed to be 140 km longer than the former, but the total costs associated with crossing the Great Belt Bridge are lower because of the Rødby-Putgarden ferry fare. In addition, the waiting time at the ferry means that the direct route across Rødby-Putgarden combined is only six minutes faster than the route across the Great Belt.

The Fehmarnbelt Fixed Link will save almost one hour’s travelling time compared with the current ferry service between Rødby and Putgarden, while costs will be slightly higher due to the fuel consumed when crossing the Fehmarnbelt link. Cars travelling by ferry do not, of course, use fuel during the crossing.

For travellers between Berlin and Copenhagen, the Gedser-Rostock route is the natural choice. However, due to the limited number of crossings compared with Rødby-Putgarden, the traffic model assumes that the 140 km longer trip via Rødby-Putgarden is, on average, the faster option. This difference in travel time will be even greater with the Fehmarnbelt Fixed Link because it will reduce travel time between Berlin and Copenhagen by 80 minutes compared with the Gedser-Rostock ferry.

These time savings are expected to have a considerable impact on the choice of route between Scandinavia and Continental Europe, which is an important reason for the expected traffic jump when the Fixed

55 Viewed over 24 hours taking into account the average waiting time for the Gedser-Rostock ferry and the average waiting time at Rødby-Putgarden
Link opens. The reduced travel time between the main destinations will also have an impact on a number of other north/southbound routes that naturally pass Copenhagen, Hamburg or Berlin. For example, this applies to Cologne-Stockholm, Frankfurt am Main-Gothenburg, Prague-Oslo and Leipzig-Helsingborg.

The ferry time includes the crossing time, waiting time, embarkation and disembarkation. In addition, the travel time estimation is adjusted for the statutory resting time resulting from the current resting time regulations for drivers. In this respect, it has also been taken into account that ferry crossings can be used for breaks or resting time, whereas the journey via the Fehmarnbelt Fixed Link does not offer this opportunity. It would, for example, be faster for freight transport between Malmö and Milan to take the ferries between Travemünde and Malmö/Trelleborg as well as Rostock and Trelleborg. This is therefore also taken into account in the estimates.

The Fehmarnbelt Fixed Link is expected to result in a reduction in travel time between Malmö and Hamburg and Antwerp respectively compared with the alternative routes.

5.5.2. Traffic jumps

As described earlier, the opening of the Fehmarnbelt Fixed Link will impact on traffic patterns between Scandinavia and Continental Europe and will also generate new traffic itself. The Fehmarnbelt Forecast 2014 anticipates that the Fixed Link will experience a traffic jump following its opening. It is well-known that such a traffic jump in the form of extra traffic occurs when the accessibility of a transport system is improved through new infrastructure. This is consistent with the new travel options brought about by the infrastructure in the form of reduced travel time, increased flexibility, etc., which was also evident in the years following the opening of the Great Belt and Øresund links.  

The traffic jump could occur for a number of reasons, including newly created traffic, i.e. motorists who have not previously travelled, or who have travelled to a more limited extent between two destinations, find it attractive to travel between the two destinations. Another reason could be transferred traffic due to the fact that travellers have previously used another route or another transport mode between destinations and now find it attractive to use the new infrastructure rather than their usual form of travel. Both newly created traffic and transferred traffic involve travellers who will benefit from the time saved and the increased flexibility etc. offered by the new infrastructure.

In the main traffic forecast for the Fehmarnbelt link, the traffic jump is estimated at 54 per cent in the traffic model used. In terms of the model, this traffic jump occurs mainly as a result of transferred traffic. Traffic growth from newly created traffic is only included to a more limited extent. The traffic jump is not expected to have a full effect immediately, but is expected to take effect during the first three years and be fully phased in during the fourth year after the opening when traffic has adjusted to the new opportunities. This is known as the ramp-up period.

There is, of course, some uncertainty involved in calculating the traffic jump’s specific size and composition. The estimate of 54 per cent is based on the best possible model calculation. However as a precautionary measure, sensitivity calculations have been conducted and presented on the traffic jump in the financial analysis for the Fehmarnbelt project. The sensitivity calculations show the specific impact on

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54 See e.g. the article on traffic jumps in the journal “Trafik & veje – august 2013” (Traffic and roads - August 2013) by research assistant Christian Twitchett and postdoc Morten Skou Nicolaisen, both AAU
the Fehmarnbelt link’s economy if the traffic jump – contrary to expectations – is considerably lower than the model calculations show.

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Without the Fixed Link</th>
<th>With the Fixed Link</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>5,395</td>
<td>8,951</td>
<td>66%</td>
</tr>
<tr>
<td>Coaches</td>
<td>74</td>
<td>93</td>
<td>26%</td>
</tr>
<tr>
<td>Lorries</td>
<td>1,392</td>
<td>1,534</td>
<td>10%</td>
</tr>
<tr>
<td>Total</td>
<td>6,860</td>
<td>10,578</td>
<td>54%</td>
</tr>
</tbody>
</table>


The main scenario in the Fehmarnbelt Forecast 2014 calculates a traffic jump of 54 per cent at the opening. Table 5.10 shows the composition of the estimated traffic jump.

As the table indicates, the calculations in the Fehmarnbelt Forecast 2014 show that the Fehmarnbelt Fixed Link will result in the number of cars crossing the Fehmarnbelt increasing from 5,395 a day before the tunnel opens to 8,951 a day after the opening, corresponding to an increase of 66 per cent. For coaches, the increase is estimated at 26 per cent, while the number of lorries is expected to increase by 10 per cent. These figures show the effect of the Fixed Link i.e. the traffic jump without regard to the ramp-up period.

Overall, this produces an increase of 54 per cent in the number of vehicles, which is the traffic jump that will be generated by the Fixed Link. Among the reasons for the increased traffic volume is traffic transferred from other transport routes and transport modes, and newly created traffic because the new and improved infrastructure will encourage both private individuals and business people to travel more.
WHAT IS A TRAFFIC JUMP?

A traffic jump is the increase in traffic on a given section as a result of new infrastructure or new transport options. For example, a traffic jump arises when a fixed link replaces a ferry service, and is due to various dynamics.*

Transferred traffic

Establishing a fixed link partly changes existing traffic patterns. Fixed links increase the accessibility of a particular section and attracts some travellers who previously chose another route rather than the fixed link. This means, therefore, that a volume of existing traffic will be transferred from other routes to the fixed link. In the traffic analysis for the Fehmarnbelt link, the traffic jump comprises mainly transferred traffic.

The Fehmarnbelt Fixed Link is expected to absorb some of the transit traffic between Scandinavia/eastern Denmark and Germany, which currently crosses the Great Belt, as well as some of the traffic on the ferry links in the western Baltic. The expectations are therefore that the Fehmarnbelt link will relieve pressure on both the road network and railways in the east/westbound traffic through Denmark.

Newly created traffic

However, the establishment of the fixed link will also help to create new traffic because it will increase the capacity of the transport system and help to relieve any bottlenecks. It can be seen from the Great Belt and Øresund links that the opportunities they provide have resulted in increased traffic volumes. The reason is that the general public and companies undertake more journeys because it is easier, faster or cheaper to do so. This produces net growth in overall traffic in the transport system as a whole. The FBF analysis assumes a three-year ramp-up period with the full phase-in during the fourth year after the opening.

The Fehmarnbelt Fixed Link will have the immediate effect of increasing traffic across the Fehmarnbelt. The effect can mainly be attributed to a different choice of transport mode, mainly in relation to air (7 per cent) and route effects (90 per cent) as well as newly created traffic that comprises about 3 per cent of the traffic jump for the Fehmarnbelt link.

WHAT IS A RAMP-UP PERIOD?

When new infrastructure opens, it can take time before traffic patterns adapt to the new transport options. In the FTC model, it is therefore assumed that the Fehmarnbelt Fixed Link will have a ramp-up period of three years. As a precautionary measure, the fact that travellers have to become accustomed to using the new option has been taken into account. These three years are therefore regarded as a transition period – or ramp-up period. The traffic jump is therefore not expected to take its full effect immediately after the link opens but traffic is expected to adapt slowly and the traffic jump will be fully phased in during the fourth year of operation. The full effect is not expected to be reflected in the traffic figures until 2025. It is assumed that the traffic jump for cars will be realised at approx. 70 per cent in the first year, 85 per cent in the second year and 95 per cent in the final year. For lorries, the traffic jump will be realised at 90 per cent in the first year, 93.4 per cent in the second year and 96.7 per cent in the last year. From the fourth year, the traffic jump is assumed to be fully phased in both for cars and lorries. There is no ramp-up effect for coaches and trains.

“See e.g. the article about traffic jumps in the publication “Trafik & veje – august 2013” (Traffic and roads - August 2013) by research assistant Christian Twitchett and postdoc Morten Skou Nicolaelsen, both AAU
5.5.3. Trends in passenger traffic across the Fehmarnbelt

Table 5.11 below shows the expected trend in the number of passengers across the Fehmarnbelt with and without the establishment of the Fehmarnbelt Fixed Link.

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>2011</th>
<th>2022 without the Fixed Link</th>
<th>2022 with the Fixed Link</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Passengers (1,000/year)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>passengers in cars</td>
<td>6,028</td>
<td>6,990</td>
<td>9,742</td>
<td>11,134</td>
<td>12,009</td>
<td>12,724</td>
</tr>
<tr>
<td>passengers in coaches</td>
<td>1,142</td>
<td>1,014</td>
<td>1,272</td>
<td>1,332</td>
<td>1,352</td>
<td>1,369</td>
</tr>
<tr>
<td>passengers in trains</td>
<td>394</td>
<td>557</td>
<td>1,141</td>
<td>1,146</td>
<td>1,083</td>
<td>1,031</td>
</tr>
<tr>
<td>ferry-walk-on passengers</td>
<td>519</td>
<td>417</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Vehicles (1,000/year)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cars (incl. motorcycles)</td>
<td>1,564</td>
<td>1,969</td>
<td>2,885</td>
<td>3,417</td>
<td>3,767</td>
<td>4,054</td>
</tr>
<tr>
<td>coaches</td>
<td>31</td>
<td>27</td>
<td>34</td>
<td>36</td>
<td>36.5</td>
<td>37</td>
</tr>
</tbody>
</table>


Without the establishment of the Fixed Link, the main scenario shows that the number of passengers crossing the Fehmarnbelt will grow from 6.0 million passengers in 2011 to 6.9 million passengers in 2022, corresponding to 18,904 passengers a day in 2022.

With the establishment of the Fehmarnbelt Fixed Link, the number of passengers is expected to rise to 9.7 million passengers in 2022, corresponding to overall passenger growth of 62 per cent, including the ramp-up effect. In 2025, it is expected that 11.1 million passengers will cross the Fehmarnbelt whereas passenger figures for 2035 shows an increase to 12.7 million per year, corresponding to 34,795 per day. This corresponds to annual passenger growth of 3.2 per cent during the entire period from 2011 to 2035. As regards passenger train traffic, a doubling in the number of passengers is expected when the link opens, from 394,000 passengers per year in 2011 to 1.14 million passengers per year in 2022.

The development in the number of passenger vehicles across the Fehmarnbelt is also shown in table 5.11. Without the Fixed Link, the number of passenger vehicles will grow from 1.6 million in 2011 to 2.0 million in 2022 due to the generally growing traffic between Scandinavia and Continental Europe. With the establishment of the Fixed Link, the number of passenger vehicles will grow significantly more; in the main scenario calculated to total 2.9 million passenger vehicles in 2022. This figure incorporates the ramp-up effect which, as a precautionary measure, takes into account the fact that traffic patterns take time to adapt to the opportunities presented by new infrastructure.
In estimating the traffic jump, the FTC model does not take account of the derivative dynamic effects that the Fixed Link can have on traffic, which was seen following the opening of the Great Belt and Øresund fixed links where increased integration of both the business and leisure sectors largely contributed to creating more traffic. In this sense, the FTC model’s calculation of the newly created traffic is a conservative projection of approx. 3 per cent.

Table 5.12 shows the isolated effect of the Fixed Link on the number of passengers. Here the ramp-up effect has been removed from passenger figures, and the most significant effect of the Fixed Link is visible for passengers in cars changing route from the Great Belt and other ferries to the Fehmarnbelt link. According to the forecast, approximately 2,000 cars will take the Fehmarnbelt Fixed Link rather than the Great Belt after the opening. Compared with FTC 2003, this transfer from the Great Belt is considerably larger, since in the intervening period, the Great Belt has gained market shares compared with the ferries, and particularly in relation to Rødby-Puttgarden.

<table>
<thead>
<tr>
<th>Effect of the Fixed Link</th>
<th>1,000 passengers/year</th>
<th>Proportion in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>New traffic (including negative effects of closing the ferry operations)</td>
<td>113</td>
<td>3</td>
</tr>
<tr>
<td>Changed choice of transport mode (modal split, mainly from air traffic)</td>
<td>263</td>
<td>7</td>
</tr>
<tr>
<td>Route effect – trains (from Padborg/Flensborg)</td>
<td>53</td>
<td>1</td>
</tr>
<tr>
<td>Route effect – coaches (from other ferries and the Great Belt)</td>
<td>289</td>
<td>8</td>
</tr>
<tr>
<td>Route effect – cars (from other ferries and the Great Belt)</td>
<td>3,004</td>
<td>81</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,722</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


The overall picture of the expected development in the number of passenger vehicles on Rødby-Puttgarden/the Fehmarnbelt Fixed Link from 2011 to 2047 can be seen in figure 5.1. The figure illustrates the estimated traffic jump and ramp-up effect, which are expected to impact on traffic trends in the first three years after the Fixed Link opens.
Figure 5.1: Forecast for passenger cars and coaches for the Fehmarnbelt Fixed Link


Note: The two scenarios in the FTC analysis are compared with the actual traffic trends (the Rødby-Puttgarden ferry 2001-2011) as well as FBF 2014

In 2025, when the traffic jump is expected to be fully realised, the number of passenger cars and coaches transported across the Fehmarnbelt will have grown to 3.5 million. This will be followed by a number of years of stable growth to, in the first instance, 4.1 million passenger vehicles in 2035 and 4.7 million vehicles in the long term up to 2047, corresponding to 12,877 a day.  

Following the first year of adjustment, the number of passenger cars is expected to increase by 1.9-2.0 per cent per year for the period 2025-2030 and thereafter by 1.4-1.5 per cent per year from 2031 to 2035. Growth will gradually decline to 1.0 per cent per year by 2047. The FTC model’s forecasts extend to 2047. After 2047, as a precautionary measure, Femern A/S expects zero growth.

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57 The 2047 forecast has been made on the basis of extrapolation, i.e. it is assumed that developments from 2025 to 2035 will continue to be unaffected by new external factors. The extrapolation is degressive, which means that traffic growth is not expected to be linear but on the contrary, will gradually fall up to 2047.
Table 5.13 shows the average annual growth distributed across traffic types in different time periods. Average annual growth of 1.4 per cent is expected for vehicles from the opening year and 25 years ahead. In the financial analysis from 2003 source average annual traffic growth from the opening year and 25 years on was assumed to be 1.7 per cent, which is the average of the high and the low growth scenario of between 0.8 and 2.5 per cent in FTC 2003.

<table>
<thead>
<tr>
<th></th>
<th>Cars and coaches</th>
<th>Lorries</th>
<th>Vehicles in total (road)</th>
<th>Rail freight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2013 - 2047</strong></td>
<td>1.8</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>2022 - 2047</strong></td>
<td>1.4</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Source: Prepared on the basis of the results in the Fehmarnbelt Forecast 2014*, Intraplan and BVU, November 2014

5.5.4. Trends in road freight traffic across the Fehmarnbelt

The Fehmarnbelt Fixed Link is expected to absorb some of the general growth in freight transport estimated between Scandinavia and Continental Europe, but far from all of it. As with passenger traffic, the analysis shows that the Fixed Link will result in a change in the freight traffic pattern, so that freight traffic across the Fehmarnbelt will also increase relatively more than total traffic growth in the corridor.

Due to the expected adjustment period (ramp-up period) in the Fehmarnbelt Forecast 2014, it is assumed that 10 per cent of the lorries with the potential to change route will stay with the original route during the first year following the opening of the Fixed Link.

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Following the opening of the Fehmarnbelt Fixed Link, the number of lorries crossing the Fehmarnbelt will increase from 366,000 in 2011 to 555,000 in 2022, corresponding to 1,520 lorries a day. In the long term, the number of lorries using the Fehmarnbelt Fixed Link is expected to increase to 673,000 in 2035, corresponding to 1,844 lorries a day.

Figure 5.3 shows the trend in road freight transport across the Fehmarnbelt measured in freight volume. **Figure 5.3: Road freight volume across the Fehmarnbelt (1,000 tonnes). Actual development (Rødby-Puttgarden ferry) up to 2013, overlapping with the main scenario, B, and sensitivity scenario, A**


5.5.5. Trends in rail freight traffic across the Fehmarnbelt

The opening of the railway across the Fehmarnbelt to freight traffic will result in a route shift for some freight transport between Scandinavia and Continental Europe. The freight line on the Fehmarnbelt Fixed Link will, therefore, relieve the freight line on the Great Belt link.

The Fehmarnbelt Fixed Link is therefore expected to have a significant impact on the route patterns for rail freight. Transit freight, which is currently transported between Continental Europe and eastern Denmark, Sweden, Norway and Finland via the Great Belt Bridge will, after 2022, use the more direct north/southbound route via the Fehmarnbelt Fixed Link.

Figure 5.4 below shows the trend in rail freight traffic on the Fehmarnbelt Fixed link. As there is currently no rail freight transport across the Fehmarnbelt link, the forecasted trend across the Fehmarnbelt link is shown compared with the trend for the Great Belt link up to 2022.
Overall, freight volumes on the railway across the Fehmarnbelt link are expected to increase by 81 per cent from 2011 to 2035. This means that in 2035, 10.1 million tonnes of rail freight transport are expected across the Fehmarnbelt link.\(^{60}\)

**Figure 5.4: Freight transport by rail (1,000 tonnes) across the Fehmarnbelt compared with the trends for the Great Belt link**

In relation to the number of freight trains, 65 are expected in 2025, 70 in 2030 and 74 in 2035. This expectation depends on a number of assumptions, such as the number of wagons per train, wagon capacity and number of days in operation. These vary a great deal between time periods and train operators. The estimate of the number of trains is outside the scope of the model, and the number is therefore based on the assumptions prepared by the Ministries of Transport in Denmark and Germany in collaboration in “The Joint Committee”, which is responsible for monitoring and promoting the State Treaty.\(^{61}\)


5.5.6. Total number of vehicles on the Fehmarnbelt link

As for total traffic on the link, i.e. both passenger and freight traffic, the main scenario shows that 3.5 million road vehicles will cross the Fehmarnbelt in 2022, which is the first complete year of operation following the opening of the Fixed Link.

In 2025, when the assumed ramp-up period is expected to be over, 4.0 million vehicles will cross the Fehmarnbelt Fixed Link. This corresponds to more than 11,000 vehicles per day all year round. The projection shows that in 2035, 4.8 million vehicles will use the Fixed Link, which corresponds to more than 13,000 vehicles a day on average.

| Table 5.14: Expected daily traffic on the Fehmarnbelt Fixed Link, main scenario in the Fehmarnbelt Forecast 2014 |
|---------------------------------------------------------------|--------|--------|--------|--------|
| Transport mode | 2022* | 2025 | 2035 | 2047 |
| Passenger cars | 7,904 | 9,362 | 11,107 | 12,775 |
| Coaches | 93 | 99 | 101 | 107 |
| Lorries | 1,521 | 1,627 | 1,844 | 2,104 |
| Vehicles on the road, total | 9,518 | 11,088 | 13,052 | 14,986 |
| Passenger train | 32 | 36 | 40 | 40 |
| Freight train** | 61 | 65 | 74 | - |
| Total number of trains | 93 | 101 | 114 | - |


*Note: Includes a phasing-in period (ramp-up) of three years with an expected full phase-in during the fourth year after the opening

**Note: The traffic forecast’s current estimations regarding train traffic only cover up to 2035

5.5.7. Traffic on the Fixed Link in the long term up to 2047

After 2035, the projection of the main scenario shows that altogether 4.7 million passenger vehicles (passenger cars and coaches) will use the Fixed Link in 2047. The number of passenger cars will grow by 1.9-2.0 per cent per year for the period 2025-2030 and by 1.4-1.5 per cent per year for the period 2031-2037. From 2038, annual growth will gradually decline to 1.0 per cent in 2047. After this, zero traffic growth is expected.

For freight traffic, the main scenario projection shows that the number of lorries for the period 2035-2047 will grow by an average of 1.1 per cent per year. Consequently, 768,000 lorries will use the Fehmarnbelt Fixed Link in 2047, 25 years after the opening. After this, zero traffic growth is assumed.

For the railway link across the Fehmarnbelt, in the current assumptions, trains are agreed only until 2035 (74 trains in 2035), when it is expected that 10.1 million tonnes of rail freight will be transported – an increase of 81 per cent from 2011 to 2035.
Table 5.15 provides an overview of the number of passenger vehicles and lorries in 2047.

<table>
<thead>
<tr>
<th></th>
<th>Million (units/year)</th>
<th>2035</th>
<th>2047</th>
<th>Average annual growth 2035-2047</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger vehicles</td>
<td></td>
<td>4.1</td>
<td>4.7</td>
<td>1.2%</td>
</tr>
<tr>
<td>Lorries</td>
<td></td>
<td>0.67</td>
<td>0.77</td>
<td>1.1%</td>
</tr>
</tbody>
</table>


5.6. Sensitivity analyses

5.6.1. Sensitivity scenario I: German growth expectations

While the main scenario is based on the official forecasts for growth from the Danish Ministry of Finance and the OECD, the sensitivity scenario is based on assumptions in the German traffic plan (BVWP). Overall, the sensitivity scenario is characterised by lower expectations for GDP growth in the countries adjacent to the Fehmarnbelt corridor than anticipated by the OECD and the Danish Ministry of Finance. The consequence of diverging growth expectations for the countries in the Fehmarnbelt corridor is that the sensitivity scenario forecasts generally lower growth in traffic between Scandinavia and Continental Europe as a result of economic developments.

In addition, the sensitivity scenario does not encompass the same assumptions about falling transport costs that the Danish Ministry of Transport predicts. In the sensitivity scenario, which is based on German expectations for transport costs, the assumption is rather that transport costs will increase marginally for the period 2011-2035, driven primarily by increasing oil prices.\(^62\)

Table 5.16 below shows the expected development in passenger traffic between Scandinavia and Continental Europe (Baltic section) in German scenario A (sensitivity scenario).
Table 5.16: Forecast for passenger traffic between Scandinavia and Continental Europe in the sensitivity scenario (A) (1,000 passengers/year)

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>2011</th>
<th>2022 (without fixed link)</th>
<th>2022 (with fixed link)</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>Average growth 2025-2035 (% per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train</td>
<td>460</td>
<td>659</td>
<td>1,298</td>
<td>1,338</td>
<td>1,433</td>
<td>1,510</td>
<td>1.2</td>
</tr>
<tr>
<td>Car</td>
<td>8,970</td>
<td>10,492</td>
<td>11,728</td>
<td>12,148</td>
<td>12,895</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Plane</td>
<td>17,226</td>
<td>26,011</td>
<td>25,714</td>
<td>28,510</td>
<td>34,446</td>
<td>39,303</td>
<td>3.3</td>
</tr>
<tr>
<td>Coach</td>
<td>2,320</td>
<td>2,474</td>
<td>2,447</td>
<td>2,518</td>
<td>2,601</td>
<td>2,668</td>
<td>0.6</td>
</tr>
<tr>
<td>Ferry, walk-on passengers</td>
<td>1,512</td>
<td>1,424</td>
<td>982</td>
<td>965</td>
<td>957</td>
<td>950</td>
<td>-0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30,488</td>
<td>41,060</td>
<td>41,229</td>
<td>44,566</td>
<td>51,584</td>
<td>57,326</td>
<td>2.5</td>
</tr>
</tbody>
</table>


As shown in table 5.16, the forecast in the sensitivity scenario is that passenger traffic between Scandinavia and Continental Europe will grow by an average of 2.5 per cent per year for the period 2025-2035 across transport modes. This is slightly lower than the forecast in the main scenario, which predicts passenger traffic growth of 2.8 per cent in the same period.

Table 5.17 below shows the sensitivity scenario’s forecast for traffic across the Fehmarnbelt Fixed Link compared with the forecast from FTC 2003.

Table 5.17: Total number of vehicles on the Fehmarnbelt Fixed Link, sensitivity scenario (A)

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>2011</th>
<th>2022 (with fixed link)</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger cars (1,000)</td>
<td>1,564</td>
<td>2,781</td>
<td>3,314</td>
<td>3,655</td>
<td>3,934</td>
</tr>
<tr>
<td>Coaches (1,000)</td>
<td>31</td>
<td>35</td>
<td>37</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Passenger vehicles in total (1,000)</td>
<td>1,595</td>
<td>2,816</td>
<td>3,351</td>
<td>3,693</td>
<td>3,972</td>
</tr>
<tr>
<td>Lorries (1,000)</td>
<td>336</td>
<td>531</td>
<td>569</td>
<td>607</td>
<td>644</td>
</tr>
</tbody>
</table>


According to the sensitivity scenario, the Fehmarnbelt Fixed Link will experience annual growth of 1.0-2.1 per cent in the number of passenger vehicles up to 2047.

Passenger traffic across the Fehmarnbelt will therefore grow from about 1.6 million passenger vehicles (cars and coaches) in 2011 to almost 3.3 million after the opening, i.e. the adjustment period for the Fixed Link. Subsequently, stable growth to 4.0 million passenger vehicles is expected in 2035.
In 2047, the projection of the sensitivity scenario shows that the total number of passenger vehicles will be 4.7 million.

For freight traffic\(^{63}\) the sensitivity scenario shows growth of between 1.0 and 1.3 per cent per year in the number of lorries using the Fehmarnbelt Fixed Link for the period 2025-2047.

The sensitivity scenario thereby represents a generally more conservative estimate for traffic trends, in particular caused by the lower expectations for economic development. Despite the lower expectations for traffic growth, the sensitivity scenario’s forecast lies within the range for traffic trends that appears from the original FTC forecast from 2003.

5.6.2. Sensitivity scenario II: Continued ferry service

Intraplan and BVU have conducted an analysis of continued ferry services that looks at the effect on the Fehmarnbelt link, including on profitability in relation to maintaining parallel ferry operations between Rødby and Puttgarden. The analysis concludes that it is not an economically viable to continue the ferry service between Rødby and Puttgarden when the Fixed Link across the Fehmarnbelt opens. In the light of this analysis, it is therefore assumed in both the main scenario and the sensitivity scenario in the Fehmarnbelt Forecast 2014 that the ferry link between Rødby and Puttgarden will cease when the Fixed Link opens.\(^{64}\)

However, as an additional sensitivity analysis, Intraplan and BVU have outlined scenarios for a situation whereby the ferry between Rødby and Puttgarden remains in operation after the Fehmarnbelt Fixed Link opens. Here it is assumed that the fare for the ferry crossing will be reduced to 25 per cent lower than the cost for crossing the Fixed Link. The parallel ferry therefore represents a cheaper alternative in terms of price compared to the Fehmarnbelt Fixed Link. It is therefore expected that the ferry will be mainly attractive for the most price-conscious and least time-sensitive passengers, mainly in the form of holiday-makers who will be concentrated in the peak holiday season and certain weekends.

Intraplan and BVU have outlined two different scenarios with parallel ferry operations whose assumptions are set out below.

Continued ferry service – two-hour service:
- One ferry between Rødby and Puttgarden will remain in operations with departures every other hour.
- The crossing time is 45 minutes, corresponding to the actual crossing time on the route today.
- The fare for the crossing will be reduced to DKK 1,490 for lorries and DKK 365 for passenger cars, which corresponds to a saving of 25 per cent in relation to the cost of crossing the Fehmarnbelt Fixed Link.

Continued ferry service – one-hour service:
- Two ferries between Rødby and Puttgarden will remain in service with departures every hour.
- The crossing time is 45 minutes, corresponding to the actual crossing time on the route today.

\(^{63}\) See figure 5.3 and 5.4 for the forecast for freight traffic across the Fehmarnbelt in the sensitivity scenario

\(^{64}\) “Fehmarnbelt Forecast 2014”, Intraplan and BVU, November 2014, page 187
The fare for the crossing will be reduced to DKK 1,490 for lorries and DKK 365 for passenger cars, which corresponds to a saving of 25 per cent in relation to the cost of crossing the Fehmarnbelt Fixed Link.

Table 5.18 shows the effect of a parallel ferry service on passenger traffic on the Fehmarnbelt Fixed Link with ferry departures every other hour.65

![Table 5.18: Effect of continued ferry operations every other hour](image)

<table>
<thead>
<tr>
<th>Transport modes</th>
<th>2022</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passengers (1000/year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>passengers in cars</td>
<td>-737</td>
<td>-849</td>
<td>-919</td>
<td>-974</td>
</tr>
<tr>
<td>passengers in coaches</td>
<td>-114</td>
<td>-121</td>
<td>-128</td>
<td>-134</td>
</tr>
<tr>
<td>passengers in trains</td>
<td>-8</td>
<td>-8</td>
<td>-5</td>
<td>-4</td>
</tr>
<tr>
<td>ferry, walk-on passengers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Vehicles (1000/year)

<table>
<thead>
<tr>
<th>Transport modes</th>
<th>2022</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars (incl. motorcycles)</td>
<td>-284</td>
<td>-328</td>
<td>-354</td>
<td>-370</td>
</tr>
<tr>
<td>Coaches</td>
<td>-3</td>
<td>-3</td>
<td>-4</td>
<td>-4</td>
</tr>
</tbody>
</table>


Table 5.19 shows the effect of a parallel ferry with departures every hour. The basis for comparison in both cases is the main scenario in the Fehmarnbelt Forecast 2014.

![Table 5.19: The effect of continued ferry service every hour](image)

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>2022</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passengers (1000/year).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>passengers in cars</td>
<td>-1,031</td>
<td>-1,159</td>
<td>-1,240</td>
<td>-1,297</td>
</tr>
<tr>
<td>passengers in coaches</td>
<td>-144</td>
<td>-152</td>
<td>-161</td>
<td>-169</td>
</tr>
<tr>
<td>passengers in trains</td>
<td>-12</td>
<td>-12</td>
<td>-9</td>
<td>-7</td>
</tr>
<tr>
<td>ferry, walk-on passengers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Vehicles (1000/year)

<table>
<thead>
<tr>
<th>Transport modes</th>
<th>2022</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars (incl. motorcycles)</td>
<td>-397</td>
<td>-448</td>
<td>-477</td>
<td>-492</td>
</tr>
<tr>
<td>Coaches</td>
<td>-4</td>
<td>-4</td>
<td>-5</td>
<td>-5</td>
</tr>
</tbody>
</table>

The sensitivity analysis for continued ferry operations shows that a parallel ferry will impact traffic across the Fehmarnbelt Fixed Link and total traffic between Scandinavia and Continental Europe, albeit to a modest extent. The lower ferry fare may prompt some passengers to opt for a car instead of a train.

<table>
<thead>
<tr>
<th>Ferry departure</th>
<th>2022</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every other hour</td>
<td>10%</td>
<td>9%</td>
</tr>
<tr>
<td>Every hour</td>
<td>14%</td>
<td>12%</td>
</tr>
</tbody>
</table>

With ferry departures every other hour, the parallel ferry service will result in a fall in traffic on the Fixed Link of 284,000 cars and 3,000 coaches in 2022 and a fall of 370,000 cars and 4,000 coaches in 2035. This corresponds to a traffic loss of about 10 per cent in 2022 and 9 per cent in 2035 compared with the main scenario with no parallel ferry service.

With ferry departures every hour, the parallel ferry service will result in a fall in traffic of 397,000 cars and 4,000 coaches on the Fixed Link in 2022 and a fall of 492,000 cars and 5,000 coaches in 2035. This corresponds to around 14 per cent in 2022 and 12 per cent in 2035 compared with the main scenario with no parallel ferry service.

Freight traffic will also, to a modest extent, be affected by parallel ferry operations. With a two-hour service, the parallel ferry service will mean a reduction of 12 per cent in the number of lorries on the Fehmarnbelt Fixed Link compared with the main scenario with no continued ferry service. For rail freight, no real reduction is evident in relation to the scenario with continued ferry services. Overall, the parallel ferry service every other hour means that the volume of freight on the Fixed Link will grow by an average of 2.3 per cent per year against an average of 2.6 per cent per year with no ferry service.

With a one-hour service, the parallel ferry service will mean a fall of 15 per cent in lorry traffic compared with the main scenario with no continued ferry service. On the railway, the continued ferry service with departures every hour will have no significant impact on the volume of rail freight, which will be approx. 10.1 million tonnes per year, while average growth in freight volumes on the Fixed Link will be 1.9 per cent per year instead of 2.6 per cent per year.

The forecast for parallel ferry operations with a two-hourly service is that 0.4 million vehicles will use the ferry rather than the Fixed Link in 2022, and around 0.5 million vehicles will take the ferry in 2035. With a one-hourly service, estimates show that 0.54 million vehicles will choose the ferry rather than the Fixed Link in 2022, and that this figure will have risen to 0.65 million vehicles by 2035.

In both cases, the analysis shows major seasonal fluctuations in traffic. It is expected that traffic will be concentrated in the summer months and at certain weekends, which is why ferry occupancy will vary dramatically. With a two-hourly service, each ferry crossing will accommodate an average of 46 vehicles in 2022 and 57 vehicles in 2035. In the one-hourly service scenario, average occupancy per ferry will be 31 vehicles in 2022 and 37 in 2035.
In the light of this, according to Intraplan and BVU there is every likelihood that a continued ferry service will not be economically sustainable.66

5.7. Summary: forecast based on the FTC model

- The Fehmarnbelt Forecast 2014 shows that the forthcoming Fehmarnbelt link will be part of a growing transport corridor and will itself generate traffic growth.

- The main scenario shows that passenger traffic across the Fehmarnbelt will more than double for the period 2011-2025. Traffic growth will in part be driven by the generally growing traffic volumes between Scandinavia and Continental Europe. Here the Fehmarnbelt Forecast 2014 shows that there will be average annual passenger growth of 3.0 per cent across transport modes between Scandinavia and Continental Europe for the period 2011-2035, while freight volumes for the same period will increase by 2.3 per cent.

- However, growth will also be driven by the fact that the Fehmarnbelt link is expected to have an increased share of the growing traffic volume because the Fixed Link, together with the other infrastructure changes in the region, will result in considerable time savings compared with the existing transport options.

- The Fehmarnbelt Forecast 2014 calculates that from 2025, when the ramp-up period has ended, and until 2030, the number of passenger cars on the Fehmarnbelt link will grow by 1.9-2.0 per cent per year. For the period from 2031 to 2037, the number of passenger cars will increase by 1.4-1.5 per cent per year after which growth will continually decline to 1.0 per cent per year in 2047. The FTC model’s forecasts extend until 2047. After 2047, i.e. 25 years after the Fixed Link opens, as a precautionary measure, Femern A/S is assuming zero growth.

- The forecast predicts that traffic across the Fehmarnbelt will experience a traffic jump of 54 per cent when the Fixed Link opens. It is assumed in the forecast that the traffic jump will occur over a number of years during the ramp-up period. The expectation of a ramp-up period is a precautionary measure which takes account of the time it will take for traffic patterns to adjust when a new transport option opens.

- The forecast for overall passenger traffic is that approx. 2.9 million passenger vehicles (cars and coaches) will cross the Fehmarnbelt Fixed Link in 2022, corresponding to 7,997 vehicles per day. In 2025, 3.5 million passenger vehicles will cross the Fehmarnbelt Fixed Link. This corresponds to 9,461 vehicles day, year round.

- The number of freight trains expected to use the Fixed Link in 2022 will be 61 freight trains per day, increasing to 74 freight trains per day in 2035. For passenger train traffic, passenger numbers will double when the link opens.

- The projection of the forecast shows that 4.7 million passenger vehicles, 768,000 lorries and 623,000 freight train wagons will use the Fehmarnbelt Fixed Link in 2047, which is 25 years after the tunnel opens.

- If the sensitivity scenario is used instead, which is based on German growth expectations for economic growth in the countries around the Fehmarnbelt corridor, the number of passenger cars on the Fehmarnbelt Fixed Link will experience annual growth of 1.0-2.1 per cent for the period from

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2026 to 2047 (corresponding to the main scenario), while the number of lorries will grow by between 1.0 and 1.3 per cent per year for the period 2026 to 2047.

- Furthermore, the analysis of the scenario with continued ferry operations between Rødby and Puttgarden following the opening of the Fixed Link shows a small reduction in the expected traffic. The assessment is that the traffic that will choose the ferry rather than fixed link will be so limited that the parallel ferry operations will hardly be financially viable, even with reduced ferry fares.

- If the Fehmarnbelt Forecast 2014 is compared with FTC 2003, it is evident that both the main scenario for traffic trends on the Fehmarnbelt Fixed Link and the German sensitivity scenario lie within the range presented in the two original scenarios in FTC 2003.

It appears from the government’s legislative programme for the parliamentary year 2014/15 that a Construction Act for a Fehmarnbelt Fixed Link will be presented in February 2015. In this connection, this report presents a complete forecast for traffic expectations for the Fehmarnbelt link.

The clear intention is for the debate on the Construction Act to be conducted on an informed and transparent basis. Therefore, all analyses are published at www.femern.dk. Any enquiries concerning the forecasts should be addressed to femernprognose2014@femern.dk.
Appendix 1: Tunnel phobia and tunnel discomfort

The 18 km immersed tunnel under the Fehmarnbelt will be the longest immersed tunnel in the world. Femern A/S is intent on constructing a safe tunnel that both minimises the risk of accidents and, should an accident occur, facilitates easy evacuation. However, this high safety level does not change the fact that some people experience a level of discomfort when driving through long tunnels.

Tunnel phobia

It is estimated that about 1-3 per cent of the population have a tunnel phobia (an irrational fear of tunnels) that means they avoid driving in them. The number of people with tunnel phobia is estimated to be on a par with the number of people suffering from other phobias, such as anxiety when driving across long bridges and anxiety when sailing. It is also estimated that the phobia can be treated to the same level as fear of flying.*

Tunnel discomfort

Tunnel discomfort is a milder form of aversion to driving in tunnels compared to tunnel phobia. There is currently very limited research on the impact of tunnel discomfort on traffic volume in existing tunnels. However, studies show that very few people with tunnel discomfort reject a route with a tunnel if the alternative is more difficult or time-consuming.*

Light and colours shorten the trip

The Fehmarnbelt tunnel will be designed with the aim of reducing any potential tunnel discomfort as much as possible. The tunnel interior will have colourful and good lighting to help ensure that the ten-minute journey offers a diverse experience so that the journey appears shorter. The Fehmarnbelt tunnel will also be equipped with emergency lanes to make it light and spacious.

Overall, it is estimated that tunnel phobia and discomfort will have no notable effect on traffic volume on the Fehmarnbelt Fixed Link. In addition, people who choose not to use the tunnel but prefer to sail across the Fehmarnbelt or use the Great Belt Bridge are expected to be more or less counterbalanced by people who opt for the tunnel due to their dislike of sailing or long bridges.
Appendix 2: Trans-Tools and Fehmarnbelt Forecast

In this appendix, the Trans-Tools model is compared with the FTC model. This has been carried out to provide a picture of the traffic growth in the forecasts that are compared in the report. However, the Trans-Tools forecast and FTC model are based on very different model backgrounds and also operate with different geographical and timing limitations. In addition, the Trans-Tools results are not related to individual years, but only to the overall period 2005-2030. Finally, as the Trans-Tools model provides a forecast for the traffic in the Fehmarnbelt corridor as a whole, the growth percentages cannot be compared directly with the Fehmarnbelt Forecast 2014 for specific traffic between Rødby and Puttgarden.

Therefore, when compared with the Fehmarnbelt Forecast 2014 results in a number of areas, assumptions and calculations must be made to enable direct comparisons. Traffic figures must be also be projected to the period corresponding to the Fixed Link’s estimated repayment horizon (39 years).

Table 1 compares the two forecasts via a number of technical calculations.

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Growth per year (2005-2030)</th>
<th>Growth per year (2011-2047)</th>
<th>Growth per year (2022-2047)</th>
<th>Growth per year (2026-2047)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger vehicles (FBF 2014)</td>
<td></td>
<td>3.0%</td>
<td>1.9%</td>
<td>2.5%</td>
</tr>
<tr>
<td>The Trans-Tools model’s result (passengers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trans-Tools – estimated annual growth after the traffic jump for passenger traffic</td>
<td></td>
<td>3.3%</td>
<td>2.7%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Lorries (FBF 2014)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Trans-Tools model’s result (lorries)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trans-Tools – estimated based on FTC volumes for lorries</td>
<td></td>
<td>3.4%</td>
<td>3.4%</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

Source: Calculation based on the Fehmarnbelt Forecast, November 2014 and “Forventet trafikudvikling i Femern-korridoren, Tetraplan, November 2014” (Expected traffic trends in the Fehmarnbelt corridor, Tetraplan, November 2014)
The results of the comparison are:

- The Fehmarnbelt Forecast 2014 shows average annual traffic growth of 3 per cent for passenger cars and 3 per cent for lorries during the entire forecast period.

- Trans-Tools shows average annual traffic growth of 4 per cent for passenger cars and 3.4 per cent for lorries during the entire forecast period.

- The growth after the traffic jump and ramp-up period in the Fehmarnbelt Forecast 2014 is an average of 1.4 per cent for passenger cars and 1.2 per cent for lorries.

- If a traffic jump corresponding to the FTC model’s is incorporated in the Trans-Tools result, the Trans-Tools forecast shows average annual growth of 2.7 per cent for passenger cars.

In conclusion, the estimated annual traffic growth in the Trans-Tools forecast is somewhat higher than the FTC forecast, both viewed across the entire forecast period and with a traffic jump included. This implies that the FTC forecast results are cautious in terms of future traffic growth.

**Method behind the comparison**

To make the above possible, the following factors were used.

**Passenger cars**

- Absolute figures in the base year (2005) and estimation for Rødby-Puttgarden (the Fixed Link):
  - Trans-Tools estimations refer to Rødby-Puttgarden, Gedser-Rostock and Swedish-German ferry routes and also have unequal figures in the base year.
  - Solution: apply the actual traffic figures for Rødby-Puttgarden and projection with Trans-Tools’ growth percentage (4.0 per cent). From 2005 – 2021.

- The traffic jump:
  - Calculation of the traffic jump is based on the estimated traffic during the opening year in the Fehmarnbelt Forecast 2014 update, corresponding to DKK 1,298 million vehicles per year (3,556 cars per day).
  - The projection from the start year for Trans-Tools (from 2005 with 4 per cent) results in a total of 553,000 “missing” cars in the opening year in order to achieve the traffic figure in the opening year in the Fehmarnbelt Forecast 2014.
  - The “missing” traffic in the opening year is (“borrowed” or) taken from the traffic in the years following the opening.
  - The traffic growth after the opening is calculated based on the traffic in 2036 (25 years after the base year (2011) in FBF 2014.) The base year traffic, projected with the Trans-Tools’ growth percentage of 4 per cent results in 4,252 million vehicles per year.
  - The annual growth percentage from the first year after the opening until 2036 is estimated as 2.7 per cent.
  - The ramp-up effect/period is as in FBF 2014 (without the ramp-up effect approx. 1.9 per cent per year)
• Traffic volume in 2047
  - The annual growth percentage of 2.5 is subsequently multiplied by the traffic figure from 2023 and onwards.
Lorries

- Absolute figures at the starting point (2005) and estimation for Rødby-Puttgarden (the Fixed Link):
  - As above

- The traffic jump:
  - Included in the FTC model but not in the Trans-Tools volumes

- Traffic volume in 2047
  - Based on actual traffic in the Fehmarnbelt Forecast 2014 base year (2011) projected with Trans-Tools’ 3.4 per cent