Jernbaneverket
Norwegian High Speed Railway Assessment Project

Contract 5 Market Analysis
Subject 5 Market Conditions for Fast Freight Trains

Final Report
14/02/2011
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Contract 5: Market Analysis

Subject 5: Market Conditions for Fast Freight Trains

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Executive Summary

Introduction

This report has considered the market conditions for fast or high speed rail (HSR) freight services on the Norwegian and Norwegian/Swedish corridors being considered for an HSR network.

The study brief requires consideration of the following:

- Combined freight and passenger trains, including the requirements for stations/terminals and time spent on loading/unloading cargo and any impact on train frequency;
- The market for high speed freight trains, including a study of current freight flows in the corridors (by all means of transport) and an assessment of possible transferable volumes to high speed freight trains;
- Interest among cargo shippers to use fast freight trains and the decisive factors in the choice of mode of transport;
- Assessment of the railway’s advantages and disadvantages compared to road and air transport for freight transport; and
- Willingness to pay for the new service, and expected price for high speed rail freight transport, compared with cost levels in other transport modes.

This market analysis has considered:

- The HSR or improved rail ‘concepts’ or scenarios to be tested for the wider passenger HSR studies;
- Examples (or proposals) in other countries of fast or HSR freight services;
- A survey of potential users of such HSR freight services in Norway and Sweden;
- Use of the Norway/Sweden Freight Model to assess likely market demand;
- A consideration of the costs of providing such freight services; and
- An overall assessment, including financial and non-financial aspects.

‘Fast’ and ‘High Speed’ Rail Freight

The brief for this study refers to both ‘fast’ and ‘high speed’ rail freight services. After considering similar services in other countries, we have defined these services as follows:

- ‘high speed’ rail freight: maximum speed greater than 200km/h; and
- ‘fast’ rail freight: maximum speed greater than around 120-160 km/h.

By comparison, ‘conventional’ rail freight can be considered to have a maximum speed less than around 120-160 km/h – in practice the operating speeds are usually much less than this because of delays introduced by the need for shunting and train assembly (the Norway/Sweden Freight Model suggests current conventional rail freight services on the corridors have an average speed of 65 km/h or less).

Types of Fast Freight Train

The report has considered two broad types of fast/HSR freight service:

- Dedicated freight trains; and
- Mixed passenger/freight trains.

We have assumed, in the light of previous studies, that the technical features of the HSR network would be defined primarily by the needs of passenger trains. HSR freight trains would therefore require similar characteristics to the passenger trains (for example, in acceleration, axle-load,
aerodynamics, etc.). This implies that the HSR freight trains would need to be essentially converted passenger train sets, which would allow the greatest timetabling flexibility.

Given the obvious need to retain the key advantages of HSR freight – speed and reliability – we have assumed that both types of train would be fixed formation. We have concluded that it would be difficult to operate HSR freight services if there were a need to operate with part-trains or ‘wagonload’ traffic – where individual wagons or groups of wagons would have to be shunted together to form complete trains - as this would cause delays that would have a negative impact on the journey times.

One advantage of mixed passenger/freight HSR trains is that there would be no timetable conflict between freight and passenger services. The main drawback is that there would be, inevitably, a limited capacity available for freight and - more importantly - this capacity would either subtract from the capacity available for passengers or result in longer trains.

**Potential High Speed Rail Scenarios**

The study considered Jernbaneverket’s (JBV) ‘concepts’ or scenarios for the development of a HSR network.

We have assumed that scenarios involving an upgrading of the existing rail infrastructure may offer the possibility of introducing ‘fast’ rail freight services. New high speed lines would be required to offer HSR freight services.

It has been assumed that the infrastructure developed primarily for HSR passenger services would not have significant spare capacity for freight; therefore, providing this additional capacity would have an additional – and probably significant – capital cost.

**Overview of Potential Impacts**

The main benefit of fast or HSR freight services is clearly increased speed. Also, because of the need to adhere to an HSR timetable for passenger services, the freight services will be more reliable than conventional rail freight services (where journey times are typically much more flexible).

The downside of HSR freight in mixed passenger/freight trains is that because of the need for quick loading and limited storage space, the quantity of freight that could be carried would be limited.

The transfer of freight from air or road would have some social benefits, in particular:

- Reduction of road accidents, due to the fewer overall road vehicle trips; and
- Reduced emissions profile - including CO₂ (although it should be noted that high speed trains have higher overall emissions than conventional rail).

One impact of HSR network development may also be some capacity benefit for conventional rail freight services (due to a reduction in conventional passenger rail services), although this effect is expected to be relatively small due to the need to continue to serve smaller intermediate stations (that would not be served by the HSR passenger service).

The Norway Freight Model shows a significant potential for increasing the tonnage of goods carried by rail if journey times by rail can be substantially reduced.

**Level and Potential Size of Market Interest**

Fast rail freight services could compete with parallel air and road freight services (as well as conventional rail services). There might also be competition between fast rail freight service providers – although this seems unlikely, given the high ‘barriers to entry’ of specialised rolling stock and limited train paths.

The message we have received from the market is mixed. Several respondents have confirmed that reliable, fast HSR freight services could play a role in their distribution services. However, cost will be a major issue, given the competition from road, air and conventional rail.
As the market study has shown, the potentially attractive price that shippers would accept for fast/HSR freight depends on which mode of transport is currently being used:

- 100%-110% of the current cost of road transport (for traffic currently moving by road);
- 100%-107% of the current cost of rail freight (for traffic currently moving by rail); or
- Up to 200% of the current cost of road transport or half the current air freight cost (for traffic currently moving by air).

**Mixed HSR Passenger/Freight Trains**

Our survey of potential users has indicated that shippers of domestic air freight would be willing to consider HSR freight services if the cost is around half that of air freight per cubic metre (this would be about twice the cost of road delivery). Our analysis suggests that there may be sufficient demand for HSR freight movements carried in an HSR mixed passenger/freight train. The order of magnitude of air freight on the corridors concerned—tens of tonnes per day—is more suited to the freight capacity on a mixed passenger/freight train than for a dedicated fast freight train. Moreover, some products, like newspapers and magazines might be transported efficiently to city centres by a mixed passenger/freight service that stops in the central main station. One essential requirement will be the incorporation of an early morning delivery in the passenger timetable.

**Dedicated Fast/HSR Freight Trains**

As has been identified by the survey and the Norway Freight Model, there is potentially significant demand for a transfer from road to fast/HSR freight, although shippers are not willing to pay a significant premium to transfer from road to rail—even with the doubling or tripling of average speeds.

Thus, if the costs of service delivery could be kept low, demand could potentially outstrip the capacity that could be provided in mixed passenger/freight trains if fast/HSR freight trains. However, providing track capacity for dedicated freight trains would be additional to what would be needed to serve the purely passenger market and would, therefore, probably incur additional significant capital and operating costs.

We have not been able to assess the potential demand from Posten Norge, which—in any case—has a policy of using rail as much as possible, and presumably would be interested in improvements in their level of service. However, the indications from experience in other countries are that postal services, facing a highly competitive logistics and distribution market, would find it difficult to finance a premium HSR postal rail service. Commercial Feasibility

To be commercially feasible, the cost structure of fast rail freight must be suitable to deliver services within the cost ranges indicated above. The introduction of fast/HSR freight services would require investment in:

- Rolling stock;
- Station/terminal facilities; and
- Cargo containers and handling equipment.

Revenue would have to cover the vehicle capital (capex) and operating (opex) costs before it could make a contribution towards any necessary rail infrastructure costs.

Air freight is commercially the most attractive market, given the potential price. However, the size of this market is relatively small and could be adequately served by the limited capacity provided by mixed passenger/freight services.

For larger flows of freight, that are sufficient to justify dedicated HSR freight trains, it would be necessary to attract traffic from road transport, for which there is likely to be little price premium. It is also likely that dedicated fast freight trains would require significant additional capex (both infrastructure and rolling stock) and opex costs.
The greatest opportunity appears to be for a shared passenger/freight service targeting air freight traffic, as the quantity/price/cost equation may be satisfactory. However, the quantities of cargo that would be carried would be limited.

For dedicated fast freight trains (which would depend on a transfer from road transport), it is anticipated that it would be challenging to deliver capex and opex costs that would be comparable to road transport, even at the relatively long distances covered by the identified corridors.

Thus, although conventional rail freight may be price-competitive over longer distances compared with road haulage (in the sense that less investment may be needed in new rolling stock), it seems unlikely that dedicated fast rail freight trains would be. International experience seems to support this conclusion – the only dedicated HSR freight service (TGV La Poste) has had to reduce its service due to lack of demand (and was unable to market its service to a wider courier market).

At present it is not possible to determine whether mixed HSR passenger/freight trains or dedicated HSR freight trains would be commercially viable. Further analysis would be required, based on the costs emerging from the ongoing rolling stock and alignment work under Phase 3 of this project. Further freight modelling may be useful in assessing the demand for fast rail freight services with an average speed of less than 160 km/h to understand better the role of journey speed in encouraging transfer from road to rail.

**Potential contribution to Business Case and Cost/Benefit Ratio**

For the reasons described above, it seems unlikely that provision of fast/HSR freight services would generate a significant contribution to the overall HSR business case.

Other social or environmental impacts would depend on the scale of transfer from air or road transport. For HSR mixed passenger/freight trains, these are expected to be small (because of the relatively small quantities of freight likely to be attracted); for dedicated HSR freight services, these could be larger.

**Impact on Conventional Rail Freight Services**

One aspect not considered (as it was outside the scope of the study) was the potential impact on conventional rail freight services of any release of capacity due to the development of additional HSR capacity for passenger services.

It is possible that improvements to the rail network will create additional capacity for other conventional services, including freight. This may provide an opportunity to improve some conventional freight services and to increase the market share of rail freight.

**Overall Conclusion**

The overall conclusion is that there does seem to be a significant potential demand for fast and HSR freight services; however the commercial viability of supplying these services remains unclear, as the cost of the required infrastructure to provide capacity for freight services - and rolling stock costs - are unknown.

In terms of the target markets, it can be concluded that air freight shippers (as opposed to those currently using road and rail transport) would be more interested in HSR freight services (as speed is a significant decision factor). To attract air freight to mixed passenger/freight trains, a key aspect would be an efficient connection with Oslo Airport, the national air freight hub.

For the much larger current flows of express goods and parcels that use road freight, the market appears to be interested in significantly faster train speeds than at present. The corridor that seems to have the most potential for the development of dedicated fast freight trains (based on demand predicted by the Norway Freight Model) is Oslo – Bergen.

However, the modelling seems to indicate that increasing speeds from a ‘fast’ rail freight service as we have defined it – i.e. under 200km/h maximum speed – to a high speed service (over 200km/h) does not seem to be able to command a significant additional price premium for current
road shippers. It may be useful to carry out some further modelling to understand better the relationship between average train speed and transfer from road transport. Recommendations

The most promising market for High Speed Freight (maximum speed greater than 200km/h) in our view appears to be the air freight market and the size of this market is comparable with the capacity of fast/HSR mixed passenger/freight trains. However, further study would be required to determine whether these services could be provided in a way that covers the costs involved.

Given the high degree of uncertainty it is obviously wise to proceed with caution. A key question remains: can fast or HSR freight services be provided within the revenue envelope implied by the findings on price premium and the – as yet undetermined – structure and level of related infrastructure, rolling stock and operating costs?

Clearly, further study will be required (for example, in Phase 3 of the project) to assess both the commercial viability and cost/benefit outcomes of the following two main options on specific routes:

- Fast mixed passenger/freight trains targeting primarily air freight and very time-sensitive courier shipments, at a premium charge, with a capacity of around 2-5t per train; and

- Fast dedicated freight trains targeting primarily a transfer from road (and potentially conventional rail), with a capacity of 100-200t per train.

The following process is suggested for such a follow-up study:

- Define the assumptions for availability (if any) of freight paths, capacity and journey times (working with the rolling stock contractor) on each corridor, in line with the assumptions of the passenger services proposed;

- Determine the additional cost of providing a fast freight capability (either mixed passenger/freight or all-freight trains) compared to passenger-only infrastructure and rolling stock required;

- Forecast demand and revenue to be gained from freight services (possibly using the Norway Freight Model, as we have in this study), particularly to investigate further the likely behaviour of road shippers to average rail speeds less that 160km/h;

- Compare the revenue with the additional capital and operating costs to determine the overall commercial viability of the freight services; and

- Consider other socio-economic costs and benefits of such services.

In addition, the treatment of any competing demand for capacity for regional passenger services would need to be considered.

Furthermore, the concept of a fast/HSR dedicated train for courier/post traffic should be followed up with Posten Norge, to investigate whether this organisation would be willing to finance – in part or in whole - the capital costs of such an initiative on its own.

We would like to express our gratitude to the contacts in the various organisations that contributed to the survey.
1. Introduction

1.1 Background

Jernbaneverket (JBV) has been mandated by the Norwegian Ministry of Transport and Communications to assess the issue of High Speed Rail (HSR) lines in Norway. There is a National Transport Plan covering the period from 2010-2019 which includes relatively minor enhancements to the railway network. The ministry wishes to understand if going beyond this and implementing a step change in rail service provision in the form of higher speed concepts could “contribute to obtaining socio-economically efficient and sustainable solutions for a future transport system with increased transport capacity, improved passability and accessibility”.

Previous studies have been carried out looking into HSR in Norway and there are various conflicting views. The aim of this study is to provide a transparent, robust and evidence based assessment of the costs and benefits of HSR to support investment decisions.

The study has been divided into three phases:

• In Phase 1, which was completed in July 2010, the knowledge base that already existed in Norway was collated, including outputs from previous studies. This included the studies that already were conducted for the National Rail Administration and the Ministry of Transport and Communication, but also publicly available studies conducted by various stakeholders, such as Norsk bane AS, Høyhastighetsringen AS and Coinco North.

• The objective of Phase 2 is to identify a common basis to be used to assess a range of possible interventions on the main rail corridors in Norway, including links to Sweden. The work in Phase 2 will use and enhance existing information, models and data. New tools will be created where existing tools are not suitable for assessing high speed rail.

• In Phase 3 the tools and guiding principles established in Phase 2 will be used to test scenarios and options on the different corridors. This will provide assessments of options and enable recommendations for development and investment strategies in each corridor.

This report is a component of the Phase 2 work.

The principles established in Phase 2 are to be used to test four scenarios:

• Scenario A – reference case. This is a continuation of the current railway policy and planned improvements, with relatively minor works undertaken shown in the National Transport Plan from 2010-2019. This forms the ‘do minimum’ scenario to which the other scenarios will be compared;

• Scenario B – upgrade. A more offensive development of the current infrastructure, looking beyond the ‘InterCity’ area;

• Scenario C – major upgrades achieving high speed concepts. This is to be based on an aggressive upgrade of the existing network to provide a step change in journey times; and

• Scenario D – new HSR. This involves the implementation of newly built, separate HSR lines.

The improvements are being considered on six corridors:

• Oslo – Bergen;
• Oslo – Trondheim;
• Oslo – Kristiansand and Stavanger;
• Bergen – Stavanger;
• Oslo – Stockholm (to Skotterud in Norway); and
• Oslo – Gothenburg (to Halden in Norway).

The scenarios will be considered in relation to the long distance travel market, for example for journeys over 100km in distance. Other studies, such as the InterCity Study will look at initiatives for shorter distance travel at a more regional level. Various route alignments, stop patterns, station designs, speed standards and fares will be tested. It will be necessary to assess conditions related to income and costs, environmental concerns, energy consumption, maintenance under winter conditions and the procurement and operational organisation of the services and infrastructure.

1.2 Overall Context of the Market Analysis Contract

To achieve Phase 2 of the study, Jernbaneverket has commissioned 6 Contracts:

• Technical and Safety Analysis;
• Rail Planning and Development;
• Environmental Analysis;
• Commercial and Contract Strategies;
• Market Analysis; and
• Financial and Economic Analysis

WS Atkins International Ltd (Atkins) is assisting Jernbaneverket in two of the contracts: Market Analysis and Financial and Economic Analysis. This report is part of the Market Analysis Contract.

The Market Analysis contract consists of five Subjects:

• Subject 1: Demand potential for high speed rail services in Norway;
• Subject 2: Analysis of expected amount of ticket revenues;
• Subject 3: Passengers choice – preferences for travel and means of transport;
• Subject 4: Location and services of stations / terminals; and
• Subject 5: Market conditions for fast freight trains.

The purpose of the Market Analysis Contract is to establish the size of the potential HSR passenger and freight markets under different HSR scenarios. This involves identifying the current market and its projected growth, mode share and the preferences and priorities of those markets. The current market is used as a basis, together with expected willingness to pay for new services, to forecast how much of this market would be attracted to new HSR scenarios and how much additional demand may be induced.

This report provides the outputs for Subject 5.

1.3 Purpose of this Report

This report deals with Subject 5: Market conditions for fast freight trains, which is part of the overall economic assessment, assessing the contribution that freight services might make to the business case for High Speed Rail in Norway.

The Terms of Reference for this Study require:

• An assessment of market conditions for different types of freight transport in the corridors;
• A judgement of whether there would be a market for new services with fast freight trains;
• An assessment of:
  - Combined freight and passenger trains;
  - Existence (or not) of a market for high speed dedicated freight trains;
Interest among shippers to send their goods with high speed freight trains;
- Assessment of railways advantages & disadvantages compared to road and air; and
- Willingness to pay for new service, expected price for freight transport.

This report is essentially an assessment of the market conditions for new services with fast
freight trains, including separate trains or parts (wagons) included in high speed passenger trains – although the study brief notes that other alternatives may be proposed.

The study brief requires consideration of the following:

- Combined freight and passenger trains, including the requirements for stations/terminals and
time spent on loading/unloading cargo and any impact on train frequency;
- The market for high speed freight trains, including a study of current freight flows in the
corridors (by all means of transport) and an assessment of possible transferable volumes to
high speed freight trains;
- Interest among cargo shippers to use fast freight trains and the decisive factors in the choice
of mode of transport;
- Assessment of the railway’s advantages and disadvantages compared to road and air
transport for freight transport; and
- Willingness to pay for the new service, and expected price for the freight transport,
compared with cost levels in other transport modes.

1.4 Contributors

This report has been produced by Atkins with the participation of:

- Institute of Transport Studies, University of Leeds¹ – Anthony Whiteing and Anthony Fowkes
provided advice on the content of the freight rail user survey form and the interpretation of
the survey results; and
- Significance² – Gerard de Jong used the existing Norway Freight Model (which he helped to
develop) to assess current freight flows on the corridors and undertook test runs of the
model to assess the likely response of shippers to fast freight rail services.

1.5 Freight on Conventional Lines

Where rail freight transport on the conventional rail network is currently limited by capacity
constraints, and where this capacity might be increased if conventional passenger services are
replaced (in whole or in part) by high speed rail services, there may be some potential benefits as
a result of a transfer of freight from road transport to conventional rail.

However, this issue is outside the scope of this fast freight study.

1.6 Organisation of this Report

This report has the following structure:

- Chapter 2: Background and Approach: ‘setting the scene’ for the report;
- Chapter 3: International Experience of High Speed Rail Freight: a review of existing and
planned high speed rail freight services in Europe;
- Chapter 4: Overview of the Norwegian Freight Market: reviewing available data on freight
flows;

¹ http://www.its.leeds.ac.uk/
² Significance is an independent research institute specialised in transport, based in The Hague.
http://www.significance.nl/
• Chapter 5: Feasibility of High Speed Rail Freight in Norway: reviewing the conclusions of previous studies of the Norwegian High Speed Rail project;
• Chapter 6: High Speed Freight Rolling Stock and Infrastructure: assessing what would be needed to provide the services, in terms of rolling stock and infrastructure;
• Chapter 7: Potential High Speed Rail Freight Service Types and Markets: further analysis of the types of service that might be offered and the markets that might be attracted to such services;
• Chapter 8: Potential Competition with other Transport Modes: an analysis of potential competition of high speed rail freight with existing freight transport services, including an analysis using the Norway Freight Model;
• Chapter 9: Market Survey: a description of the industry survey and a discussion of the results; and
• Chapter 10: Conclusions and Recommendations.

Appendices give details of:
• Appendix A: Organisation and individuals contacted;
• Appendix B: The survey form developed; and
• Appendix C: Tests using the Norway Freight Model.
2. **Background and Approach**

2.1 **Introduction**

This section sets out the background of this freight market study and described the overall approach we have taken.

2.2 **The Wider High Speed Rail Study**

This report forms part of Phase 2 studies of a wider High Speed Rail (HSR) Study, which will focus mainly on passenger demand. However, this report assesses the parallel freight demand that fast freight rail services might serve.

2.2.1 **High Speed Rail Corridors**

The potential high speed rail (HSR) corridors being considered for passenger services are both domestic and international (with Sweden):

- **Domestic:**
  - Oslo – Bergen;
  - Oslo – Kristiansand – Stavanger;
  - Oslo – Trondheim; and

- **International:**
  - Oslo – Gothenburg; and
  - Oslo – Stockholm

For the international services, any improvements proposed by Norway would also have to be supported by Sweden, which has already developed its high speed passenger technology and has its own concepts for improving these high speed rail services (discussed below).

Clearly, there is an argument that whatever is adopted for these international HSR services should be consistent and compatible with what is adopted for domestic HSR services, to allow potential through-running of services and shared use of locomotives and rolling stock.

2.3 **Scope of the ‘Fast Freight’ Study**

This ‘Fast Freight’ study deals with new rail freight services that are not provided at present in Norway and that could be developed in parallel with new HSR passenger services.

This ‘Fast Freight’ study does not therefore deal with ‘conventional’ rail freight services in Norway or the impact on conventional rail freight services of HSR development.

The terms of reference talk about both ‘fast’ and ‘high speed’ rail freight services. As will be discussed, we have treated these as similar types of service, although they would obviously be differentiated by the planned maximum speed of the rail network developed and the freight rolling stock. Generally, however, the terms ‘fast’ and ‘high speed’ freight are in this report interchangeable, except where the speed difference is made explicit.

This ‘Fast Freight’ study will consider the potential demand for two main types of HSR freight train:

- **Full fast/HSR freight trains;** and
- **Freight carried as part of a mixed passenger/freight fast/HSR train.**
2.4 Potential Benefits of Considering High Speed Rail Freight

If the development of HSR passenger services give the opportunity to develop HSR freight services, this might be expected to help to strengthen the overall HSR Business Case, through providing additional net revenue or other social or environmental benefits. For example, potential HSR freight customers may be willing to pay for fast and reliable delivery, such that the offer becomes commercially viable.

In addition, social and environmental benefits may be gained by transferring freight traffic that would otherwise use road or air transport – for example by reducing road accidents or reducing air pollutant or carbon emissions.\(^3\)

A further benefit – which is not considered in any detail in this study (as noted above) – is the potential impact of the HSR developments in releasing capacity on the conventional rail network (by transferring passenger rail services) for additional conventional freight services.

2.5 The Four High Speed Rail Development ‘Concepts’

The Phase 2 work is required to consider four HSR ‘concepts’ or scenarios for HSR development:

- **Scenario A** – reference case. This is a continuation of the current railway policy and planned improvements, with relatively minor works undertaken shown in the National Transport Plan from 2010-2019. This forms the ‘do minimum’ scenario to which the other scenarios will be compared;

- **Scenario B** – upgrade. A more offensive development of the current infrastructure, looking beyond the ‘InterCity’ area;

- **Scenario C** – major upgrades achieving high speed concepts. This is to be based on an aggressive upgrade of the existing network to provide a step change in journey times; and

- **Scenario D** – new HSR. This involves the implementation of newly built, separate HSR lines.

<table>
<thead>
<tr>
<th>Fastest 2010</th>
<th>Concept A</th>
<th>Concept B</th>
<th>Concept C</th>
<th>Concept D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Freq</td>
<td>Time</td>
<td>Freq</td>
<td>Time</td>
</tr>
<tr>
<td><strong>Long Distance Services:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oslo-Kristiansand</td>
<td>04:25</td>
<td>240</td>
<td>04:20</td>
<td>120</td>
</tr>
<tr>
<td>Oslo-Stavanger</td>
<td>07:42</td>
<td>240</td>
<td>07:30</td>
<td>120</td>
</tr>
<tr>
<td>Oslo-Bergen</td>
<td>06:28</td>
<td>240</td>
<td>06:30</td>
<td>120</td>
</tr>
<tr>
<td>Oslo-Trondheim</td>
<td>06:38</td>
<td>360</td>
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</tr>
<tr>
<td>Oslo-Stockholm</td>
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<td>240</td>
<td>06:00</td>
<td>120</td>
</tr>
<tr>
<td>Oslo-Gothenburg</td>
<td>03:55</td>
<td>360</td>
<td>03:30</td>
<td>120</td>
</tr>
<tr>
<td>Bergen-Stavanger</td>
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<tr>
<td><strong>InterCity Services:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oslo-Halden</td>
<td>01:44</td>
<td>60</td>
<td>01:30</td>
<td>60</td>
</tr>
<tr>
<td>Oslo-Tønsberg</td>
<td>01:29</td>
<td>60</td>
<td>01:15</td>
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<tr>
<td>Oslo-Hamar</td>
<td>01:23</td>
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<td>01:20</td>
<td>60</td>
</tr>
<tr>
<td>Oslo-Lillehammer</td>
<td>02:11</td>
<td>60</td>
<td>02:10</td>
<td>60</td>
</tr>
</tbody>
</table>

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\(^3\) Fuel consumption may also be reduced but the benefit of this would be included in either revenue (reflecting user costs) or environmental/carbon reduction benefits.
The target journey times for passenger services have been set by Jernbaneverket, as shown in the table above. The main features are:

- **InterCity service frequency:** doubling frequency in Concepts B/C/D to two trains per hour (one train per hour on the Oslo-Kongsvinger route);
- **Long-distance services:** doubling frequency in Concept B (to one train every two hours) and quadrupling frequency in Concepts C/D (to one train per hour, except Bergen-Stavanger, which is one train every two hours);
- **Long-distance reduction of journey times:**
  - in Concept B: up to 60 minutes;
  - in Concept C: up to 2 hours; and
  - in Concept D: up to 5 hours (Oslo-Stavanger).

### 2.5.1 Concept A - Reference Alternative

Concept A, the Reference Alternative will form the ‘do minimum’ scenario to which the other scenarios will be compared.

### 2.5.2 Concept B - Faster Conventional Freight Services

Concepts B may provide an opportunity for faster mixed passenger/freight services and may help to improve the offer of conventional rail freight services. However, the scope for faster dedicated freight trains would seem to be limited.

### 2.5.3 Concept C - More Aggressive Development of the Current Railway Infrastructure

Concept C envisages a more extensive ‘conventional’ railway infrastructure. This, of course, may provide the basis for improving conventional rail freight services (by providing additional capacity and improved trip times). It also may offer the opportunity to introduce new, faster rolling stock for both passenger and freight services.

‘Tilting’ trains are mentioned in the Government’s mandate to Jernbaneverket and one option under Scenario ‘C’ is running a ‘tilting’ train on the Swedish model. The performance and costs of Swedish tilting trains are more easily identified than a completely new HSR system (i.e. Scenario D) and would be useful to ‘sense check’ any conclusions on HSR.

Obviously the ‘tilting’ technology is only relevant for passenger services, but a timetable of fast tilting service may allow ‘fast’ freight trains to operate. Also mixed passenger/freight trains could be envisaged on the ‘tilting train’ model.

The Swedish tilting train technology is obviously very relevant for the routes to Gothenburg and Stockholm (i.e. partially or mainly in Sweden), as any improvements proposed by Norway would also have to be supported by Sweden, which has its own proposals for improving high speed rail services (these are discussed in following sections). This offers the opportunity for relatively early introduction of fast or HSR services on some sections of existing rail – not only in Norway but also in Sweden - in parallel with the development of the Norwegian IC network.

In addition, considering tilting trains plus additional track capacity would allow the staged improvement of faster passenger and freight trains using mainly legacy track. It might also create more capacity for conventional passenger and freight services (e.g. through passing loops, track doubling, etc.). However, using existing track for these tilting train services would obviously limit

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4 “Consider to what extent the use of tilting train material could be appropriate in certain concepts” (Section 4 of the Mandate).

5 More information on Sweden’s tilting trains is given in later sections of this report.
the development of conventional rail freight services, due to lack of capacity at periods of peak passenger use.

2.5.4 Concept D – Mainly Separate HSR Lines

Concept D would be similar to HSR development in France or Germany – segregated HSR lines that would carry primarily passenger services.

For this concept we have considered the options for HSR freight – freight trains moving in excess of 200 km/h. However, the technical parameters of the HSR (such as axle-load, inclines, loading gauge, etc.) would be set primarily in relation to passenger services, so any HSR freight services would have to be – essentially - freight variants of HSR passenger rolling stock, rather than conventional rail freight rolling stock. However, it is also possible that some lighter conventional freight trains – such as container trains operated at higher speeds than at present – may use the line, for example, by running in the wake of an HSR passenger service. (These issues are considered further in later sections.)

2.6 Study Approach

The approach taken for this ‘Fast Freight’ study is essentially a market study, based on a review of international experience and previous studies of high speed freight and freight movements in Norway, as typified by the Norway Freight Model.

The approach, therefore, consists of the following elements:

- Review of previous studies;
- Review of international examples of ‘fast’ and ‘high speed’ rail freight services;
- Identification of potential users of ‘fast freight’ services;
- Market survey of potential users; and
- Analysis based on the Norway Freight Model.
3. International Experience of High Speed Rail Freight

3.1 Introduction

This section provides an overview of the international experience in fast and high speed rail freight – both existing and planned services. In practice, all the examples identified were from Europe; for example, Japan, which has a well-developed HSR network, has not developed fast freight services.

With the exception of the older German high speed lines, most continental European high speed lines have been designed with the specific intention that freight will *not* be carried, although freight as well as passenger traffic benefits from the new construction because paths are freed for freight on the conventional network.

The Channel Tunnel Rail Link, now renamed High Speed 1 (HS1), has been designed to handle freight - at significant extra cost – but very few paths have been set aside for freight and it is unclear whether even these trains will ever be carried (although further tests are currently being carried out).

Other countries in Europe have excluded freight trains and run only passenger trains on their HSR lines - with the exception of France, where some TGVs converted for postal service operate on the TGV network.

The following examples are considered below:

- France – and in particular the TGV La Poste service: a dedicated HSR freight train;
- Germany – especially the use of the passenger high speed and fast services to carry courier cargo;
- Sweden – including the experience of the X2000 service and the plans for the future new high speed rail concept;
- The Channel Tunnel Rail Link between London and the Channel Tunnel; and
- Finally, a review of the proposals for integrating air cargo and high speed rail services.

![Figure 3.1 - TGV La Poste train – The Fastest Freight Train in the World](Source: SNCF)
3.2 National Experience

3.2.1 France

Running of freight services on the French LGV route (Ligne á grande vitesse) between Paris and Toulouse was amongst the first to demonstrate the feasibility of high speed freight trains, at first running at 160km/h, and the only barrier to 200km/h operation was the availability of suitable wagons.

La Poste TGV

La Poste, the French postal carrier, currently uses TGV trainsets operated by SNCF to transport its “high speed mail”, consisting of letters, parcels and media.

A total of 7 half-train sets of SNCF TGV La Poste were produced (consisting of one power unit and four cars - used to form 3 full trains, the last remaining half being a backup). These were built or converted from passenger TGVs by Alstom, the French high speed train manufacturer in the period 1978–1986. Large plug doors replace the conventional doors. Rubber stripping protects the sides against impacts from mail carts during loading and unloading. However, the trains have a relatively limited axle-load: 16t.

The top speed is 270 km/h (168 mph), making them the fastest freight trains in the world.

Figure 3.2 – TGV Post – Original Concept

Note: High Speed Line between Paris and Lyon only
Source: Troche, 2005

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6 ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005
TGV La Poste three trainsets are operated on the TGV Sud-est line (8 trips per day) between Paris and Cavaillon (south) via Mâcon (Burgundy). The figure on next page shows the transport system as it looked when operations began in 1984 (during the 90s the operations were extended to Avignon, while conventional rail links were subsequently suspended).

As can be seen, the TGV La Poste services were complemented by road haulage and conventional mail trains. Some of the conventional mail traffic on the railways is co-produced in the traditional way with passenger traffic by coupling mail coaches to passenger trains. Conventional mail trains, however, have now been completely discontinued and replaced by trucks. The last conventional mail train ran in December 2000 between Besancon and Paris. On the other hand, the TGV mail network has expanded and now also serves terminals located on conventional lines.

**Recent TGV La Poste Service Reductions**

It has been reported that TGV La Poste services are being reduced – from 8 to 6 trains per day. This is a result of the reduction in the quantity of letters sent in France – approximately 9% in 2009 alone (300 million fewer letters). Although it is felt (by SNCF) that TGV La Poste services can still compete with air transport, plans to open new TGV La Poste lines have also been shelved for the time being.

**TGV Fret**

The TGV La Poste trains are used exclusively for mail and the traffic system is designed especially for them. SNCF therefore conducted a project called TGV Fret in order to study the financial, technological, infrastructural, and traffic-related prerequisites and possibilities for introducing high speed freight trains across a broad front.

The joint venture project to create Fret GV (Grande Vitesse) was announced in late 2006. Fret GV is a 50/50 subsidiary of both SNCF and La Poste that was expected to start operating service in January 2009 – but this has not happened yet.

Both partners plan to install their hub in Roissy, south of Charles de Gaulle international airport and to serve more cities, beginning with two more trainsets: Strasbourg, Dijon, Rennes, Lyon, Bordeaux, and Lille. The ambition is to operate outside the French boundaries in the near future - serving European cities like Amsterdam (Netherlands), Cologne (Germany), London (UK), Basle (Switzerland), Turin (Italy), and also a link between Spain and Italy.

The figure below shows a possible future high speed freight train based on the TGV Duplex trainset. The trains would combine high speed with high capacity and would be able to carry pallets, air cargo ULDs and 10'- mini-containers.

**Figure 3.3 - TGV Fret Concept**

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7 La Poste supprime un quart des TGV postaux Le Figaro, 24/04/2009
3.2.2 Germany

Unlike high speed lines in most other European countries, the earlier German high speed lines also carried a significant number of conventional trains running at lower speeds, and were also designed to carry freight. This wider capability significantly increased costs, because of the need to limit gradients and install passing places.

The lines were also designed for a lower maximum speed than has been used for other ‘high speed’ lines in Europe (250km/h).

**Germany ICGE – InterCargo Goods Express**

The German initiative in the field of high speed freight transport by rail (ICE-fracht) was technically very different from TGV Fret. In Germany the initiatives are aimed at high speed transport of relatively heavily-loaded cargo trains.

When the high speed stretches between Hanover ands Würzburg and Stuttgart and Mannheim were opened, German Rail (DB) introduced the InterCargo Goods Express (ICGE) express freight trains, primarily intended for intermodal traffic (i.e. maritime containers and swap-bodies).

In June 1991, services began on the Bremen–Stuttgart and Hamburg–Munich routes, each with their own pair of trains. The trains operated at 160 km/h on the newly constructed lines and 140 km/h on upgraded lines. The higher speed reduced the running time by 2 hours to about 8 hours between Bremen and Stuttgart and 9 hours between Hamburg and Munich. The trains consisted of 20 four-axle container wagons. Five two-axle covered wagons were introduced on the Hamburg-Munich routes for single consignments and part-cargo (during trials, these wagons reached speeds of up to 213 km/h).

The trains had a maximum gross weight of 900 tonnes with a payload of 500 tonnes and were hauled by Type 120 locomotives. The original intention was for the trains to travel coupled together on the shared Hanover–Würzburg stretch but this proved to be unfeasible due to technical problems that have yet to be resolved.

After a few years, the ICGE trains’ maximum speed was again lowered to 120 km/h - according to German Rail, as a result of poor profitability. In the long term, however, they still felt that the prerequisites exist for higher speeds, especially for intermodal traffic. At present, a speed increase to 140 km/h for certain selected freight trains is being considered. High speed freight trains between Frankfurt and Paris (see below) are also being planned in cooperation with SNCF and other operators.

The average speed terminal to terminal on the Hamburg-Munich ICGE route was 92 km/h; the average line speed was about 130 km/h. The losses occurred mainly around the terminals themselves, due to shunting and locomotive switching (from diesel to electric).

The 2006/2007 Feasibility Study (into the Norwegian HSR project) highlighted the fact it was subsequently decided not to allow the running of un-enclosed freight trains and high speed passenger trains in tunnels at the same time, due to the possibility that the high air pressure generated would dislodge loads on the freight train and cause an accident. This decision limited freight operations to the night-time. Even during the night there are some high speed passenger trains and allowing these to overtake freight trains would increase the travel times for freight traffic so significantly that there would be higher running times than on the conventional lines. In any case, at night there is available capacity on conventional tracks for freight trains.

**German Postal Services**

One side-effect of the world of modern logistics is that Germany's national postal service now hardly uses trains to move packages. The former state-owned enterprise is forced to keep up with a pace set by competing courier services which use air cargo and vans to deliver their

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8 ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005

5096833/Norway - HS Freight Report_140211.docx
goods: overnight delivery is considered the standard in express shipping and conventional freight trains are not able to guarantee next-day delivery.  

**ic: kurier (Lufthansa / time:matters / DB InterCity)**

Germany offers an example of a successful rail-borne courier-goods service: “time:matters”, a daughter company of airline Lufthansa, buys capacity onboard of Deutsche Bahn’s InterCity and InterCityExpress trains and markets it to both private and commercial customers under the **ic: kurier (inter-city courier)** brand. Consignments can be delivered and picked up at all major stations, but door-to-door service is available, too. The system offers frequent services, fast transport times (enabling same-day delivery in most relations) and high geographical coverage.

The **ic: kurier** service is currently offered at about 140 train stations throughout Germany that have an IC (InterCity), EC (EuroCity), and/or ICE (InterCity-Express) connection. The shipment can weigh up to 20 kg and the maximum size is one metre long or two metres in circumference.

### 3.2.3 UK Channel Tunnel High Speed Link (HS1)

The dominant British rail freight operator, now owned by DB (as DB Schenker), has conducted trials of conventional freight trains on the UK High Speed Line (HS1) between London and the Channel Tunnel - sharing with high speed passenger trains. Detailed planning by freight operator DB Schenker and HS1 Ltd is at an early stage, and a number of operational options are under consideration.

The route was designed with future freight traffic in mind and several freight loops were built into the system. It is likely that most freight would run at night, when there is lower demand from Eurostar and South Eastern domestic passenger services.

A possible terminal for the bigger ‘high cube’ Continental loading gauge containers, carrying freight of all kinds, already exists at Barking, east London.

An aspiration is for an ultimate freight train top speed of around 220 km/h (140 mph), which will be the maximum speed of Class 395 domestic services, although this would require new locomotives. When the service starts it is expected that the locos to be used – dual-voltage Brush Traction built Class 92s, introduced in the mid-90s – will run between 100km/h (60mph) and 130 km/h (80mph). Top speed of the 127-tonne locos is 140 km/h (87mph).

### 3.3 Proposals for Air Cargo and High Speed Rail

A number of proposals have been developed to integrate air cargo and HSR freight services at airports.

#### 3.3.1 The Carex Project

The Carex project was initiated in February 2006 in France by both private entities and public authorities in order to create a European high speed rail freight service. European and global air freight leaders are fully involved in this project, including: FedEx, UPS, TNT, Groupe La Poste, Air France- KLM, Cargo, WFS, etc.

Today, the Carex project is a European project approved by the European Commission, which considers an initial network comprised of Roissy, Lyon, Liège, Amsterdam, London and Cologne. The objective of the Carex project is to ensure modal shift from trucks and short-/medium-haul flights to high speed trains when such shift becomes desirable.

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9. Overnight Deliveries by Rail French to Team with FedEx for TGV Parcels in Europe By Christian Wüst, Der Speigel 02/13/2008
11. ‘Freight trains could move on to HS1 by next year’ Railnews May 2009
The Carex project has strong political support in France. The Carex project was officially endorsed by the French state and forms part of a €7bn national ‘Rail Freight of the Future’ initiative that was unveiled in September 2009. It will benefit from public finance totalling €170m (US$238m) to fund the construction of terminals at Roissy-CDG and Lyon St Exupery, and rail infrastructure. Carex also figures prominently in SNCF’s plans to develop a high speed train offering for freight.

Alstom would also supply the trains that will be used in the Carex venture. They are based on the double-decker TGV Duplex trains that currently run between Paris and Lyon and would provide sufficient space to accommodate standard air freight containers up to three meters (9.8 feet) tall.

Carex estimates the investment in the trains and infrastructure for the first phase of the project at just under 1 billion ($1.47 billion).

According to Carex, a large cargo aircraft consumes more than 20 litres of kerosene and a truck about one litre of diesel fuel to carry one ton of cargo 100 km (62 miles); the freight TGV emits only about 2% of the carbon dioxide emitted by a cargo plane to achieve the same outcome.

The Carex trainset maximum useful load is more than 100 tonnes - at least the equivalent of (according to Carex):

- 1 Boeing B747 Freighter or
- 1 MD-11 Freighter or
- 3 Airbus A310 Freighter or
- 7 Boeing B737 Freighter or
- 6 to 7 trucks

### 3.3.2 GEC Carex (Roissy Airport)

In 2009, an interest group, GEC Carex, was formed comprising Air France-KLM, FedEx, UPS, TNT, La Poste and WFS. It was intended to give long-term commitments on traffic volumes to be transported by Carex, using Paris' Roissy Airport ('Charles de Gaulle') as its European logistics hub.

GEC Carex has had discussions with European railway operators, related to scenarios of traction, pricing and organization of services, marketing and investment in rolling stock. It is planned that 20 high speed TGV trains -- which operate at speeds of 300 km/h (186 miles per hour) and will be equipped with nine unfurnished cars designed to carry standardized air freight containers. The project has largely been supported by the French postal service La Poste and US package delivery service FedEx, which uses Paris' Roissy Airport ("Charles de Gaulle") as its European logistics hub.

More than 50 FedEx cargo planes take off and land at Roissy every night, connecting Paris with faraway continents, as well as domestic airports like Nice, Toulouse, Lyon and Marseilles.

However, it remains unclear who will invest the required €200m to purchase the eight specially adapted trains, each carrying between 100 and 150 tonnes of freight, which would operate the Carex service in the initial phase. Initially, it was thought that the potential customers of the service – express operators and airlines – would provide the funding, but it will now be a pool of rail freight operators.
3.3.3 Euro Carex (CArgo Rail Express) Initiative (Air freight)

Using high speed trains to carry freight had been proposed some time ago in Paris as a possible alternative to certain night flights by cargo-only aircraft. It was also around this time that SNCF conducted a study to examine the principle of a "TGV Fret" (high speed rail freight) train.

This was followed by consultation and discussion in several European countries by stakeholders which would later come together as part of Euro Carex. These included SAB, the Liège Airport management company, which, in 2000, joined together with Aéroports de Paris to form the "TGV Fret" working group, which also involved express freight operators and rail operators.

Preliminary studies of possible connections and routes were conducted soon after. In 2003, Amsterdam-Schiphol Airport conducted its Co-Act (Creating Viable Concepts for Combined Air/Rail Cargo transport) research project funded by a European Commission programme. The goal of Co-Act was to come up with a concept of what a future express or high speed rail service to carry air freight and perishable goods (like fresh flowers, for example) might look, and to set up a test link between Amsterdam and Frankfurt airports.

Euro Carex was created in 2009 and is a non-profit European association which federates all Carex railports, and has its headquarters in Brussels; it is chaired by Yanick Paternotte (the creator of the concept) and each Carex railport has 2 representatives at its Board of Directors.

This association uses a lobbying activity and can also urge all types of actions to ensure the feasibility of this service (Raising of European funds, etc) and to develop its utilization.

Euro-Carex plans to run high speed trains between a new express freight station at Paris Charles de Gaulle airport, Lyon, Liege, Amsterdam, Lille and London in a first phase from 2012, and then extend the network eastwards to Cologne and Frankfurt and southwards to Bordeaux and Marseille. Italy and Spain could potentially be linked at a later stage.

The organisation plans to will initially employ 8 high speed trains specially designed for air cargo with a capacity to transport up to 100 tonnes of express shipments per train every night. The cost of the investment required has been put at €600 million for trains (each cargo freight train could cost about €15 million) and €300 for terminals. The key project members include French railway operator SNCF, Air France Cargo, FedEx, La Poste, TNT and UPS.
Delay in Implementation of Euro Carex Operations

The launch of Euro Carex (Cargo Rail Express) – a pan-European, high speed rail service for express and air cargo currently handled by truck and aircraft - has been significantly delayed, but the project’s managers have played down suggestions that this is due to the economic slowdown.

The first Euro Carex trains had been earmarked to operate between Paris-CDG and Lyon St Exupery airports from end-March 2012. However, the launch is now expected to happen only in 2015.13

Technical issues are being blamed; specifically, the work involved in linking the new service to the existing French high speed rail network.

3.3.4 Other Carex initiatives

There are a number of other Carex initiatives:

- Lyon Carex: created in 2008 to promote the creation of a high speed rail freight service connected to Lyon-Saint Exupéry Airport platforms.

- Liege Carex: created in 2008 to build on the success of Liege airport in developing a strategy of full cargo planes. This strategy has enabled the Liege Airport to reach the 8th rank in the classification of European cargo airport and the 1st rank in Belgium, handling 482 142 tonnes of cargo in 2009. Liege Airport houses the European TNT sorting centre.

- Amsterdam Carex: The Amsterdam Carex Association was created in 2007, based on Schiphol Airport. Amsterdam Carex is in the process of organizing itself around an important inter-modal project called ACT (Amsterdam Connecting Trade) conducted by SADC (Schiphol Area Development Company), in which the freight rail station will be inserted. The

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12 Carex Project, High speed European Rail Freight Service Connected To Airport Areas, Presentation, April 2010
13 ‘Launch of Carex high speed rail project delayed’, IFW 3 Feb 2010
Dutch government has allocated EUR 11 million to the development of the Carex terminal and the rail connection to the high speed line, near Hoofddorp.

3.3.5 The FEX (Freight EXpress) project – Cologn/Bonn & Frankfurt Airports

The FEX (FreightExpress) project has the explicit aim of developing cross-border high speed freight trains based around either ICE or TGV technology and was developed by SNCF and German DB within the framework of the German-French ‘Deufako’ co-operation, were studying the possibilities for joining together to operate high speed freight traffic between Frankfurt and Paris.

The concept is that wagons must be able to load air cargo containers and will therefore probably be equipped with the same type of roller floor that aircraft have. The trains would operate between Cologne and Brussels and running time between the Paris and Frankfurt termini will be 6 hours. Newly laid high speed stretches or substantially upgraded stretches of track will mainly be used.

The service is principally aimed at the express and door-to-door freight markets. Great importance is attached to integrating the rail and air freight systems. The trains will stop at the airports in Cologne/Bonn, where an Air/Rail cargo terminal is planned, and Frankfurt which already has an air cargo terminal with a rail connection, but which is not - as it stands - adapted to the planned type of high speed freight traffic. In France, a rail connection is being planned for Charles de Gaulle airport. In the long term, the intention is that the Paris-Frankfurt pilot route will have connections from Brussels and Paris to London, between Brussels and Amsterdam and between Frankfurt and Zurich. This “basic network” is intended to be later a part of a coherent pan-European high speed rail freight network.

3.3.6 Air Cargo Express (ACE) Initiative – Leipzig/Halle Airport

The Air Cargo Express (ACE) concept is based around Leipzig/Halle Airport, which has a €30 million rail freight station, located next to the DHL Express air hub. The aim of Air Cargo Express (ACE) is to operate twice-daily trains between Leipzig and Frankfurt at up to 200km/h, with open access for all interested customers. The trains would have capacity for 8 ULDs per car and be specially adapted for air cargo-style container loading and unloading.

DHL is part of a consortium planning an air/rail freight hub in Leipzig Airport / Halle to serve as a European model for air freight connecting with high speed rail freight. The concept would:

- Connect high-volume areas for express consignments in conurbations with DHL’s European express air hub;
- Offer uninterrupted intermodal air transport chain between air and rail and rail and road;
- Make both short and middle-distance transport of express consignments (up to 400 km) considerably more cost-effective and profitable by offering an alternative to the common practice of using air transport for time-definite consignments for these distances; and
- Lessen environmental impacts by shifting away from truck transports.

Following successful tests with DHL, ACE had hoped to launch in 2009. However, it has been admitted that DHL volumes alone would not be sufficient and other partners would be required.

At a later stage, other airports such as Hamburg, Munich and Düsseldorf could be added. One key aspect will be whether centrally-located Cologne Airport decides to build a rail freight station and thus link into the European network. Few airports will be able to afford the investment required for the rail freight terminals, implying that public subsidy would be required.

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14 Air freight containers - Universal Loading Devices
15 Can DHL’s HUB in Leipzig / Halle serve as a European model for air freight connecting with high speed rail freight? Michael Reinboth, DHL
3.3.7 UPS Germany

UPS Germany supports the concept of rail transport, and is the largest single rail customer in the US. UPS Transport in Germany has agreed that rail freight services at 200km/h could beat road transit times and be suitable for time-sensitive products as well as deferred deliveries. However, rail services had to be reliable, secure and offer appropriate schedules.

3.3.8 Deutsche Bahn Railion View

German national railway Deutsche Bahn has shown limited enthusiasm for the Carex project. Deutsche Bahn's Railion freight division has concluded that it would offer no real added value for customers.

Courier freight is a minor player in the industry, which makes it, from Deutsche Bahn's perspective, an unattractive commodity for shipping on freight trains. Railion operates only a few individual trains designed to handle courier freight, but none of them on high speed lines, where signal technology alone is very expensive.

The core business consists of heavy cargo, such as raw materials and industrial products, and it is highly successful. Annual freight transport volume, which has been growing for years, now amounts to significantly more than 100 billion tonne-km.

That's a strong contrast to France where, unlike the TGV sector, the freight rail system is in poor shape. Freight volume in France is in steady decline and is currently less than half of the corresponding German value.

For this reason, Carex is seen as primarily a prestige project for a fundamentally ailing transport company (SNCF). The 20 TGV freight trains are expected to carry about 350 million tons of freight a year – a relatively small amount, compared with total French rail freight. By the same token, Railion believe that French railways have no reason to pin high hopes on express services.

3.3.9 Sweden

Swedish Tilting Train – X2000

Sweden’s state-controlled infrastructure operator, Banverket, and Swedish state railways (SJ) developed a high speed rail network in the mid-1980s.

Most HSR systems have considered the contribution to the economic case that could be made by sharing new dual track HSR lines with heavy freight trains. Sweden's national rail administration, Banverket, faced similar transport problems to Norway:

- Large distances between cities;
- Low population density;
- Heavy conventional freight trains (lumber, iron ore etc.); and
- Severe winter weather.

A particular problem was that high speed passenger trains - in Europe usually over 200 km/h/125 mph - normally require tracks in a very good state of repair to operate safely and with sufficient passenger comfort. Unfortunately, heavy freight trains with up to 25 tonnes axle load (compared with 17 tonnes for HSR trains) tend to wear tracks quickly.

Realising that it would be expensive to build its rail lines as straight as the high speed lines in the likes of Japan and France, SJ designed the system around tilting train technology, which allowed the use of existing tracks and introduced special train technology, so that the tracks would not have to be repaired so frequently to maintain operational safety.

Designed in the 1980s by AdTranz (now a subsidiary of Bombardier), the Swedish high speed network features an array of technologies such as automatic train control, sensor-based active tilt control and an important innovation: soft bogies. The standard configuration is two bogies of two
rigid axles each underneath the car. The X2000’s bogies are made "soft" by special actuators that keep each individual axle perpendicular to the track, even on fairly tight curves.

Safe, comfortable operation at 200 km/h on legacy tracks shared with heavy freight trains was achieved with the introduction in 1990 of rapid rail service based on the X2000 train. Passenger volume went up dramatically with the new service, as did public willingness to invest in major rail transport upgrades, e.g. the Øresund bridge/tunnel to Denmark.

Each X2000 formation consists of one 4400hp power car, powered at 15kV ac. Each unit can be made up of up to 16 intermediate vehicles with a maximum capacity of 1,200 to 1,600 passengers, but a typical train will only have five intermediate vehicles.

The X2000 trains are complex and therefore expensive to buy and maintain. However, that must be weighed against the savings achieved by using legacy track. In comparison with the cost of the trains, upgrading of infrastructure has been relatively modest, but has arguably represented far better value for money than other countries' high speed lines which have been built from scratch. For example, Sweden’s upgrading for X2000 worked out at US$0.5 million per km, compared with the US$9 million per km cost of Spain’s AVE high speed route, and US$18 million per km for Germany’s ICE network.16

The train’s designated top speed is 210 km/h (during a trial with double locomotive units in 1993 it reached 276 km/h), but the maximum allowed speed in regular traffic is 204 km/h (127 mph) since the signal system (and systems like the catenary) are not built for higher speeds for safety reasons. In addition, the X2000 services share the track with conventional trains and as most of the lines it uses were built in the mid- to late- 19th century. In comparison to other high speed trains, the X2000 is not particularly fast; but compared to regular train services, it cuts journey time by about 25% - enough to make it competitive with airlines on many routes.

While the initial route chosen for X2000 was the main Stockholm-Gothenburg corridor, infrastructure works have subsequently been carried out over the whole of the country’s network to allow all routes to benefit from the success of X2000. However, it is on this main corridor where the most dramatic time savings have been achieved. In 1990, before the introduction of X2000, journey times averaged three hours 45 minutes. Eight years later, the journey time was cut by one hour.

X2000 Service to Oslo

In 2000-2004, seven X2000 high speed tilting trains were operated by Linx on the lines Oslo-Gothenburg-Malmö-Copenhagen and Oslo-Stockholm. Linx was a joint venture between SJ and its Norwegian counterpart NSB.

The travel time between Oslo and Stockholm was reduced by more than one hour to 4h 50min, and the number of daily departures increased from two to three in each direction. Although the journey was still faster by plane, travel by train offered the opportunity for continuous travel time spent for work and relaxation. Traffic on the Oslo-Gothenburg route increased initially by 30%.

Subsequently Linx tried to persuade Jernbaneverket and Banverket to upgrade the Oslo-Stockholm line to achieve a journey time of 3 hours.

The Linx services were wound up when SJ wanted to move the trains to more profitable lines in Sweden. Low-fares airlines also played a part in siphoning off passengers from the comparatively slow Linx services, the main ones taking well in excess of 3 hours.

After the withdrawal of the Linx services, the route Oslo – Stockholm was served (in 2005) by daily InterCity services in the summer (around 6 hours) and X 2000 services at the weekend. There was also a night service via Gothenburg (8 ½ hours). NSB operated 3 trains a day between Oslo and Gothenburg (2 trains a day at weekends, 4 hours).

After X2000 - Sweden’s Gröna Tåget (Green Train) 17

A few years ago, Banverket launched a new public-private research program called Gröna Tåget (Green Train) to build on the success of the X2000. Partners include top Swedish engineering universities and Bombardier. Key objectives include:

- Improved reliability in severe winter conditions;
- Increasing top speed in commercial operation to at least 250km/h (155mph);
- Exploiting the generous track spacing with five instead of four seats abreast;
- Improved passenger comfort in curves;
- Reduced wear and tear on the infrastructure;
- Lower electricity consumption; and
- No increase in noise over the X2000.

The project overview states that the new, higher top-speed will only be achievable on upgraded or brand-new track sections. That is because the signalling on the legacy tracks imposes a limit of around 200 km/h. In addition, the popularity of the X2000 has introduced capacity problems. The high cost of enhanced rail infrastructure in rural areas makes more sense if it can support passenger trains running at higher speeds.

The key innovation expected from the research program is active lateral suspension (ALS), which will reduce wear and tear on the rails and also improve passenger comfort in curves. Most other upgrades, including electric multiple unit (EMU) traction based on permanent magnet synchronous motor (PMSM) technology, triple brake system, wide car bodies etc. are already present in Japanese, German and/or French train designs. What sets the Swedish effort apart is the ambition to make all of that work very reliably in arctic winter conditions - a task that off-the shelf HSR train designs on the European market are not able to do.

In the summer of 2008, the Gröna Tåget test train set a new Swedish speed record of 303 km/h on a section of straight legacy track originally designed for 200 km/h.

Swedish Rail Freight Market for Mail and Express Goods

Sweden has dedicated mail trains operated for the Swedish post office at 160 km/h; the rolling stock is based on modified freight wagon designs.

Until 2000 Swedish Railways (SJ) offered an express parcel service (SJ Expressgods) - express freight traffic on passenger trains - marketed by SJ itself (which carried 90% of SJ Expressgods consignments by rail). However, this business was sold at the end of 2000. The new owner has discontinued all overnight shipments on board night trains and transferred them to road, retaining however shipments on board the InterCity and X2000 day trains, where rail is attractive in both speed and frequency. However, no separate express freight wagons are attached to the trains anymore; the cargo is shipped in dedicated freight compartments on board the passenger trains.

For the mail business, freight train operator Green Cargo has invested in new rolling stock, in order to meet the demands from the Swedish Post Office. The mail train network currently operated by Green Cargo consists of three lines: Stockholm – Sundsvall, Stockholm – Gothenburg and Stockholm – Malmö, of which the latter even calls at Norrköping, Nässjö and Alvesta to set out and pick up wagons, while the others are direct trains without intermediate stops. In Stockholm two terminals are served: Tomteboda to the north of the city with four tracks under roof, and Årsta to the South. From the terminal track in Årsta truck transport is arranged to the nearby mail terminal.

http://3.bp.blogspot.com/_WE8MqK1sWTg/Sd5Wg9JriCI/AAAAAAAAALA/QxBVJileXvU/s1600-h/greentrain.jpg

5096833/Norway - HS Freight Report_140211.docx
The Swedish mail train network consists of three lines radiating from Stockholm to Sundsvall, Gothenburg and Malmö.

Swedish Rail Freight Trials

In trials undertaken for the EU-sponsored IDIOMA project\(^\text{19}\), the following types of rail express service goods service were tested:

- Goods wagons for passenger trains, with a maximum speed limit of 160 km/h;
- Passenger rail cars with a goods and/or luggage compartment with a maximum speed limit of 160 km/h;
- Goods racks in the machine rooms of the high speed trains (X 2000) compartment with a maximum speed limit of 200 km/h;
- Goods in rear driving compartment in electric multiple units (X10/X11), also named Pågatåg; and
- Goods racks in vestibules of diesel multiple units (Y2 – Kustpilen).

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\(^{18}\) ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005

\(^{19}\) Innovative Distribution with Intermodal Freight Operation in Metropolitan Areas (IDIOMA), Final Report, PTV Planung Transport Verkehr AG (Project Leader), July 2002
This study also analysed the current methods of using the passenger terminal areas for loading and unloading of goods and made suggestions on how to improve the situation. The terminal handling study was made on location in Malmö and Helsingborg.

The results of the demonstrated approach in combining passenger and goods transport shows that generally the staff had positive attitudes towards the approach. No significant technical and operational problems were identified during the demonstration phase. However it was noted that safety aspects would have to be considered when transhipment activities take place on the platform.

Economically, the approach of combined freight and passenger transport showed a poor profitability.

Technically and operationally, the approach showed no significant limitations. However, it was recommended that any follow-up approach should concentrate on a safer interaction between pedestrians and goods handling equipment. This means that new handling equipment for loading and unloading of goods on pallets etc. is needed. Important in this development process is that the new equipment can handle pallets to and from trains from a fixed position on the passenger platform and beside the train.

**International Extension to the Swedish High Speed Passenger Service**

The Swedish rail company Statens Järnvägars (SJ) has announced plans to begin high speed rail service between Copenhagen, the Danish capital, and the city of Odense on Funen, Denmark, a core railway stretch for Danish rail operator DSB.
SJ plans to operate the route using its high speed X2000 train and that this was only the first step of a larger market push in Denmark. Although within Denmark, the X2000 is cleared for top speeds of 200 km/h it will not be able to run that fast in Denmark.

**Nya Tåg i Sverige (New Train in Sweden)**

This 2008 study looked at the future role of rail freight demand in Sweden and the role that fast freight trains could play. It identified a core triangle of freight terminals Stockholm – Gothenburg – Malmö. Connections to the Norwegian system would be via Gothenburg or Hallsberg.

![Figure 3.9 – Proposed Rail Freight Core Triangle in Sweden](image)

Note: the blue lines represent existing network; the green lines represent the planned HSR lines

Source: Nya Tåg i Sverige Study 2008

### 3.4 Conclusions on Existing Fast/HSR High Speed Freight Services

Two examples of HSR/fast freight can be identified:

- **TGV La Poste**: a dedicated HSR freight train; and
- **ic:kurier** (German ICE): the use of HSR passenger trains to carry courier and express parcels
However, it is noted that TGV La Poste has recently reduced the frequency of its services, due to falling postal volumes and the TGV Fret initiative has not been developed, apparently due to lack of interest from other potential users.

Other relevant initiatives include the air/rail freight proposals from Euro-Carex and Air Cargo Express, two major projects have been launched to try to set up rail services to carry express and freight shipments between major European airports. The prospects for diverting express and freight shipments in Europe from air and road transport to more environmentally-friendly high speed rail services are promising but remain caught up in financial and political problems.  

Thus it is clear that there is no reason why fast rail freight services would not be technically feasible; however the prospect commercial success – particularly for dedicated HSR freight trains - is far from guaranteed.
4. **Overview of the Norwegian Freight Market**

4.1 **Introduction**

This section provides an overview of the Norwegian freight market, reviewing data on air, road and rail freight and potential segments of these modal transport markets that might be attracted to fast rail freight services.

Even though there are a number of sources of freight statistics, these provide freight data that are - in part - inconsistent and conflicting. One issue is the inclusion of pipeline data - the transport of oil and gas from the continental shelf to the mainland accounts for around one-fifth of all goods transport measured in tonnes. Therefore, the following overview should be seen as a synthesis of selected data rather than a providing a consistent dataset.

4.2 **Role of the Government in the Norwegian Freight Sector**

The private sector has normally the responsibility for facilities for freight transport, such as terminals, lifting cranes, containers, vehicles, etc. The public sector has the responsibility for road and rail infrastructure, airports and some parts of the sea infrastructure. The municipalities usually own the ports, but a few of them are also private owned - none of them are owned by the state.

Although the State is normally not involved in freight terminals in Norway, the State owns the infrastructure in larger railway terminals to ensure fair competition for freight transport on rail between different rail freight operators.

There are no specific public subsidies for intermodal transport in Norway, except to the infrastructure in railway freight terminals. Indirectly there are some subsidies to railway transport through the policy of pricing of infrastructure – rail freight operators pay only a relatively small amount for the use of the railway infrastructure (probably less than the average social costs). This policy is indirectly a way to subside railway transport, recognising that heavy road vehicles probably do not pay their full social costs. User fees for shipping are also higher than the social costs.

There is a debate in progress of the possibility for the state to support new intermodal transport solutions. The Government has, so far, not suggested any new measures to support new intermodal transport. However, through Norwegian participation in the EU Marco Polo programme the Government hopes it will be possible to make funds available for measures that can assist in reducing market barriers to intermodal transport.  

4.2.1 **Norwegian Freight Transport Policy**

The main features of the Government’s transport policy are presented in the current National Transport Plan for the period 2006-2015. The Government has adopted the following five main goals for transport policy:

- Fewer fatalities and serious injuries on the roads and a continued high level of safety in other modes of transport;
- More environmentally sound urban transport – with reduced dependence on private cars and increased public transport;

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21 Senior Adviser Hans Silborn, Norwegian Public Roads Administration PIARC meeting and seminar 13-15 June 2005
22 Hans Silborn, 2005 ibid.
• Improved traffic flow in and between regions in order to promote development of viable districts and growth-oriented housing and labour markets while meeting the transport needs of business and industry;

• A more efficient transport system, increasing the element of competition in order to bring about the best possible transport provisions for the total investments in transport; and

• A transport system which is accessible for all people, and a transport service which makes it possible for all people to participate in an active life.

In relation to freight transport, the third goal is possibly the most important: improved transport links are essential to meet the needs of trade and business.

Most of the country’s overland transport goes by road, and the road network also plays an important role in linking other forms of transport, with road transport providing the final link at one or both ends of an intermodal journey.

In the National Transport Plan the Government also says that it is an important goal to enable more freight transport to be carried out by sea and rail.

According to a previous survey of businesses in Norway, road transport is the preferred mode of transport, although about a quarter of firms transporting their goods by truck are able to shift to sea or railway under certain conditions.23

The Government's policy is to make provisions for transition to sea and railway transport where this is possible and efficient. The following measures are supporting this policy:

• Investments in railway infrastructure and terminals;
• Adopting of a new port structure;
• Taxation policy and infrastructure fees;
• Feeder trunk roads to important terminals and national harbours;
• Implementation of systems for better information flow; and
• Research and development.

The Government recognises that the railway system must compete with road transport on reliability, quality, price and flexibility to strengthen its competitiveness. In order to contribute to this, the National Transport Plan includes new double tracks and crossing tracks, upgraded carrying capacity and tunnel sections as well as improved railway freight terminals. Freight transport is also to be given increased priority on the rail system.

4.3 Freight Transport Flows

Total freight movements include domestic and international freight movements.

The easiest to measure (as it crosses a border and is usually recorded by customs officials) is international freight. Estimates of domestic freight movements can be obtained from the rail operators, the airports and for road transport – to some extent – through surveys of road haulers.

4.3.1 Domestic Freight Movements

Norway is unusually dependent on coastal shipping; regarding domestic freight transport, ships transport the same quantity as trucks (measured in tonne-km). As of 2008, 48% of all domestic freight transport activity – measured in tonne-km – was by road transport and 45% was by sea with rail transport accounting for the remaining 7%. Rail therefore has a small market share overall, but is important on some routes, especially between the large cities.

Over all transport modes, the growth in transport activity in 2008 - measured in tonne-km - was 4.6%. The total goods volume has almost tripled as from 1965 to 2008, while the transport

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23 Hans Silborn, 2005 ibid.
performance measured in tonne-km has increased six-fold. However, in 2008 the growth in freight transport by sea slowed to only 0.5%. In contrast, freight transport by road increased considerably in 2008, as did the tonnage (and tonne-km) transported by rail.

![Domestic goods transport, by mode of transport. 1965-2008](source: Statistics Norway)

About 80% of the goods are carried less than 50 km; at these distances there is no real competition to truck transport. In general, both sea transport and railway transport are more attractive than road over longer transport distances.

In the last thirty years, freight transport by truck has increased over three-fold, while sea transport has increased by about 35% and railway transport has been stagnant. Over the last ten-year period, freight transport with heavy vehicles (with maximum loads over 17.5 tonnes) on the road system has increased more than six-fold. According to the official forecasts the market share of road transport will continue to increase.

Goods transport by air remained relatively modest throughout the period.

### 4.3.2 Trip Length by Mode

For goods transport by lorry, the tonne-weighted average length of journey in domestic transport has almost quadrupled between 1965 and 2008 - when the average length of journeys was 58 km.

The goods volume via ship has more than doubled, but the distance that goods are transported is considerably shorter than previously.

Measured in tonnes, rail transport has remained steady since 1965. But the goods are transported over longer distances and the transport activity measured in tonne-km has more than doubled.

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4.3.3 **Freight Corridors**

Oslo is the most important hub in the Norwegian freight transport system. In terms of tonnage the sea route along the Norwegian west coast is the most important freight transport corridor in Norway. In terms of economic value, the road transport corridors to and from Oslo are of equal importance.

4.4 **International Freight Movements**

The volume of goods imported was 34.5 million tonnes in 2008, compared to an export volume of about 46 million tonnes the same year (excluding oil and gas).

4.4.1 **Exports**

Norway exports oil, gas and fish, as well as some industrial products; the main destinations are EU countries and the US. Oil and gas constitute 69% of the total exports (in tonnes) from Norway, with 181 million tons of oil and gas being exported directly from the Norwegian continental shelf in 2008, slightly more than in 2007. There has been a trend over the last few years towards more oil and gas export being transported by pipe, while there has been a decrease in oil and gas exports by ship.

4.4.2 **Imports**

Imports to Norway are dominated by consumer goods from Sweden, America, Asia, Germany and Great Britain, but the country also has significant imports from many other EU countries.

4.4.3 **International Transport Mode**

Sea transport dominates shipments to and from abroad, as 89% of the volume of freight to and from the mainland being carried by ship. About 90% of the export and 80% of the import are transported by ship. However, the last ten-year period the freight transport crossing the border between Norway and Sweden by truck has increased by more than 60%. Freight transport by railway over the Norwegian boarder is of less importance.26

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26 Senior Adviser Hans Silborn, Norwegian Public Roads Administration PIARC meeting and seminar 13-15 June 2005
Table 4.1 – International Trade by Mode of Transport (Tonnes) 2008/2009

<table>
<thead>
<tr>
<th>TONNES</th>
<th>2008</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td><strong>IMPORTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ship</td>
<td>24,742,023</td>
<td>20,530,027</td>
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<tr>
<td>Ferry</td>
<td>1,363,196</td>
<td>1,089,044</td>
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<td>Railway</td>
<td>1,164,911</td>
<td>951,751</td>
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<tr>
<td>Lorry, road transport</td>
<td>7,148,996</td>
<td>6,280,531</td>
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<tr>
<td>Aircraft</td>
<td>37,735</td>
<td>30,058</td>
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<tr>
<td>By Mail</td>
<td>11,991</td>
<td>2,713</td>
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<td>Pipeline</td>
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<td>0</td>
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<tr>
<td>Other</td>
<td>34,453</td>
<td>20,553</td>
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<td><strong>Total</strong></td>
<td><strong>34,503,305</strong></td>
<td><strong>28,904,677</strong></td>
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<td><strong>EXPORTS</strong></td>
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<tr>
<td>Ship</td>
<td>129,568,097</td>
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<td>Ferry</td>
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<td>Lorry, road transport</td>
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<td>By Mail</td>
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<td>Pipeline</td>
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<td><strong>Total</strong></td>
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<td><strong>214,242,239</strong></td>
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<td><strong>TOTAL IMPORTS + EXPORTS</strong></td>
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<tr>
<td>Ship</td>
<td>154,310,120</td>
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<td>Ferry</td>
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<td>Railway</td>
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<td>Lorry, road transport</td>
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<td>Pipeline</td>
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<td>Other</td>
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<td><strong>Total</strong></td>
<td><strong>258,222,415</strong></td>
<td><strong>243,146,916</strong></td>
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</table>

Source: Norway Statistics (various)
4.5 Rail Transport

Norway has 13 railway freight terminals owned and financed by Jernbaneverket and operated mainly by CargoNet (a partly-state-owned railway company).

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
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<tr>
<td>National</td>
<td>8 204 361</td>
<td>8 062 357</td>
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<tr>
<td>Import</td>
<td>15 099 578</td>
<td>13 244 486</td>
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<tr>
<td>Export</td>
<td>1 498 793</td>
<td>1 654 527</td>
</tr>
<tr>
<td>Total</td>
<td>24 802 732</td>
<td>22 961 370</td>
</tr>
</tbody>
</table>

Source: Norway Statistics
Note: International rail flows differ from those given in Table 4.1

In 2009 there was a fall in the traffic by rail on Norwegian territory after some years of growth. The number of passengers fell to 57.9 million; a decrease from 2008 by almost 2%; the decrease in tonnes transported was 7% – from 24.80 million tonnes in 2008 to 22.96 million tonnes in 2009. However, the bulk of rail freight tonnage was made up of imports.

The total goods production by rail did however increase slightly (0.8%) and came to almost 3.7 billion tonne-km. This can be explained by an increase in the average transport length per tonne of 13 km.

4.5.1 Rail Freight Operators

CargoNet

CargoNet AS is the primary operator of freight trains on the Norwegian railway system (excluding Malmtrafik’s iron ore exports via Narvik). CargoNet AS is owned by NSB (55% share holding).

http://www.railfaneurope.net/list/norway.html

The original national railway company NSB was been split in an infrastructure company, freight operating company CargoNet AS (until 2002 named NSB Gods) and a passenger operating company still called NSB.
and the Swedish freight company Green Cargo (see below). The Norwegian CargoNet AS has a subsidiary company in Sweden called CargoNet AB which was purchased as RailCombi AB.

CargoNet freight trains carry trailers, swap-bodies and containers from 20 to 45 feet as well as tanks over a network of freight terminals in Norway and Sweden, offering up to seven freight trains in each direction. CargoNet serves:

- 11 freight terminals in Norway, including Alnabru in Oslo, Drammen, Kristiansand, Stavanger, Bergen, Åndalsnes, Trondheim, Mo i Rana, Fauske, Bodo and Narvik.
- 11 freight terminals in Sweden, including: Luleå, Umeå, Sundsvall, Gävle, Hallsberg, Stockholm, Jönköping, Gothenburg, Älmhult, Malmö and Trelleborg.

In addition to this System trains in Norway offer closed transport systems for major industrial clients. CargoNet also operates further afield in Scandinavia and Continental Europe.

![Figure 4.3 – CargoNet Rail Freight Services](source: CargoNet)

**Green Cargo / TKAB**

Norwegian CargoNet is partly owned by Green Cargo and has operations in Sweden.

Green Cargo (formerly part of Swedish Railways) is the main Swedish rail freight operator. It is now an international logistics company with 3,500 employees in over 100 locations throughout the Nordic region and Europe. Some 94% of its goods are transported on electrically-powered trains.

The company has 30 terminals and logistics centres, and provides the complete range of road haulage distribution services to customers. Services include warehousing, as well as advanced logistics solutions; occasionally it is also responsible for the final production process and for the distribution of goods to the customer.

The main stream of its international transport flow goes to Norway, Germany and Italy. Some 80% of its revenue is generated through railway operations, while 13% and 7% is derived from road-based haulage and third party logistics services, respectively.

Green Cargo and Railion (Germany) now jointly own Railion Scandinavia (based in Denmark).
Cargolink/Autolink

Cargolink is an open-access freight operator that operates automotive trains on behalf of Autolink AS, a Norwegian automobile distributor with port facilities in Drammen, Oslo and Malmö. Autolink prepares and redistributes to dealerships three quarters of all automobiles in Norway.

Cargolink operates ten Di 6 locomotives and more than 100 autoracks, and annually distributions 50,000 automobiles on 600 trains to terminals in Stavanger, Bergen, Åndalsnes, Trondheim, Mosjøen, Mo i Rana, Bodø and Narvik. At the terminals, Autolink redistributes the automobiles using 60 trucks to the dealerships.

Tågåkeriet

Tågåkeriet i Bergslagen AB, also called TÅGAB is a Swedish railway business, based in Kristinehamn. Together with Green Cargo, TÅGAB operates freight services in Norway and Sweden.

Malmtrafik

Malmtrafik i Kiruna AB or MTAB is a Swedish railway company which operates the iron ore freight trains on the Ore Line and the Ofoten Line. MTAB is a wholly owned subsidiary of the mining company Luossavaara–Kiirunavaara (LKAB). In Norway, operations are handled by the
subsidiary Malmtrafikk AS (MTAS). Malmtrafik hauls ore from LKAB’s mines in Kiruna, Malmberget and Svappavaara to the ports of Luleå and Narvik, the latter located in Norway.

**Peterson Rail**

Peterson Rail is a new open-access freight operator that runs lumber and woodchip trains in Norway and to Sweden.

**Hector Rail**

Hector Rail provides line-haul traction between facilities / terminals.

Hector Rail has recently purchased a Taurus locomotive from MRCE (Mitsui Rail Capital Europe B.V.), with the option to buy an additional four. The locos have a maximum speed of up to 230 km/h, faster than any locomotive currently used in Sweden. The locomotives have an installed power of 6,400 kW (short term 7,000 kW) twice as much as an X2000-unit or an Rc-loco - the standard Swedish locomotive. The investment strengthens Hector Rail's existing fleet of 32 line haul locomotives.

**4.5.2 Rail Operator Statistics**

CargoNet is the largest domestic operator but in international rail movements, the largest operator (by tonnage) is Malmtrafik – carrying iron ore from Sweden to Narvik port in the north of Norway.

<table>
<thead>
<tr>
<th>Table 4.3 – Rail Freight Operator Traffic, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic traffic, total</td>
</tr>
<tr>
<td>- Of which, CargoNet</td>
</tr>
<tr>
<td>- Other</td>
</tr>
<tr>
<td>Cross-border Traffic, total</td>
</tr>
<tr>
<td>- Of which, CargoNet</td>
</tr>
<tr>
<td>- Malmtrafikk</td>
</tr>
<tr>
<td>- Other</td>
</tr>
</tbody>
</table>

Source: Norway Statistics

**4.6 Road Freight**

Norwegian domestic road freight transport is carried out overwhelmingly by Norwegian lorries.

During 2008, Norwegian lorries transported 289 million tonnes while foreign lorries transported only 8.1 million tonnes of goods in Norway (2.7%).

Of the 8.1 million tonnes transported by foreign lorries, 7.6 million tonnes were transported into or out of Norway, while 0.5 million tonnes were carried from one place in Norway to another (referred to as ‘cabotage’ – see below). By way of comparison, the Norwegian lorry survey estimated that Norwegian lorries transported 282.8 million tonnes of goods domestically and 6.3 million tonnes into or out of Norway.

The main commodities carried by road in Norway are:

---

29 A European standard loco built by Siemens, with more than 400 units produced between 1999 and 2006
30 Source: Hector Rail website.
31 Based on new statistics derived from surveys of road goods transport conducted by the EU/EEA countries, reported in ‘Goods are transported by Norwegian lorries in Norway’, Statistics Norway
http://www.ssb.no/english/subjects/10/12/20/godstransutl_en/
Bulks, such as metal ores, aggregates and cement (around 62% of the tonnage in 2009);
Food products and animal fodder (around 9% of the total tonnage);
Coal, oil and chemicals (just over 9% of the total tonnage); and
Agricultural and forestry products (around 6% of the total tonnage).

None of these commodities is likely to be attracted to HSR freight – over 86% of the tonnage.

Table 4.4 – National Road Transport by Commodity 2008/2009

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Agricultural products, forestry products, fishing products</th>
<th>Food products, beverages, tobacco and animal fodder</th>
<th>Coal, oil and chemicals and chemical products</th>
<th>Metal ores, stone, sand, gravel, clay, salt, cement, lime, manufactured construction materials</th>
<th>Other manufactured goods, grouped goods and other goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonnage carried (million tonnes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>282.8</td>
<td>19</td>
<td>25.8</td>
<td>23.3</td>
<td>170.7</td>
<td>44</td>
</tr>
<tr>
<td>2009</td>
<td>252.0</td>
<td>15</td>
<td>22.9</td>
<td>23.6</td>
<td>155.4</td>
<td>35.2</td>
</tr>
<tr>
<td>Transport performance (million tonne-kilometres)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>16 728.1</td>
<td>2 063.3</td>
<td>3 579.5</td>
<td>1 606.1</td>
<td>3 743.3</td>
<td>5 735.8</td>
</tr>
<tr>
<td>2009</td>
<td>15 272.8</td>
<td>2 296.9</td>
<td>2 894.1</td>
<td>1 553.6</td>
<td>3 668.0</td>
<td>4 860.3</td>
</tr>
</tbody>
</table>

Note: For hire or reward and own account

Source: Statistics Norway

4.6.1 International Road Freight

A total of 3.1 million tonnes of goods were imported and exported by lorries crossing the national border on road during the second quarter of 2010, 390 000 tonnes (14.3%) more than in the corresponding quarter of 2009. The share of the total cross-border traffic transported by Norwegian lorries remained unchanged at 44.1%.

4.6.2 Activities of Foreign Lorries

Foreign lorries carried 6.3 billion tonne-km in their transport to, from and inside Norway during 2008 (these figures also include the part of the distance driven abroad). The transport performance by the Norwegian lorries amounted to 20.6 billion tonne-km in total, of which 16.7 billion were domestic and 3.9 billion on international tours. Thus the foreign lorries’ share of the total transport performance by lorry to, from, and inside Norway was 23.5% in 2008.

Swedish lorries performed 1.8 billion tonne-km while driving to, from, or inside Norway in 2008, while Danish lorries performed 1.2 billion tonne-km. German and Polish lorries followed, both with 0.8 billion tonne-km. In Norway itself during 2008, Swedish lorries transported 3.7 million tonnes of goods, while Danish lorries transported 1.7 million tonnes.

The foreign lorries transport more goods from their home country to Norway than back. During 2008, 50.4% of all the goods transported by these lorries were carried from their home country to Norway, while 26.4% were carried from Norway back to their home country.

Cabotage

In recent years it has become more common for foreign road hauliers to undertake transport commissions inside Norway - so called ‘cabotage’ - or to transport goods from one foreign country to another - so called ‘cross-trade’ transport. Cabotage transport is governed by international regulations. In principle, such transport is prohibited, but transporters from the EU/EEA countries have permission to transport goods inside another country for short periods of time.
In 2008, 17.2% of the goods transported by foreign lorries to or from Norway was cross-trade (in 2000, the share was only 6.2%). The share of the tonnage carried in cabotage increased from 2.5% in 2000 to 6% in 2008.

A total of 488 thousand tonnes of goods were transported in cabotage by foreign lorries in Norway in 2008 or 0.2% of all goods carried by Norwegian and foreign lorries inside Norway. Norwegian lorries transported 264,000 tonnes of goods as cabotage in other countries during 2008.

During 2008, Danish lorries transported 228,000 tonnes of goods from one place in Norway to another. This is more than any other country and amounts to 13.6% of all the goods Danish lorries carried to, from or in Norway.

German lorries were biggest on cross-trade. As much as 385,000 tonnes of goods were transported between Norway and a country other than Germany by these lorries. The German lorries carried fewer goods directly between Germany and Norway than between Norway and third countries. German lorries had 52.6% of their Norway transport as cross-trade and 7.7% as cabotage.

### 4.7 Air Freight

With 46 airports spread all over Norway, Avinor's airports handle close to 96% of Norwegian air traffic. There are six airports in Norway not owned by Avinor. Two of these are large airports - Sandefjord/Torp (TRF) and Moss/Rygge (RYG) - located close to Oslo and competing partially for the same passengers as Oslo Airport; the other four are smaller airports.

The tonnages of freight moved by air are relatively small, but are typically high in value. In 2005, 126 824 tonnes of goods and mail were received and sent from Norwegian airports. Although in 2008 air freight reached 132 657 tonnes, by 2009 air cargo at Norwegian airports had fallen to 111 738 tonnes – lower than the traffic in 2005. Around 60% of the traffic was domestic in 2009.

The large majority of air freight is carried on scheduled passenger services – nearly 92% in 2009.

<table>
<thead>
<tr>
<th>Table 4.5 – Norwegian Air Freight 2005, 2008,2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tonnes</strong></td>
</tr>
<tr>
<td>Domestic total</td>
</tr>
<tr>
<td>- Scheduled</td>
</tr>
<tr>
<td>- Freight or Charter</td>
</tr>
<tr>
<td>International total</td>
</tr>
<tr>
<td>- Scheduled</td>
</tr>
<tr>
<td>- Freight or Charter</td>
</tr>
<tr>
<td>Total Domestic + International</td>
</tr>
</tbody>
</table>

Source: Avinor, Civil Aviation Administration
Table 4.6 – Passenger Traffic at Selected Airports 2009

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total all airports</td>
<td>34 803 987</td>
<td>37 915 120</td>
<td>126 824</td>
<td>131 420</td>
<td>111 738</td>
</tr>
<tr>
<td>Oslo Gardermoen</td>
<td>15 895 722</td>
<td>19 344 459</td>
<td>84 272</td>
<td>89 770</td>
<td>78 000</td>
</tr>
<tr>
<td>Bergen Flesland</td>
<td>3 863 198</td>
<td>4 480 876</td>
<td>7 259</td>
<td>6 104</td>
<td></td>
</tr>
<tr>
<td>Trondheim Værnes</td>
<td>2 935 799</td>
<td>3 423 927</td>
<td>5 532</td>
<td>7 553</td>
<td>6 207</td>
</tr>
<tr>
<td>Stavanger Sola</td>
<td>2 785 031</td>
<td>3 417 400</td>
<td>5 879</td>
<td>9 667</td>
<td></td>
</tr>
<tr>
<td>Sandefjord Torp</td>
<td>1 210 501</td>
<td>1 574 161</td>
<td>247</td>
<td>482</td>
<td></td>
</tr>
<tr>
<td>Kristiansand Kjevik</td>
<td>761 760</td>
<td>844 363</td>
<td>1 240</td>
<td>546</td>
<td></td>
</tr>
<tr>
<td>Haugesund Karmøy</td>
<td>437 963</td>
<td>532 352</td>
<td>392</td>
<td>337</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Statistical Yearbook 2009 and Avinor; aOslo Airport; bTrondheim Airport; Benchmarking Avinor’s Efficiency – A Pre-Study Cranfield University, May 2010; c2008

Oslo Gardermoen Airport was by far the busiest air freight hub, handling nearly 70% of all air freight in 2009 – 78 000 tonnes, of which 28,000 tonnes were mail. In 2008 95% of Norwegian international air freight passed through Oslo Airport; the airport also handled just under half (45.6%) of the domestic air cargo.

Table 4.7 – National and Oslo Gardermoen Air Freight 2008

<table>
<thead>
<tr>
<th>Tonnes</th>
<th>Total National Airports</th>
<th>Oslo Gardermoen</th>
<th>Oslo as % of National Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic air freight</td>
<td>71,198</td>
<td>32,457</td>
<td>45.6%</td>
</tr>
<tr>
<td>International air freight</td>
<td>60,222</td>
<td>57,313</td>
<td>95.2%</td>
</tr>
<tr>
<td>International + Domestic</td>
<td>131,420</td>
<td>89,770</td>
<td>68.3%</td>
</tr>
</tbody>
</table>

Source: Statistical Yearbook 2009

The other busy airports are Bergen Airport (Flesland), Stavanger Airport (Sola) and Trondheim Airport (Værnes) – other airports are much less busy.

4.7.1 Oslo Airport

Oslo Airport is the main Norwegian air transport hub. Almost 70% of all international trips to and from Norway and 70% of domestic air traffic start or end in Oslo. It is particularly Western and Northern Norway that is dependent on Oslo Airport as a hub – more than 90% of travellers from these regions used the airport.32

Oslo Airport is also a national hub for air cargo – with most of the cargo being carried in scheduled passenger services. Air freight handled at Oslo Airport has been broadly constant over the last 10 years at 70 000 to 100 000 tonnes per annum, with a peak in 2007 followed by a decline in 2008 and 2009.

As is common in most of Europe, much inter-Europe “air” freight transport is actually transported by road. Avinor report that 43% of air freight arriving at Oslo Airport is transported onwards by road, the rest is transported to domestic air services.
4.7.2 Domestic Air Freight

As Oslo handles 95% of international air freight, the ‘Freight and Mail’ tonnages handled at other airports consist mainly of domestic cargo – including international cargo transhipped at Oslo to domestic air services.

Table 4.8 – Domestic Air Freight and Mail (Received & Sent), 2008

<table>
<thead>
<tr>
<th>Freight and mail (tonnes)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic traffic, total</td>
<td>71 198</td>
</tr>
<tr>
<td>Oslo Gardermoen</td>
<td>32 457</td>
</tr>
<tr>
<td><strong>Selected Airports</strong></td>
<td></td>
</tr>
<tr>
<td>Stavanger Sola</td>
<td>8 024</td>
</tr>
<tr>
<td>Trondheim Værnes</td>
<td>7 468</td>
</tr>
<tr>
<td>Bergen Flesland</td>
<td>5 168</td>
</tr>
<tr>
<td>Kristiansand Kjevik</td>
<td>470</td>
</tr>
<tr>
<td>Sandefjord Torp</td>
<td>425</td>
</tr>
<tr>
<td>Haugesund Karmøy</td>
<td>332</td>
</tr>
<tr>
<td><strong>Total for Selected Airports</strong></td>
<td><strong>21 887</strong></td>
</tr>
</tbody>
</table>

Note: Showing only airports likely to be served by HSR

4.7.3 Air Freight Flows on High Speed Rail Corridors

Avinor has provided more detailed statistics on the annual freight (mail and air freight) in tonnes between cities most likely to be served by HSR. There has been a decrease in the amount of goods from 2007-2009 between all the listed cities. The ‘busiest’ connection is Oslo-Gothenburg with and amount of 2 415 tonnes in 2009 - equivalent to less than a lorry load per day (based on a 350-day year).
### Table 4.9 – Air freight Traffic on Selected Routes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oslo-Gotthenburg</td>
<td>3 182</td>
<td>2 975</td>
<td>2 415</td>
</tr>
<tr>
<td>Oslo-Bergen</td>
<td>1 786</td>
<td>1 398</td>
<td>1 406</td>
</tr>
<tr>
<td>Oslo-Stockholm</td>
<td>1 815</td>
<td>1 401</td>
<td>1 143</td>
</tr>
<tr>
<td>Oslo-Stavanger</td>
<td>1 440</td>
<td>1 252</td>
<td>929</td>
</tr>
<tr>
<td>Oslo-Trondheim</td>
<td>1 488</td>
<td>1 126</td>
<td>754</td>
</tr>
<tr>
<td>Oslo-Kristiansand</td>
<td>494</td>
<td>435</td>
<td>299</td>
</tr>
<tr>
<td>Stavanger-Bergen</td>
<td>427</td>
<td>336</td>
<td>277</td>
</tr>
</tbody>
</table>

Note: the above tonnages are carried in aircraft

Source: Avinor

### 4.8 Maritime Freight

Goods moved by sea are generally not expected to be attracted to HSR freight services, as they are unlikely to be time-sensitive. Having said that, some types of maritime freight – such as container and new cars (e.g. from Gothenburg Port) might be attracted from road to a fast rail service.

In 2007 a survey of sea freight revealed that, in total, 25 million tonnes of goods were transported as bulk, as cargo and in containers between Norwegian ports. More than half was between ports within the regions of south east and west. Liquid bulk dominated domestic transport between the western and south eastern regions with 2.9 million tonnes. In dry bulk, ports in the western region did most of the domestic transport with 2.5 million tonnes. In general cargo, the south east ports were the most important ports with 0.7 million tonnes of the domestic transport.

Transport between Norwegian and foreign ports accounted for 74% of port activity in 2007 (at 124 million tonnes). Transport between Norwegian ports accounted for 15% of the total sea transport and transport between Norwegian ports and offshore installations accounted for 11% at 18 million tonnes.\(^{33}\)

### 4.8.1 Port of Gothenburg

As shown in the following figure, there are substantial road freight flows between Gothenburg and Oslo.

---

\(^{33}\) Sea freight transport survey, 2007, Statistics Norway
From 2001 to 2007 the total number of containers coming in or out of Gothenburg port, grew from 595,000 to 841,000. Over the past ten years the Port of Gothenburg has invested heavily in increasing the volume of goods moved by train to and from the port. This initiative has proved successful – 45% of all containers are now transported by rail. This represents around 200,000 containers annually, which means 550 fewer large trucks on the roads each day.  

Rail container shuttles operate between Malmö, the Port of Gothenburg and Oslo. Container traffic between Gothenburg and Norway amounts to around half a million loaded TEU (Twenty Foot Equivalents) – a counter-flow of similar number of empty containers must also be assumed. 

[34] Port of Gothenburg  
[35] Nordregio – the Nordic Centre for Spatial Development  
http://www.nordregio.se/?vis=artikkel&id=10602&id=0206201015453128096
4.9 Forecasts of Future Freight Movements

Forecasts of future freight movements (produced by TOI\textsuperscript{36}) assume relatively modest annual growth rates of growth of 1-2\%, as shown in the following tables.

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|c|c|c|}
\hline
\hline
\textbf{Domestic} & & & & & & \\
Road & 253.1 & 1.46\% & 1.60\% & 1.30\% & 1.37\% & 1.30\% \\
Sea & 35.2 & 1.53\% & 1.63\% & 1.20\% & 1.30\% & 1.28\% \\
Rail & 7.0 & 1.88\% & 1.59\% & 1.45\% & 1.47\% & 1.38\% \\
\textbf{Sum} & 295.3 & 1.49\% & 1.57\% & 1.36\% & 1.42\% & 1.34\% \\
\hline
\textbf{Foreign trade} & & & & & & \\
Road & 10.8 & 1.70\% & 1.36\% & 1.54\% & 1.37\% & 1.30\% \\
Sea & 63.6 & 1.65\% & 1.09\% & 1.06\% & 1.19\% & 1.26\% \\
Rail & 1.7 & 1.88\% & 1.59\% & 1.45\% & 1.47\% & 1.38\% \\
\textbf{Sum} & 76.1 & 1.67\% & 1.64\% & 1.14\% & 1.22\% & 1.27\% \\
\hline
\textbf{Total} & & & & & & \\
Road & 263.9 & 1.47\% & 1.59\% & 1.31\% & 1.37\% & 1.30\% \\
Sea & 98.8 & 1.61\% & 1.57\% & 1.11\% & 1.23\% & 1.27\% \\
Rail & 8.7 & 1.88\% & 1.59\% & 1.45\% & 1.47\% & 1.38\% \\
\textbf{Sum} & 371.4 & 1.51\% & 1.61\% & 1.26\% & 1.33\% & 1.33\% \\
\hline
\end{tabular}
\caption{Norway Freight Forecasts}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|c|c|c|}
\hline
\hline
\textbf{Domestic} & & & & & & \\
Road & 16 125 & 2.19\% & 1.78\% & 1.31\% & 1.44\% & 1.22\% \\
Sea & 15 693 & 1.25\% & 1.00\% & 1.32\% & 1.41\% & 1.43\% \\
Rail & 2 374 & 2.91\% & 2.58\% & 2.05\% & 1.95\% & 1.46\% \\
\textbf{Sum} & 34 192 & 1.81\% & 1.49\% & 1.37\% & 1.47\% & 1.33\% \\
\hline
\textbf{Foreign trade} & & & & & & \\
Road & 1 992 & 2.17\% & 1.53\% & 1.53\% & 1.52\% & 1.64\% \\
Sea & 31 554 & 1.34\% & 1.49\% & 0.77\% & 0.92\% & 1.05\% \\
Rail & 464 & 2.28\% & 1.42\% & 1.57\% & 1.56\% & 1.68\% \\
\textbf{Sum} & 34 010 & 1.40\% & 1.49\% & 0.82\% & 0.97\% & 1.10\% \\
\hline
\textbf{Total} & & & & & & \\
Road & 18 117 & 2.10\% & 1.83\% & 1.31\% & 1.43\% & 1.26\% \\
Sea & 47 247 & 1.33\% & 1.31\% & 0.99\% & 1.07\% & 1.17\% \\
Rail & 2 638 & 2.72\% & 2.23\% & 1.91\% & 1.64\% & 1.32\% \\
\textbf{Sum} & 58 202 & 1.58\% & 1.49\% & 1.09\% & 1.21\% & 1.22\% \\
\hline
\end{tabular}
\caption{Adjusted growth in ton k_m by mode. Mode split in 2006 according to official figures for Norway (Rideng, 2007). Figures in million ton k_m and per cent. Excluding transit, crude oil and natural gas.}
\end{table}
4.10 Conclusions on the Norwegian Freight Market

From the information presented above, it can be seen that Norway has a substantial and competitive freight transport market, dominated by road and coastal sea transport. Most road freight is composed of relatively low-value and non-time-sensitive bulk materials that would not be suitable for an HSR freight service.

Rail has a relatively small share of transport activity and the majority of this traffic is imported material – for example, from the Gothenburg corridor in the south or on the Narvik corridor in the north.

Air freight is – in tonnage terms – tiny compared to the totals for road and sea transport but clearly represents part of the potential market for HSR freight. However, the air cargo on the identified HSR corridors does not currently exceed an average of one truck load per day. The air freight market is dominated by Oslo airport, which handles nearly all of the international connections for air cargo and is the hub for domestic air cargo. This implies that any HSR services seeking to capture domestic or international air cargo would probably have to serve Oslo airport.
5. Feasibility of Fast Rail Freight in Norway

5.1 Introduction
This section considers the feasibility of carrying HSR freight on the proposed improved or HSR network. This is both a technical issue, related to the characteristics of the proposed track - such as axle load, gradient, curve radius, operating speed, etc. – as well as the overall system capacity, in terms of train paths for fast freight trains.

5.2 Defining High Speed Rail Freight
The primary field where higher maximum speeds could be valuable is for specialised fast or high speed rail freight.

The term high speed often is connected not only to speed alone, but even to other attributes of a train or a train service. High speed (passenger) trains are normally semi-permanently coupled trainsets with a uniform outer (and inner) design and aerodynamically shaped fronts. Furthermore HSR trains often operate over a dedicated infrastructure (new-built or heavily upgraded lines), either in combination with conventional lines (as the French TGV or the German ICE) or exclusively (as the Spanish AVE or the Japanese Shinkansen).

When it comes to freight, high speed (HSR) rail freight is - at best - a small and specialised activity for the railways where it occurs. Consequently there is today no generally established definition.

There are, of course, the French TGV postal trains, running at speeds up to 270 km/h since the 1980s. This service is clearly HSR freight – indeed it represents the fastest rail freight train in the world. By comparison, a heavy iron ore train or any other slow-running freight train for bulk commodities like coal, oil, etc. is clearly ‘conventional’ not HSR freight.

For conventional rail freight, the benefits of higher maximum speeds would in many cases be rather limited due to the fact that the average speed in a transport chain is here to a higher degree influenced by factors such as shunting, marshalling and waiting times rather than by the maximum speed of the rolling stock or the permissible line speed. In conventional rail freight traffic neither the gains in competitiveness nor in productivity – if such can be achieved at all – would probably in most cases be able to counterbalance the higher costs required for an increase of the maximum speed.

The question is where to draw the line between these two extremes. Factors to be considered can comprise both technical, operational and market aspects. Rolling stock designs for high speed rail freight show a large variety of different train concepts - from single wagons to freight multiple units. It is common for them to use passenger train technology or be directly derived from passenger trains.

In practice, the term ‘high speed’ has to be interpreted relatively, not absolutely. There has to be a point of reference, and this point of reference is the speed normally achieved by other trains in a network. This speed can vary between different countries. The speed of an HSR train is ‘high’ just in relation to the speed achieved by those other trains. There is no absolute speed which has to be exceeded in order to qualify for the denomination HSR - the trains simply have to run faster than ‘conventional’ trains.

This might explain why HSR in, for example, France and Germany normally stands for speeds ≥ 250 km/h, while in Sweden the ‘only’ 200 km/h fast X2000 could join the European HSR train family. France and Germany simply already had trains with a maximum speed of 200 km/h in service since the mid-sixties or seventies, while in Sweden passenger trains’ maximum speed
before introduction of the X2000 had been 130 km/h (160 km/h on some shorter sections for some few trains).

However, when considering speed, 200 km/h can be set as a lower limit for the demarcation of HSR freight and a speed of around 120-140 km/h marks the boundary between ‘conventional’ and ‘fast’ rail freight – as summarised in the following table.

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Speed</th>
<th>Predominant Vehicle Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>High speed rail freight</td>
<td>&gt;200 km/h</td>
<td>Modified high speed passenger trains Fixed trainsets</td>
</tr>
<tr>
<td>Fast rail freight</td>
<td>&lt;200 km/h</td>
<td>Modified high speed passenger trains Fixed trainsets and individual freight wagons</td>
</tr>
<tr>
<td></td>
<td>&gt;120-160 km/h</td>
<td>Modified freight wagons, approved for faster speeds</td>
</tr>
<tr>
<td>Conventional rail freight</td>
<td>&lt;120-160 km/h</td>
<td>Conventional freight wagons</td>
</tr>
</tbody>
</table>

Source: based on Troche 2005

### 5.3 High Speed Rail Freight Business Concept

The business concept of high speed rail freight has been defined as follows:

**HSR Freight: Faster than by truck – cheaper than by air**

This summarises the market niche, which is certainly fairly small as far as total tonnage is considered. It offers, however, a high specific revenue-potential and it also includes two fast-growing market segments, including:

- Air freight – such as the integration with passenger services, such as the Lufthansa ‘fast’ ic:kurier service or dedicated freight trains, such as the planned Carex HSR services; and
- Postal/express parcels/courier shipments - such as carried by the TGV La Poste trains (and TGV Fret proposals).

### 5.3.1 Mail and Express Freight

HSR freight addresses – par excellence - the market segment of mail and express freight. For a long time rail held a strong position in this market. However, since the middle of 20th century, rail has lost much traffic to both road and air transport and new traffic was quickly absorbed by the competing modes.

Today the situation varies between countries: In some countries new traffic systems were built up (again) and new rolling stock able to run at high speeds was introduced. In other countries traffic declined and finally ceased totally.

In addition, it is possible that the development of HSR passenger services may release freight capacity on the conventional rail network, providing more opportunities for transfer of freight from road to rail transport, with benefits for road decongestion, safety and emissions.

### 5.4 Previous Studies of Freight on the Norwegian High Speed Rail Network

Previous studies of the proposed Norwegian system have considered the possibility of integrating conventional freight services.

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37 ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005
38 Troche 2005 ibid.
39 ‘Status of knowledge on high speed rail lines in Norway Report’ July 2010 - Phase 1 HSRHSRR Report
5.4.1 DB International GmbH / Norsk Bane Study

DB International GmbH was commissioned by Norsk Bane AS to carry out a market analysis so as to prepare a new railway and traffic concept for South and Central Norway.

Norsk Bane also made projections for goods transport, although using a different model than for passenger transport. For goods transport, Norsk Bane estimates that the transport work (measured in million tonne-km per day) that could be done on the line between Oslo and Trondheim will be 10.1 million tonne-km per day. The corresponding figure for Oslo – Bergen / Haugesund / Stavanger is 11.5 million tonne-km per day.

<table>
<thead>
<tr>
<th></th>
<th>Million tonne-km per day</th>
<th>Total</th>
<th>Existing Rail Traffic</th>
<th>Transfer from Road Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oslo - Bergen / Haugesund / Stavanger</td>
<td>11.5</td>
<td>5.5</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Oslo - Trondheim</td>
<td>10.1</td>
<td>6.9</td>
<td>3.3</td>
<td></td>
</tr>
</tbody>
</table>

Source: Deutsche Bahn, 2009

5.5 Feasibility Study Concerning High Speed Railway Lines in Norway (VWI 2006/07)

This study highlighted the technical constraints of integrating freight onto an HSR network primarily intended for passenger services. For example, for the utilisation of a line for freight traffic the base maximum gradient is very important - it should be no higher than 12.5% to run heavy freight trains, much more restricted than for passenger trains alone (although engineering trains would also have to be accommodated).

5.5.1 Effect on Line Capacity

There is a large difference in speed between HSR passenger services and a conventional freight train, which has the effect of reducing the overall capacity of a line if they are operated together and requires passing loops for passenger trains to overtake freight trains by passenger trains. As the freight trains need a wide slot between the passenger trains there is often only one or two slots an hour available, this means that the freight trains must wait for the passenger train before they can go on to the next passing section where they wait again. The analysis of daily operation showed that the average speed is often much lower than on the old conventional lines where – paradoxically - capacity increased because passenger traffic had been transferred to the HSR line.

Detailed simulations in Phase 2 of the Study in the corridor Oslo – Trondheim showed that it is very difficult to combine HSR and conventional freight traffic on the same line even if it is double tracked. It causes restrictions in operation and because of overtaking and the lower priority of freight traffic on HSR lines, the saved journey time for freight trains is not as high as might be expected. Especially in the corridors between Oslo and Bergen, this is more significant because around 20 daily freight-trains per direction are expected, which means at least a train an hour.

On the line from Oslo to Bergen via Hallingdal and Hardangervidda the study looked at a new double-track line for both high speed and freight. The results showed that the gradient has to be even higher than on the existing line because of the shorter and more direct HSR line, so the loads that can be hauled by the freight trains will decrease. In addition, the operation of freight traffic is degraded by the need for frequent stops to allow the HSR passenger services to overtake the freight trains.

In the Haukeli-Concept, the average speed of the HSR trains is reduced by more stops. This increases the possibility of running freight trains as well. In the opinion of the VWI-group, this...
might be different concept based on medium speed but it is not a HSR concept, where trains are really competitive to air transport with limited stops and short journey times.

5.5.2 **Experience of the early German HSR System**

Air pressure in tunnels can also be a constraint. The first two HSR lines in Germany from Hanover to Würzburg and from Mannheim to Stuttgart were constructed for mixed traffic. Operation showed, however, that the high air pressure in the tunnels can cause accidents with loads if they are not well attached to the wagons. Therefore the German Directive for Fire and Emergency Protection in Long Railway Tunnels prohibits the operation of passenger and freight traffic in tunnels at the same time.

Due to all these aspects not a single freight train has used these original German HSR lines in the last 10 years - not even in the night. Moreover, the newer HSR lines in Germany have been constructed only for passenger transport.

Other countries in Europe have a similar experience; only France has a type of freight traffic with converted TGVs used for carrying mail - all the other countries are running only passenger trains on their HSR lines.

5.5.3 **Study Conclusions**

The study concluded that freight traffic on HSR lines would only be feasible during the night. As there are only very few hours during the night where there is no passenger transport, the daily capacity for freight transport on HSR lines was considered to be very low. “As there are increased running times for freight-traffic compared to running-times on the old line and as therefore no benefits for freight traffic can be realized and the integration of [conventional] freight traffic on high speed-Lines causes high additional investment-costs, freight traffic will diminish the cost-benefit results of high speed Rail Service. It is more economical to run it on the conventional line.”

This conclusion rules out most conventional freight traffic, such as bulk traffic and container trains.

5.6 **Capacity for HSR Freight**

As has been discussed, two general types of fast rail freight service are being considered:

- Dedicated fast freight trains – where freight is loaded mechanically at a freight terminal; and
- Mixed passenger/freight fast trains – where cargo is loaded manually on the passenger platform.

5.6.1 **Mixed passenger/freight fast trains**

For the mixed passenger/freight trains the constraint is on the loading capacity per train; it is likely that freight could only take a small part of a mainly passenger train, so the maximum load is likely to be of the order of a couple of tonnes. There could be up to 12 or more passenger trains in each direction each day – giving a total daily capacity of dozens of tonnes on the corridors.

5.6.2 **Dedicated fast freight trains**

For dedicated fast freight trains, the situation is more complex and depends on the available train slots and the train speed. To maximise line capacity, we have assumed that the HSR freight trains would have a similar speed to the HSR passenger services – and would therefore be able to ‘slot in’ behind one of the passenger services.

The capacity of a single HSR freight train could range from 70 tonnes (TGV La Poste) up to 100 tonnes (Carex plans).

As has been indicated, a number of ‘concepts’ or scenarios are being examined for the Norwegian HSR network, ranging from upgrading the existing network to new, separate HSR lines.
At the current stage of development of the Norwegian HSR proposals, it is not possible to come to any final conclusions about the cost of adding line capacity for freight under the different ‘concepts’. In practice, the potential design for a passenger network will be driven by the requirements of operating a passenger-only service. A justification for additional capacity to accommodate freight traffic would then have to be made.

In addition, track maintenance would obviously require track possessions and would reduce the available train slots, so the availability of night-time train paths cannot be assumed without further analysis.

The ease with which HSR/fast freight trains could be added will depend on the HSR scenarios that are considered – and also the specific details of the individual corridors. However, it is possible to make the following broad assumptions:

- Upgrading the existing network may allow higher speeds for passenger services but will almost certainly reduce the overall capacity for other types of operation, given the timetabling constraints for fast passenger trains, resulting in very little capacity for HSR/fast freight services;
- Sections of new single-track HSR lines on some corridors have been suggested as a way of minimising the costs. Providing for an hourly HSR passenger service in each direction will involve the use of passing loops and the need for careful timetabling and timekeeping – any capacity for freight trains would be very limited. At passing loops, non-HSR and HSR freight trains would have to wait for HSR passenger trains. This might mean that the reliability of HSR freight services might be affected; and
- New dual-track HSR lines may give some substantial capacity increase for HSR freight trains, given that a freight trains passenger could be operated ‘in the slipstream’ of a passenger train and consume relatively little additional track capacity. However, it may be planned to operate some regional passenger services partially on the HSR line, which could reduce capacity available for HSR freight trains.

These different options would have varying levels of cost to provide the required freight capacity.

If train path capacity is available (or can be added) and given the capacity of a dedicated HSR freight train, there is potentially capacity for hundreds of tonnes of freight per day on any particular corridor.

Assuming that there is sufficient track capacity, the choice between planning for mixed passenger/freight and dedicated freight trains will therefore depend on the level of market demand and the commercial viability of the proposed services.

5.7 Conclusions on Fast Freight Services in Norway

As discussed in this section, previous studies have highlighted the incompatibility of conventional rail freight with the Norway HSR proposals.

As established by previous studies, it is expected that any trains carrying freight will need to have similar operating characteristics to all-passenger trains:40

- In terms of efficient timetabling, fast freight train speeds should be similar to all-passenger services;
- In terms of the HSR infrastructure, this is likely to be constructed to suit the axle-loads and curve radii for passenger trains; HSR/fast freight trains should be designed for these parameters (which will limit the trailing load of the freight trains); and
- Any cargo carried must be fully enclosed (to avoid the tunnel pressure issues identified in Germany).

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40 When operating together with passenger services – different characteristics may be possible for night-time operation; some ‘flighting’ of slower freight services behind HSR passenger trains may also be possible.
Rail infrastructure proposed for passenger-only services will be planned primarily to deliver the capacity required for the level of this passenger service only. However, it is possible that rail improvements – either to the existing network or by introducing new HSR lines – could provide some additional capacity for a new transport mode: fast or HSR freight:

- With a single-track HSR line, there is not likely to be much scope to introduce train paths for freight-only services, due to the requirement to provide (typically) one HSR passenger services per hour in both directions; and
- With a double-track HSR line, it may be easier to introduce additional train paths for HSR/fast freight services, with appropriate passing points.

All of the ‘concepts’ considered will allow fast (or HSR) mixed passenger/freight trains, which potentially would provide the capacity to transport dozens of tonnes of cargo on improved rail corridors. Development of HSR dual-track lines might allow sufficient capacity for dedicated HSR freight trains that could provide capacity of the order of hundreds of tonnes of cargo on the improved corridor. However, further analysis of the track proposals would be necessary to identify spare capacity (if any) for freight trains. If no spare capacity exists, additional infrastructure would be required to create the necessary capacity for freight.
6. **High Speed Freight Rolling Stock and Infrastructure**

6.1 **Introduction**

In order to develop high speed rail freight it is crucial to look at it as a system, comprising not only the rolling stock but also terminals, loading units, transshipment techniques and train operations.

6.2 **High Speed Rail Freight Train Options**

As has been indicated, the choice of rolling stock will be defined largely by the characteristics of the new HSR line, which in turn will target primarily the passenger market.

The parallel of the air cargo industry shows that two general solutions - transport in dedicated freight aircraft and on board passenger aircraft - can be justified and that they together can form part of an integrated transport concept. Thus for fast rail we can consider:

- Dedicated freight trains, in which only goods are transported; and
- Combined freight/passenger trains in which goods as well as passengers can be transported, although it is assumed that the freight section of the train would be relatively small.

For dedicated freight trains, a first distinction may be made between:

- Shuttles: fixed trains, running at a certain time, between fixed locations; and
- Split-shuttles: transport-flows from several locations that are transported to a certain location, split up, and collected for trains that will go to various destinations.

The shuttle concept provides the fastest service. Shuttles also provide a better basis for logistics development and marketing. This is one of the reasons that the SNCF takes the shuttle concept as starting point (together with the geographical aspects of the French rail-network).

Although other solutions are possible, until the market for high speed freight transport by rail is proven, there is a strong presumption in favour of dedicated shuttle trains, because this will provide the highest service level, in terms of speed and reliability.

6.2.1 **Integrated, Fixed-Formation Passenger/Freight Train**

This represents the highest level of integration: cargo is transported in the same train as the passengers. Freight traffic is as good as fully integrated with passenger traffic as regards timetables, networks, stops, vehicle circulation etc. Loading and unloading along the way is only possible at passenger stations and naturally only at those where the train stops to let passengers on and off.

This means that the freight must be loaded/unloaded on the same platform, and also at the same time as passengers are boarding and alighting, and must often be completed during very short stops. Stopping times are almost always dimensioned by the time required for passenger exchange; no extra time just for loading and unloading express freight or mail – with certain exceptions for night trains – would be allowed, as a rule.

It should also be pointed out that the transformation of passenger train stations into modern travel centres does not always take the needs of express freight handling into consideration.

The operational safety aspects of sharing passenger platforms for loading and unloading cargo would have to be considered.
6.2.2 Multiple-Coupled Freight or Passenger Trains

One possible variant is for passengers and freight to be transported in separate trains that can be multiple-coupled. This would make express freight traffic more independent of passenger traffic. Passenger and freight trains could, for example – travel, coupled together, on shared stretches, yet have different starting points and destinations.

When necessary, the freight ‘part-trains’ could be switched between different passenger trains, which would give greater opportunities for creating direct connections. In the same way, the freight trains could be used together with passenger trains during the day and as pure express freight trains at night, which would increase rolling stock utilisation.

The ability to multiple-couple the rolling stock could naturally also be exploited to join several freight units together.

However, the key disadvantage of such an approach (apart from the technical challenge of designing appropriate rolling stock) is the time that would be needed to couple the trainsets together and the potential delay to HSR passenger services. In our view, this is sufficient reason to exclude this approach from further consideration. (However, it should be noted that the Swedish Green Train proposals include a similar concept of joining together part-trains on its passenger service – so the concept should perhaps not be dismissed entirely without further study).

6.2.3 Dedicated Freight Train

In this variant passenger and express freight traffic are coordinated only as regards timetables. Running the freight trains “in the shadow” of the passenger trains (or vice versa) reduces the capacity needed for the additional trains and would allow slower freight trains to be run.

The key advantage is greater capacity for express freight movement than would be possible with a mixed passenger/freight train. Other advantages are that stops for loading and unloading need not be made at the same time as passengers board or leave the trains, and that the trains do not necessarily need to stop at the same stations as the passenger trains (this is important, for example, if goods terminals are called at where passenger trains do not stop).

It should, however, be pointed out that stopping times and/or stopping patterns between the passenger and freight trains make it difficult to coordinate the train’s positions over greater distances.

A draft outline of a fast multiple-unit freight train has been produced by the Swedish KTH Railway Group.\footnote{‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005} The basic principle is to build on an existing multiple-unit train concept and adapt it to express freight traffic. Windows, interior fittings and comfort installations like air-conditioning are not needed; on the other hand, the doors need to be large to permit fast loading and unloading. The walls can be straight between floor and ceiling to increase space utilisation and simplify the design.

If the train is to be used at conventional terminals, as for the mail services today, a design with normal floor height could be used. The load would consist of wheeled bins that are rolled onto the train. In the long term, a fully automated system could be developed.

A 4-axle bogie wagon would have a volume capacity of approx. 150 m\(^3\) (about the same as a truck) and be able to load approx. 30 tonnes, equivalent to two 2-axle mail cars. A three-car train would take the place of a mail train consisting of a locomotive and six 2-axle wagons. For larger volumes, more units could be added.
### 6.2.4 Mixed Trains

The fact that express freight transport on passenger trains is reliably practised in many countries in Europe already today, shows that the concept can and does work successfully. The solutions applied, however, need to be reviewed if larger volumes of express freight need to be handled and the service is tied to the passenger train network and its stopping patterns. Mixed passenger/freight trains – in the case of daytime transport – would give a higher frequency of service than dedicated freight trains. At night, the synergies are limited to using the same tractive power and train positions for both passenger and freight traffic.

High speed rail freight is to a high degree based on the joint utilization of infrastructure and production resources with passenger traffic. This ranges from the joint use of dedicated high speed-lines and the use of passenger stations for terminal functions to the integration of passenger and goods transport on the same train. There are synergy-effects between express freight traffic and passenger traffic. This does, however, not mean that the joint production of passenger and express freight traffic is conflict-free.

The advantages and disadvantages of co-producing express freight traffic and passenger traffic need thus to be weighed against each other from case to case. What will probably emerge – as today – is a mixture of integrated and separate production systems for passenger and express freight traffic.

### 6.3 Rolling Stock

In HSR freight traffic the maximum speed plays a bigger role than in conventional freight traffic, where other factors often are more important, for example a high loading capacity. In HSR freight higher maximum speeds can translate into higher average speeds, a crucial competition factor in this market. The production principles for HSR freight traffic therefore normally exclude time-consuming marshalling and long waiting times (for example, at passing loops).

Rail vehicles for high speed rail freight can appear in very different forms, although one common feature of all rolling stock in this market segment is obviously a relatively high maximum speed compared to conventional freight wagons.

Maximum speed plays a more important role in express freight traffic than in conventional freight traffic, where the vehicles’ maximum speed is often subordinate to other requirements.

The demand for high maximum speed puts special demands on the rolling stock’s engineering and technical equipment.

*Enhanced freight wagon designs* are used primarily for speeds up to about 160-200 km/h. The changes that are needed to be able to operate at these speeds are mainly in the braking system and running gear and in certain cases also the load securing equipment.

At speeds over 200 km/h, *passenger train designs* are used exclusively. Examples include the TGV mail trains in France and the use of multiple-unit trains instead of locomotive-hauled trains, in the U.K. for mail traffic.

The rolling stock for high speed rail freight can be grouped into two types of vehicles:

- Vehicles derived from conventional freight car constructions, as for example the new B-mail wagons of Green Cargo or the container bogie wagons for DB's Parcelnet-system, both with a maximum speed of 160 km/h; and

- Vehicles derived from passenger rolling stock, adapted to carry freight, as represented by the TGV Poste or the British class 325 mail Electric Multiple Units.
Another way to categorize high speed freight trains is after the train configuration. High speed freight has even in this respect seen the entry of concepts from the passenger side. While the loco-hauled train formed of individual wagons is the classical train type in conventional freight traffic, fixed trainsets and multiple units are common in high speed rail freight.

Three different types of train types can be identified:

- Loco-hauled trains of individual wagons (Example: “classical” mail trains);
- Fixed trainsets with integrated power units (example: TGV La Poste); and
- Multiple units with distributed power underfloor (example: Royal Mail Class 325).

In France, mail has been carried between Paris and Lyon by the TGV Poste high speed trains since 1984. A total of 7 half-sets are available to the service. Two half-sets coupled together make up a full train consisting of 2 motor units and 8 freight cars. A full TGV Postal train can thus – unlike the TGV passenger trains – be split in the middle, which makes maintenance easier and reduces the need to hold trains in reserve.

Each train can carry a load of up to 75 tonnes. If necessary, a half-set can also be put into service as a separate unit.

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42. ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005

5096833/Norway - HS Freight Report_140211.docx
Energy consumption per ton on the Paris-Lyon route with a payload/train of 75 tonnes is stated to be 0.02 TOE/tonne (tonnes oil equivalent per tonne of cargo) compared with 0.12 TOE/tonne if the mail had been transported by air (Transall with a payload of 14.3 tonnes).

Loading and unloading is done through doors in the middle of the car. Each car takes 30 load containers in which 40 letter-sorting racks are arranged, with a total maximum weight of 10.8 tonnes per car.

### Table 6.1 – TGV La Poste Technical Data

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical power systems</td>
<td>1.5 kV DC / 25 kV 50 Hz AC</td>
</tr>
<tr>
<td>Length</td>
<td>200m</td>
</tr>
<tr>
<td>Configuration</td>
<td>2 motor units + 8 freight cars (full train)</td>
</tr>
<tr>
<td>Service weight</td>
<td>345 tonnes</td>
</tr>
<tr>
<td>Output</td>
<td>6 430 kW</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>270 km/h</td>
</tr>
<tr>
<td>Loading capacity</td>
<td>61-75 tonnes</td>
</tr>
</tbody>
</table>

Source: Troche 2005

### 6.3.1 Dedicated HSR Freight Trains

**Freight version of the German ICE trains**

In connection with the development and introduction of the ICE trains at the beginning of the 1990s, the requirements for high speed freight traffic and the possibility of producing a freight version of the train were also studied.

The Hamburg-Munich route with stops in Hanover and Nuremberg was identified as a possible pilot route. Including the 2 stops of 20 minutes each, the running time from Hamburg to Munich would be approximately 6.5 hours. Mail would be the basic load, and truck freight and air cargo would also be carried.

![Figure 6.3 – Freight Version of ICE Train](image)

Source: Troche, 2005, citing Waggon Union/Thyssen

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43 ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005

5096833/Norway - HS Freight Report_140211.docx
The figure above shows the proposed freight car. To allow freight to be loaded and unloaded quickly (this was assumed to be done manually, at least to begin with), the wagons would have roller shutters along the whole length of the load area. Once on the train, the wheeled bins would thus not need to be moved.

The train was never been built, but the high speed freight train concept is still being pursued within the framework of the FEX (Frachtexpress) project, with France’s SNCF among the operators involved.

CAREX Train Design

Carex have two possible designs for their trains – produced by Alstom and Siemens, respectively. Both designs share common features:

- Traditional aerodynamic loco profile, based on high speed passenger trains;
- Enclosed cargo areas (to reduce aerodynamic drag);
- Side-loading doors, with internal rollers to position cargo containers; and
- Total cargo capacity of more than 100 tonnes.

6.4 The Network

Options for the Norwegian HSR network are still being considered and the pattern of HSR passenger services is yet to be defined in detail. For example, it is not yet clear how many of the passenger services will stop at Oslo Gardermoen station – it may be just those heading for...
Trondheim: this would obviously have an impact on the likely movement of air cargo on mixed HSR passenger/freight trains.

The proposed network offers two possible HSR freight network models:

- A radial network, based on a hub in Oslo, with the opportunity for transhipment of cargo there between the HSR corridors; or

- A national ring network of scheduled freight services (this would exclude Trondheim and the Swedish destinations) in which all terminals are visited in one round trip.

Obviously, a hybrid of these two service patterns would be possible – much would depend on the pattern of passenger services, as this would largely define the use of available line capacity.

6.5 Station/Terminal Requirements

The development of suitably located and designed terminals is crucial; these locations need to be attractive to the distribution industry, as well as offering the possibility to improve intermodality in relation to road and air transport.

For mixed passenger/freight trains, it has been assumed that the cargo loading/unloading would be done at the passenger stations, at the same time as the passenger movements.44

For the dedicated freight trains, it has been assumed that the cargo loading/unloading would be done at dedicated freight terminals.

6.5.1 Passenger Stations and High Speed Freight

Passenger stations are already today used for handling of courier goods, which are carried on board passenger trains. Formerly – and in a number of countries still today – passenger stations were and are used even for transhipment of letter and parcel mail.

The use of passenger stations has the advantage that they are part of the existing network infrastructure. In the case of courier goods they can be used without major adaptation, since the volume that has to be handled is very limited and typical item sizes are very small. Especially for courier goods also the central location of passenger stations in the centre of the cities can give a competitive advantage.

When it comes to mail the situation is more complicated. In earlier times, passenger stations were used extensively for mail handling; railways and mail services were developed in a close symbiosis for more than a century. The main mail offices in the cities were often located adjacent to the railway stations and many long-distance (and as well regional) passenger trains conveyed mail wagons. Consequently the necessary infrastructure to handle mail at passenger stations was designed-in from the beginning. At larger stations, for example, dedicated tunnels and elevators connected the mail terminals with the platforms. The logistic concepts of mail transport evolved around the use of rail for practically all long-distance mail transport.

Two developments have made the use of passenger stations for mail handling less suitable – and in many cases probably even impossible:

- Changes in the logistic concepts: For both economical and service reasons, trucks took over from rail in most less-than trainload routes and air took over from rail on distances where rail could no longer offer competitive transport times. The result was that mail handling moved out from the city centres into new (automated) sorting centres in the periphery – with good accessibility to the road network, but seldom rail-connected.

- The conversion of passenger stations into travel centres: The conversion of passenger stations into modern “travel centres” seldom has been done with the requirements of cargo-

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44 It would be more convenient, of course, to load the cargo at a separate facility and then move the train to the passenger terminal – however, this would introduced operational complexity into the system and would hinder a fast turnaround of the passenger train at the terminus stations. Such a system would not be workable at intermediate stations.
handling in mind. Apart from physical accessibility to platforms, and platform layout, which already can present major obstacles for the use of passenger stations for cargo handling, conflicts with passengers are likely to arise if loading and unloading has to be done from the same platforms that are used by the passengers, particularly, if larger volumes of cargo have to be handled. It is normally not possible to have any fixed installations on passenger platforms, which might allow an automation of the loading and unloading process.

A solution would be to let passengers board and alight on one side of the train and to load and unload cargo on the other. This was done earlier at big stations in Europe; it requires, however, dedicated freight platforms. Since these normally do not exist anymore and since it would be virtually impossible to integrate new freight platforms in existing passenger station layouts, this solution must in almost all cases be regarded as unrealistic.

Another alternative would be to have separate tracks (and platforms) for cargo handling in immediate proximity to the passenger platform tracks. Even this solution existed (and sometimes still exists) in many places in Europe; however, it requires additional track space and shunting, which in its turn may affect the capacity of a station.

Summarizing the above it can be said that a return of mail handling to passenger stations has been made practically impossible in many cases – and is probably not even desirable, since it would be difficult to address today’s logistical needs (for example concerning loading/unloading). Where passenger stations still are used for express cargo handling it is likely that it will disappear sooner or later. In order to avoid that this results in a loss of traffic for rail it is however important that alternative solutions are offered, i.e. that new terminals can be created in other places.

The use of passenger stations for express cargo handling will, therefore, in the future most likely be limited to the small – but not necessarily less interesting – market segment of courier goods. The expansion of the ic:kurier service in Germany, operated by Lufthansa-daughter time:matters and Deutsche Bahn shows that this market segment offers a market potential.

Passenger Baggage

HSR passenger trains serving the airports might be expected to cater for substantial amounts of passenger baggage. Checked-in baggage is carried in special compartments on German ICE high speed passenger trains and transhipped at the passenger platforms of the Frankfurt/Main airport station.

6.5.2 HSR Freight Terminals

The prototype for an HSR freight terminal exists today - in the form of a mail train terminal. However, there is a need for further development – both in quantitative and qualitative terms – if the traffic potential of high speed rail freight is to be widened and if larger volumes are to be brought onto the train.

Good accessibility is essential for a competitive high speed rail freight system. This means that there is a need for efficient “interfaces” for transshipment of cargo between different modes of transport – train, truck and aircraft – and in some cases even directly from and to the customer.

In designing an HSR freight terminal the following inter-related aspects must be considered:

- Terminal location in the rail network;
- Track layout design: train length; number of loading/holding tracks; shunting requirements;
- Train operating principles: dedicated freight or mixed freight/passenger; loco-hauled or not; starting/terminating or through trains;
- Rolling stock concepts: enclosed/open wagons; door dimensions;
- Transhipment techniques; and
- Cargo flow / peak handling requirement.
6.5.3 Air-Rail Terminals

Air cargo is one of the target market segments. However, the integration of airports into the HSR freight system would raise several design issues.

During recent years many airports worldwide have been connected to the rail network – in Scandinavia recently the three big national airports Kastrup (1998), Gardermoen (1999) and Arlanda (1999) – but the specific requirements for handling of express cargo have seldom – if at all – been taken into account. Railway links to airports are in most cases exclusively designed for passenger traffic – often with sub-surface stations, which are neither suited for cargo handling nor easily adaptable to the needs of handling of larger volumes of freight. To the extent to which there exists separate rail links to airports dedicated to freight these are normally intended for the transport of aviation fuel cannot immediately be used by express freight trains.

There are few examples of airport rail links used for the transport of express freight. One is in Frankfurt/Main, where the Air Cargo City Süd is connected by a freight branch to the rail network. The terminal however is a conventional intermodal terminal. For some time it has been served by CargoSprinter services feeding express cargo from Northern Germany to Frankfurt and vice-versa.

More ambitious plans for new Air/Rail cargo terminals exist for Paris Charles-de-Gaulle and other airports; however, these are only plans and their commercial feasibility has not yet been demonstrated.

A pre-study has been carried out for a freight link to Arlanda airport. There has also been a proposal for Air/Rail freight terminal at Skavsta in connection with construction of the new Ostlänken high speed-line between Stockholm and Norrköping.

6.6 Loading Units and Transhipment Techniques for HSR Freight

The loading/unloading process represents a critical moment in the transport chain. It is both time-consuming and intensive in human resources.

The sorting and transhipment of express freight must be quick, reliable and cost-efficient. The handling equipment has to be flexible in respect to both extreme peak loads and a heterogeneous goods structure, the latter concerning both weight, size, form and package of the shipments.

The upper size limit of the shipment unit will obviously depend on the type of cargo. For air freight, this can be taken as the maximum volume of an air transport pallet. For postal services, smaller transport units would be applicable.

Increasing express freight volumes have already led to a high degree of automation of the sorting process in mail and express freight terminals. Due to the high costs of the necessary equipment, the result is a concentration on few high-capacity terminals. In order to reduce loading and unloading times attempts have been made to automate even here. The ambition is in both cases to reduce time consumption and costs.

An earlier proposal for high speed freight on the ICE network in Germany would have – at least initially – mainly relied on manual loading and unloading, partly due to the fact that loading and unloading was expected to happen at passenger platforms. Simple equipment in the form of lifts would, like in the British postal train example, speed up the process.

For most of the express cargo some type of loading unit is used in order to simplify terminal handling and transport. A large variety of different loading units has been developed over time, from the classic and simple mailbag over pallets to containers. Dimensions and capacity vary from a bag for holding kilogrammes to containers carrying several tonnes. The size of a loading unit is influenced by the:

45 Source: ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005
• Maximum size of individual items;
• Ability to consolidate sufficient volume;
• Handling equipment (especially weight restrictions when manual handling); and
• Available space in/on rail wagons, aircrafts and trucks.

Often even several kinds on loading units are used in combination, for example a mailbag in a rolling bin in a container.

Not all loading units are necessarily intermodal, i.e. designed to be used on different modes of transport. Especially when it comes to air transport a number of highly specialized loading units have emerged in order to maximize the utilization of available space onboard of aircraft. These loading units normally do not leave the air transport system.

Neither do loading units have to be specific for the small market segment of express cargo, or HSR freight in particular. Much European express cargo is carried in standard ISO-containers or swap-bodies. (Standard ISO-containers and swap-bodies are not described here, since they are probably well-known to most readers of this study and information on these is easily available.)

For some types of cargo there is also a need for insulation and/or temperature control. There is a trend towards equipping these loading units with tracking technology (e.g. RFID).

In the following, two kinds of loading units specific to express cargo are presented, rolling bins and air cargo loading units. The latter are currently not used or usable for rail transport, although such use is proposed in the context of increased cooperation between rail and air, so it is useful to include air cargo loading units in this overview.

**Figure 6.5 – Train Loading Using Rolling Bins**

![Figure 6.5 – Train Loading Using Rolling Bins](image)

Note: Based on an earlier planned freight version of the German ICE

Source: Troche 2005

6.6.1 Rolling Bins

Rolling bins are widely used by mail companies all over the world. Rolling bins allow manual handling. They are used both for internal terminal handling and transport onboard of trucks and trains. Several bins can be coupled together to be hauled by (often battery-driven) trolleys, making terminal operations more efficient.

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46 ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005
Deutsche Post Rolling Bin

Designs can vary but most are more or less similar to the design shown in the illustration below (showing a rolling bin of Deutsche Bahn). Dimensions are 1040 x 920 x 1435 mm (W x D x H). Tare weight is 140 kg and the loading capacity 500 kg or 1.4 m³.

Source: Troche 2005

York Roll Container

The rolling bin used by British Royal mail is called the York Roll Container. It is used for letter and parcel mail and was introduced in connection with the start of a new system for the conveyance of mail on rail in 1996. It is purpose-designed to carry no less than 28 standard letter trays stacked neatly inside its U-frame with a rugged build and 500 kg total load capacity, the ’York’ is non-towable; it can be nested when empty. A four-car postal EMU class 325 carries 180 York-containers. The use of the ’York’ is not limited to rail; it is used for road transport and handling in sorting offices.

The range of related equipment includes:

- The York Lifter;

Source: Envosort

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47 ‘High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005
• The York Interface Ramp; and
• The Pedestrian Controlled Tug (to assist with moving the roll containers on the platform).

### 6.6.2 Air Cargo Loading Units

Air Cargo loading units come in a large variety of different forms and dimensions. They are designed to make maximum use of the available cargo space on aircraft. The most ‘basic’ air cargo loading unit is a pallet, on which the cargo is secured by a net. Containers can have different forms in order to adapt to the rounded form of the aircraft body. For temperature-sensitive goods insulated containers exist.

In opposite to wheeled loading units used in land transport, air cargo loading units are not equipped with wheels. Instead “rolling floors” are used, both inside the aircraft and on the loading equipment. This makes it possible to move the units easily and quickly.

**Table 6.2 – Air Cargo Unit Load Devices**

<table>
<thead>
<tr>
<th>Container type</th>
<th>Volume</th>
<th>Linear dimensions (base width / overall width × depth × height)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD1</td>
<td>4.90 m³</td>
<td>156 / 234 × 153 × 163 cm</td>
<td>contoured, half width</td>
</tr>
<tr>
<td>LD2</td>
<td>3.40 m³</td>
<td>119 / 156 × 153 × 163 cm</td>
<td>contoured, half width</td>
</tr>
<tr>
<td>LD3</td>
<td>4.50 m³</td>
<td>156 / 201 × 153 × 163 cm</td>
<td>contoured, half width, dimension according to IATA; available at 45” height for loading on Airbus A320 family</td>
</tr>
<tr>
<td>LD6</td>
<td>8.95 m³</td>
<td>318 / 407 × 153 × 163 cm</td>
<td>contoured, full width, equivalent to 2 LD3s</td>
</tr>
<tr>
<td>LD8</td>
<td>6.88 m³</td>
<td>244 / 318 × 153 × 163 cm</td>
<td>contoured, full width, equivalent to 2 LD2s; DQF-prefix</td>
</tr>
<tr>
<td>LD11</td>
<td>7.16 m³</td>
<td>318 × 153 × 163 cm</td>
<td>same as LD-6 but without contours; rectangular</td>
</tr>
</tbody>
</table>

LD3s, LD6s, and LD11s will fit 787s, 777s, 747s, MD-11s, Il-86s, Il-96s, L-1011s and all Airbus wide-bodies. The 767 uses the smaller LD2s and LD8s because of its narrower fuselage. The less common LD1 is designed specifically for the 747, but LD3s are more commonly used in its place because of ubiquity (they have the same floor dimensions such that one LD3 takes the place of one LD1.

**Figure 6.8 – The Ubiquitous LD3 Air Cargo Container (or Unit Load Device)**

Source: British Airways Cargo ‘Unit Load Devices’
6.7 Costs of Fast/HSR Freight Services

The Norwegian/Swedish freight market is highly competitive (as will be discussed in the following section), and only a relatively small amount of cargo could be carried – even a dedicated HSR freight train might only carry 70-80t (cf. the capacity of the TGV La Poste trains). It is therefore a priori questionable whether HSR freight would cover even its direct train and terminal costs, let alone be able to contribute towards the costs of tracks and stations provided primarily for passenger use.

Our assumption is that there is limited ability for freight to ‘ride on the coat-tails’ of the investment in primarily passenger facilities; capacity and facilities for freight would have an additional cost and would have to be justified commercially. Freight may also have to compete for train paths with conventional regional passenger services that might also wish to make use of the HSR tracks.

As has been discussed, it may be assumed that if only single-track HSR lines are developed, then it would be difficult to provide additional train paths for freight (together with a typical pattern of one HSR train per hour per direction).

6.7.1 Types of Freight Operations

We have distinguished two main types of freight operation, with different sets of costs:

- Mixed passenger/freight fast/HSR trains: freight is handled at passenger stations on the same platforms and at the same time as passenger movements; and
- Dedicated fast/HSR freight trains: freight is handled at dedicated freight terminals.

The main costs associated with these two types of service are shown in the following table.

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Mixed Passenger/Freight</th>
<th>Dedicated Freight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing example</td>
<td>ic:kurier</td>
<td>TGV La Poste</td>
</tr>
<tr>
<td>Rolling stock capex</td>
<td>Cost of adapting one or two sections of passenger train design for freight</td>
<td>Cost of adapting an entire passenger train design for freight – in particular, larger door openings are likely to be required (for the larger cargo containers – see below)</td>
</tr>
<tr>
<td>Station/terminal capex</td>
<td>Sharing passenger platforms – would require good access for freight to/from platforms</td>
<td>Dedicated freight terminal close to the HSR network</td>
</tr>
<tr>
<td>Station/terminal handling equipment</td>
<td>Mainly manual loading/unloading (due to presence of passengers on platform)</td>
<td>More mechanised loading possible</td>
</tr>
<tr>
<td>Cargo containers</td>
<td>Mainly rolling cages; electric-powered tugs for access to/from platforms</td>
<td>Larger air-cargo-type containers could be used; scissor-lifts (for easy loading) and electric powered tugs</td>
</tr>
<tr>
<td>Storage collection area</td>
<td>Relatively small area required</td>
<td>Area required for full trainload – stuffing/unstuffing of containers may also be required</td>
</tr>
<tr>
<td>Train operating opex (power, crew, maintenance)</td>
<td>Similar to passenger trains</td>
<td>Similar to passenger trains (although train crew staffing could be less – e.g. no conductor, catering crew etc.)</td>
</tr>
<tr>
<td>Track/station usage charges (including capex, maintenance, signalling opex, etc.)</td>
<td>Shared with passengers – station costs limited to cargo handling costs and costs related to dedicated freight areas/facilities</td>
<td>Full cost of track costs – costs of dedicated terminal operations</td>
</tr>
</tbody>
</table>
6.7.2 **Cost of Loading/Unloading Terminals**

As has been concluded previously, the logic of the passenger timetable implies that mixed passenger/freight fast or HSR trains should be handled solely at the passenger stations and facilities should be provided on the platforms to load/unload freight. Clearly additional facilities would have to be available at the station to transport the cargo to/from the platform. **This implies that station design would have to consider the needs for cargo handling at the outset.**

6.7.3 **Cost of Rolling Stock**

Both dedicated freight trains and mixed passenger freight trains would probably be adaptations of the selected fast/HSR passenger train. The adaptations for a dedicated freight train would probably be different compared with the freight sections of mixed passenger/freight trains, as the all-freight trains could be expected to carry larger unit loads/containers.

The adapted designs could be developed in such a way as to allow easier return to all-passenger use, if the freight services do not develop a viable market.

6.7.4 **Cost of Loading Units/Containers**

If all-cargo trains are justified by the market, then there would be a case for using large cargo units and more mechanical loading/unloading than mixed passenger/freight trains, where cargo handling on the platform would be surrounded by passenger movements.

6.7.5 **Train Operating Costs**

Train operating costs, such as energy, crew costs and maintenance could be expected to similar to all-passenger services, although all-cargo trains might have smaller crews – without the need for conductors, cleaners and catering staff.

**Loading/Unloading Costs**

Freight loading/unloading costs are likely to be similar per tonne of goods for the two types of operation – mainly manual handling would probably be required for mixed passenger/freight trains, given the presence of passengers on the platforms, whereas mechanical unloading for all-freight trains would be more efficient but would require more skilled staff.

6.7.6 **Track Charges**

In principle, both types of train should pay similar track charges, as the marginal costs imposed on the network would be broadly similar.

For mixed passenger/freight trains, these costs should be allocated between the two types of activity. However, an element of ‘what the market will bear’ may apply – if all-freight trains are only using ‘spare’ capacity, outside of daily peaks – it may be possible to consider a degree of lower track charges for freight compared to passenger services.

6.7.7 **EuroCarex Costs**

EuroCarex have provided some cost details on their website: ⁴⁸

- Average cost per container carried, based on a reference aircraft container **AMJ**
  - roughly €450 per container carried over the first phase of the network
  - roughly €370 per container carried in 2021

- Carex trains: the cost of construction of 20 high speed trains varies between €600-700 million according to the manufacturer and options selected. These proposals include development costs and fixed costs but do not incorporate the maintenance costs that will be covered by a specific contract with the designated manufacturer (see below).

• Railway branch (or connecting) lines: the unit cost will depend on their length and complexity. It varies from €10 to over €100 million depending on the site.

• Carex "Railport" terminals: According to initial studies, the cost of a basic terminal was estimated at €15 million, including the land acquisitions, building, two channels 235 m long, integrated facilities, ancillary facilities (including security and surveillance equipment in particular) and the necessary road development. The choice of loading mode (automatic/conventional) will also impact size and design and affect cost as will the earthmoving work that may prove necessary.

6.8 Conclusions on HSR Rolling Stock and Infrastructure

The discussion above has identified two main operational models of fast rail freight:

• Mixed passenger/freight trains, in fixed formations, with cargo capacity making up a small part of the train – possibly a couple of tonnes; cargo loading/unloading operations would be in passenger stations, at the same time as passenger movements; and

• Dedicated freight trains, with a cargo capacity up to 100 tonnes, with loading/unloading at freight terminals.

It is likely that both types of train would be designed as variants of the basic passenger rolling stock and would be fully enclosed. The dedicated freight train would handle larger unit loads and consequently would need larger cargo openings and more complex in-car fittings to move and secure the containers – possibly by mechanical means (e.g. similar to air cargo techniques). The mixed passenger/freight trains would have smaller cargo openings and would be planned around manual handling of unit loads or roll containers.

The cost of dedicated freight trains is likely to be significant, due the additional design effort required and the likely small number of units to be produced.

Even if – from the outset - all passenger trains are produced with an integrated freight capability, there would be additional costs – for example in the need for longer platforms and ongoing additional operating and maintenance costs. The design may be such that later conversion to all-passenger use is feasible, should fast cargo operations prove not to be commercially viable.
7. Potential High Speed Rail Freight Service Types and Markets

7.1 Introduction
High speed freight transport by rail would be a new logistics product in Norway. The first important question that arises is which (current) market segments and product/market combinations should be looked at in marketing this new product, and what specific market demands have to be met.

7.2 Potentially interesting market segments
A previous study of high speed rail freight concluded that the market segments of interest for HSR freight transport are:

- **National or regional air transport of goods by air.** National or regional air cargo seems the most promising market for high speed rail. Measured in total transit time, HSR freight would probably be able to compete with air transport. The volume of goods transported in this segment, however, is not very high.

- **National or regional air transport of goods by road ('trucking').** A substantial proportion of air cargo moved transport within Europe between airports is transported by road under a "flight-number" – usually termed ‘trucking’. Typically it is used to get the goods of an intercontinental flight to the final destination airport. Time and cost aspects make road transport a good alternative for additional air transport. Trucking is also used as a tool for air transport companies to broaden their markets. Trucking is a potential segment for high speed freight transport by rail because hundreds of thousands of tonnes are transported on a limited number of long-distance routes in Europe, and because the transport demands can be met.

- **Express transport.** A key characteristic in the transport market for express goods is the existence of an efficiently-run "hub and spoke" system. High speed freight transport by rail could contribute towards transport between the hubs in Europe. Based on total transit times (door-to-door) several sub-segments in the market of Express transport can be identified:
  - **Same-day delivery** - In this sub-segment a package is usually picked up in the morning and delivered the same afternoon. This type of transport usually takes place within a limited area and with relatively small vehicles. It seems unlikely that high speed freight transport by rail can play a role in this sub-segment, because it is unlikely to be competitive over short distances.
  - **Overnight transport** - In this sub-segment goods are collected at a hub and brought to several other hubs overnight - on the second day goods are distributed. HSR transport could only be an alternative for (air) transport between the hubs. These transports, however, are limited in volume and further integration (between companies as FedEx, DI-IL and UPS) seems unlikely, so no large concentration of volumes is to be expected. Furthermore high speed rail transport lacks the flexibility of road transport to be a successful alternative in this segment.
  - **2-4 days delivery** - In this sub-segment usually heavier and bigger shipments occur. Most shipments are transported by road. Because of the higher volume and the "relatively" lower demands on speed, high speed rail transport could play a role here.

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49 High speed Freight Transport; First Steps Towards Intra-European High Speed Freight Transport By Rail Drs. M.M. Kraan, NEA, Transport Research and Training et al.
The analysis is summarised in the following diagram that highlights the first, second and third preferences for different potential market segments.

**Figure 7.1 - Concepts for High Speed Rail Freight**

Source: Kraan et al, 1997

### 7.3 Express Freight

The express freight market traditionally embraces courier, parcel and express goods services which are differentiated from other freight transport services primarily through their short transport times and small shipment sizes.

The three services can to some degree be differentiated by the shipment size as well, with courier services taking the smallest shipments and express freight at the other end of the scale.

The average item weight in 1998 of freight handled by the express industry worldwide was around 5-6 kg, increasing slightly over time. Many airlines restrict individual items to a maximum weight of 30 kg, being that weight, which can still be handled by one individual.

Same-day delivery is a typical feature of courier services, while the others mainly offer Day B-delivery and even longer transport times.

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50 High speed Freight Transport; First Steps Towards Intra-European High Speed Freight Transport By Rail M.M. Kraan NEA, transport research and training et al. European Transport Conference 1997 Freight Policy And Practice In Europe
The following table gives an overview over services in the express market, as defined by a previous study.

**Table 7.1 – Services Offered in the Express Market**

<table>
<thead>
<tr>
<th>Service Factor</th>
<th>Express (Same-day)</th>
<th>Express (Next-day)</th>
<th>Express (Deferred)</th>
<th>Forwarders &amp; Parcels Operators</th>
<th>Mail Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>very high</td>
<td>high</td>
<td>medium</td>
<td>medium/low</td>
<td>low</td>
</tr>
<tr>
<td>Speed</td>
<td>very fast</td>
<td>fast</td>
<td>medium</td>
<td>medium/low</td>
<td>medium/low</td>
</tr>
<tr>
<td>Distance</td>
<td>restricted</td>
<td>unrestricted</td>
<td>unrestricted</td>
<td>restricted</td>
<td>unrestricted</td>
</tr>
<tr>
<td>Item Size</td>
<td>unrestricted</td>
<td>unrestricted</td>
<td>unrestricted</td>
<td>restricted</td>
<td>restricted</td>
</tr>
<tr>
<td>Need for large, regular flows</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Reliable Delivery Time</td>
<td>same day</td>
<td>next day</td>
<td>2 or more days</td>
<td>2 to 7 days</td>
<td>variable</td>
</tr>
<tr>
<td>Standard Global Service</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Consignor / Consignee</td>
<td>door to door</td>
<td>door to door</td>
<td>door to door</td>
<td>door to doors</td>
<td>variable</td>
</tr>
<tr>
<td>Mode of Transport</td>
<td>usually road</td>
<td>road and air</td>
<td>road</td>
<td>road, air, rail</td>
<td></td>
</tr>
<tr>
<td>Tracking and Tracing</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>basic</td>
<td>no</td>
</tr>
<tr>
<td>Hub and Spoke</td>
<td>no</td>
<td>yes</td>
<td>varies</td>
<td>varies</td>
<td>varies</td>
</tr>
</tbody>
</table>

Source: Troche 2005, quoting Doganis/AT&C/York

The common denominator of the goods handled in the express market is **time-sensitivity**. Furthermore the goods often have a **high specific value** (value per kilogramme or per cubic metre), compared to traditional rail cargo. Compared with conventional wagonload freight the value of express freight can be over 100 times higher per kilogramme, but with large variations.

**Perishability** may be a more important characteristic than value. Flowers, for example, lose freshness when not delivered in time and fruits and vegetables become less attractive or even unpalatable. Newspapers have a relatively low material value, but lose their news value if delivered too late. These goods retain their high value only for a very limited period of time, after that they lose value rapidly.

Another further market area may be for high value items, for which it is difficult to foresee and to plan demand, as for example in the case of spare parts or pharmaceutical products.

### 7.4 Flows Identified by Carex

It will be recalled that Carex is the European initiative to attract air cargo to high speed rail freight services.

The Carex project identifies that the containerised or palletised freight to be carried on Carex high speed trains will be within Europe at either end of a journey to or from the rest of the world, or strictly intra-European. Depending on the future clients/shippers of the European HSR freight service, it will be split into 2 types of flow:

- **‘Express Flow’**
  - This flow usually contains small packages of high added-value;
  - Meeting delivery deadlines is non-negotiable on the basis of next-day services;
  - Delivering the guaranteed service takes precedence over cost;
  - Usually provided by air; freight operators use cargo-only flights or hold capacity on passenger services;
  - Time constraints are very tight, with back-up solutions in place; and
- Deadlines determine the volumes that will be mode-shifted to Carex trains.

- ‘Cargo Flow’
  - This is for less urgent freight carried under 3-day delivery arrangements;
  - Cost takes priority, but contractual delivery times must be met;
  - These are goods for pre- and post-final destination shipping within Europe, the majority of which are carried by road under air freight regulations in specialist trucks adapted to take aircraft pallets. These are referred to as "truck services"; and
  - The time constraints are less tight.

### 7.5 Potential HSR Freight Market Segments for Norway

Based on the discussion above, the following market segments have been identified for Norway:

- Postal services;
- Courier integrators; and
- Air freight.

### 7.6 Postal Services

The national post offices are not always considered as being part of the express freight industry, probably due to their special status and historical background as state-owned monopolies. However, as their services address, in principle, the same market as their private counterparts and their ‘protected’ status is eroding more and more, it appears to be justified to include them in the express freight industry.

Furthermore, an HSR freight service addressing and meeting the needs of the post offices may, to a large extent, be of interest to and applicable to the transport needs of private express companies as well – although the failure to develop the TGV Fret service indicates that this is not without challenges.

The production system of the post offices is based on a fixed network of collection points (letter boxes and post offices) served according to a fixed timetable. The private express companies in most cases collect the shipments on demand and directly from the shipper – although many have fixed delivery times for regular clients.

The mail services offered by the national post offices are adapting to a more commercial and competitive environment – this is particularly true in Scandinavia, where the activities of the national postal companies are extending beyond national borders.

#### 7.6.1 Posten Norge (Norway Post)

Posten Norge is a nationwide postal service with more than 20,000 employees making it one of Norway's largest companies. Its business concept is to deliver complete communications and logistics solutions across four segments: postal service, express delivery, logistics and electronic services.

In 1996, Posten Norge BA was established as a state-owned company in which the Norwegian state had limited liability. In 2002 Posten changed its corporate structure into a stock company, as a process of preparing the company to an expected deregulation of the Norwegian postal market. Posten Norge AS is still fully owned by the Norwegian state and the liberalization process has been postponed until 2011 by the government.

The postal service is divided into four divisions: Post, Logistics, Distribution Network and ErgoGroup AS.

In 2002 the private Swedish postal company CityMail was partly bought, with Posten Norge acquiring 57% of the shares in 2002 and the remaining 43% in the first quarter of 2006. Posten Norge also owns, or partly owns Nor-Cargo, Frigoscandia, Box Solutions, Box-Group/Delivery,
Pan Nordic Logistics (PNL), Scanex B.V., Nettlast Hadeland - many of which have their own subsidiaries in the logistics field.

Its express segment provides domestic and international courier services for parcels and express-related logistics solutions through Posten in Norway and through Box Delivery and PNA Nordic Logistics (PNL) in the Nordic countries. The logistics segment offers cargo, temperature-regulated and air and sea transport solutions as well as third-party logistics solutions. Posten Norge is represented in this segment by its subsidiaries Nor-Cargo, Box Solutions and Nettlast AS.

**Bring**

Bring is part-owned by Posten Norge and is a Nordic operator in the post and logistics industry, consisting of six specialist areas: Express, Citymail, Mail, Logistics, Frigoscandia and Dialogue.

In Norway, Bring Mail is building a new world-class postal terminal in Lørenskog just outside Oslo. The new Østland terminal will be finished in 2010. The other 15 postal terminals in Norway have also put modern automation technology to use.

Bring Citymail runs its own distribution in Sweden and Denmark. Citymail is the main challenger of the national postal companies in Sweden and Denmark (Posten Sverige and Post Danmark have given notice of a merger in 2008). Posten Norge distributes to roughly 2 million households and businesses in Norway.

Bring Logistics offers Nordic and international logistics within general cargo, batch loads, special freight, warehousing service and packages. Bring Logistics will help the customer to achieve the best possible flow of goods, and simultaneously strengthen the customer’s competitiveness through competence, availability and quality.

Bring Express is the Nordic countries’ leading supplier of express services. The product range includes all types of express solutions where speed and punctuality are important, locally, nationally or in the Nordic countries. Express is present with 10 offices in Norway, 7 in Sweden, 4 in Denmark, 1 in Finland and 1 in Estonia. Bring Express has more than 1400 associated drivers and makes 25 000 deliveries a day.

### 7.6.2 Posten Norge / Bring Rail Services

Posten Norge and Bring have expanded their rail services and started an innovative train route between Oslo and Rotterdam for the transport of fresh food to and from the Continent. Logistics operator Bring established in 2009 a direct rail route between Oslo and Rotterdam. The trains are loaded typically with fresh Norwegian salmon, fruit and vegetables and packaging being returned to Germany (by Grønt Punkt Norge - Green Dot Norway plc), where it is recycled.

In 2008, Posten Norge entered into Norway's biggest ever railway contract and Posten Norge buys rail transport worth NOK 1 billion each year. More than 80% of all the mail in Norway, over distances covered by railway lines, is transported by rail.

Through its Bring companies, Posten Norge has transferred goods that would fill approximately 2,000 semitrailers each month over to rail transport. With this, they report having reduced the distance driven by 1.5 million vehicle-km and lowered their CO\(_2\) emissions by 1.3 million kilogrammes a month.

The Bring train that now leaves from Alnabru in Oslo each Saturday and returns from Rotterdam each Wednesday, replacing 32 trailers on the road each way. In the space of one year, this will mean 4 million fewer vehicle-km driven and a reduction in CO\(_2\) emissions of 4,000 tonnes.

The goal is for Bring to increase the capacity to Europe to three weekly trains by the end of 2010.

In April 2009, Posten Norge’s major road transport route between Oslo and Bergen became fully rail-based. As a result, a total of 1,250 trucks have been replaced by rail transport between Norway’s two largest cities. Other transport routes are close to achieving a 100% rail-based
service, but challenges remain in terms of continuing to meet customers’ quality and time requirements.\textsuperscript{51}

Figure 7.2 – Posten Norge / Bring’s Intermodal Road/Rail Services

Source: \textsuperscript{52} Posten Norge

7.6.3 Nordic Competition for Postal Services

In recent years, national postal services across the Nordic countries have been increasingly transformed into commercial companies. Although these organisations continue to engage in extensive cooperation, they are now competing with each other, particularly in the field of transport and logistics – and even the traditional ‘national preserve’ of mail distribution is under attack.

Posten Norge has over the last three years invested no less than five billion NOK in buying up companies “to gain a good foothold in the Nordic market” as they state in their press release - this expansion has been primarily in Sweden.\textsuperscript{53}

For this reason all the postal operators are highly sensitive about releasing details of the logistics and distribution plans.

7.6.4 SWOT Analysis – Postal Services

The following table presents a SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats) for HSR freight and postal services.

\textsuperscript{51} Postal Sector Sustainability Report 2009  
\url{http://www.ipc.be/~media/Documents/PUBLIC/Sustainability/Sustainability%20Report%202009_old.ashx}

\textsuperscript{52} Press release November 2009  
\url{http://www.postennorge.no/Forside/20430.cms?print=on&print=on&print=on}

\textsuperscript{53} Nordregio  
\url{http://www.nordregio.se/?vis=artikkel&fid=10595&id=0206201010172817470}
### Table 7.2 – SWOT Analysis – HSR Freight and Postal Services

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantial existing flows</td>
<td>Rail distribution currently based around conventional rail freight</td>
</tr>
<tr>
<td>High use of rail favoured by Posten Norge</td>
<td>Existing overnight rail delivery provides next-day delivery</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of mixed passenger/freight HSR trains would be relatively straightforward, without the need for major investment</td>
<td>Cost of developing dedicated HSR trains may be significant</td>
</tr>
<tr>
<td>May be possible to share dedicated trains with other users</td>
<td>Distribution competitors may not wish to share dedicated train services</td>
</tr>
<tr>
<td></td>
<td>Competitive pressure on Posten Norge limits profitability and therefore ability to pay a premium price</td>
</tr>
</tbody>
</table>

### 7.7 Courier Integrators

The four main worldwide participants in the express industry, generally known as ‘integrators’ are: DHL, FedEx, TNT and UPS. In addition to these there is a large number of small courier and express companies concentrating on regional markets or on selected niches.

Market concentration is high. The market share held by the integrators in the European express market was estimated at about 47% (in 1998). In Germany, United Kingdom and France 70% of the turnover in the express market is accounted for by the 10 biggest companies. The market shares between them are quite stable over time, indicating a high customer loyalty.

From the four integrators all but one (TNT) have their origin in the United States, where the express market developed first. However, the European express market is growing and has strengthened its importance and attractiveness to both global players.

#### 7.7.1 Courier Integrator Example - DHL Norway

DHL Express Norge handles DHL Norge land-based domestic and international traffic, as well as Air Express. DHL Norge is the local unit of global sector group DHL, a unit of German postal services group Deutsche Post AG.

DHL Norge has invested over 20 million NOK ($3.1 million/2.5 million euro) in an extended logistics terminal in Bergen, on Norway’s west coast. The terminal was built to meet the demand from the steadily increasing transport activities in the western region of Vestlandet.

Previously, DHL Express Norge operated two logistics terminals. The company handles air, land and sea transports from the extended terminal. DHL Norge has 870 employees and 35 offices, terminals and stations in Norway. It has three divisions, also including the flight and sea unit DHL Danzas Air & Ocean, and integrated third-part logistics provider DHL Solutions.

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54 'High speed rail freight’ Sub-report in Efficient train systems for freight transport, Gerhard Troche, KTH Railway Group Report 0512 Stockholm 2005
55 Originally Australian and then merged with a Dutch company developed from PTT Post.
7.7.2 **Courier Integrators – SWOT Analysis**

The following table presents a SWOT Analysis for HSR freight and the courier integrators.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantial existing flows</td>
<td>Emphasis on road distribution, less existing contact with the railways.</td>
</tr>
<tr>
<td>Some existing use of rail</td>
<td></td>
</tr>
<tr>
<td>Existing use of air cargo</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSR freight may offer greater reliability than road transport, particularly in bad weather</td>
<td>Mixed passenger/freight HSR trains may not offer the required timetable for early morning delivery</td>
</tr>
<tr>
<td>Use of mixed passenger/freight HSR trains would be relatively straightforward, without the need for major investment and would provide good frequencies</td>
<td>Cost of developing dedicated HSR trains may be significant; joint development would be complicated contractually - distribution competitors may not wish to share dedicated train services</td>
</tr>
</tbody>
</table>

7.8 **Air Cargo**

As identified earlier, current air freight flows between the cities that might be served by HSR are quite modest and appear at present to justify only limited HSR freight services, such as those provided by a mixed passenger/freight HSR train.

However, HSR freight may offer a good value mix compared with air cargo costs, if suitable connections to the HSR network are possible.

7.8.1 **Air Cargo – SWOT Analysis**

The following table presents a SWOT Analysis for HSR freight and air cargo.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing flows of air cargo on the identified corridors</td>
<td>Current air cargo flows equivalent to less than 1 truck-load per day – not sufficient to justify dedicated HSR freight trains</td>
</tr>
<tr>
<td>Oslo Airport already served by high speed rail service (although no cargo facility)</td>
<td>Most air cargo is international</td>
</tr>
<tr>
<td></td>
<td>Only Oslo Airport likely to be served by HSR lines.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSR freight may offer a good value mix compared to regional air freight rates</td>
<td>Mixed passenger/freight HSR trains may not offer the required timetable for early morning delivery</td>
</tr>
<tr>
<td>HSR freight less disrupted by bad weather – more reliable</td>
<td>Use of HSR freight would reduce incomes of airlines using the airport</td>
</tr>
<tr>
<td>Use of mixed passenger/freight HSR trains would be relatively straightforward, without the need for major investment and would provide good frequencies</td>
<td></td>
</tr>
</tbody>
</table>

7.9 **Conclusions**

The following market segments have been identified for Norway:
• Postal services;
• Courier integrators; and
• Air freight.

All of these offer the potential for HSR rail-freight as well as mixed passenger/freight trains. Key requirements of these market segments include reliability and the ability to provide an early morning delivery.

Posten Norge is already a major rail user and must be viewed as a key potential user – and possibly developer - of fast freight services.
8. Potential Competition with Other Transport Modes

8.1 Introduction
This section describes the competition that fast or HSR freight services would face from other transport modes.

We have examined the potential competitive position of HSR freight from three perspectives:

- Review of available data on the proposed HSR corridors;
- Existing studies on modal choice for freight transport; and
- Analysis using the existing Norway Freight Model.

8.1.1 Contestable Commodities
As discussed in previous sections, we have assumed that the market for HSR freight will include mainly time-sensitive, high-value goods, either because of demanding delivery schedules or because of the perishable nature of the goods.

This profile is most similar to the air freight market, as well as the express road delivery market.

This definition excludes most existing freight flows, such as low-value commodities: timber, bulks.

8.2 Corridors and City Pairs Examined
We have considered the relatively long trips between the main city pairs to be served by HSR:

- Oslo city region (including Oslo Gardermoen Airport) and:
  - Trondheim;
  - Bergen;
  - Stavanger; and
  - A circular route connecting Bergen and Stavanger with Oslo.

- Oslo – Gothenburg; and
- Oslo Stockholm.

All of these corridors are included in the Norway Freight Model.

8.2.1 Existing Mode Performance on the Corridors
The following table summarises information on the proposed HSR corridors, including population (a reasonable proxy for passenger and express freight demand), approximate distance by rail, current journey times by road, conventional rail and air transport and the frequency of air services.
### Table 8.1 – Basic Data on Proposed High Speed Rail Corridors

<table>
<thead>
<tr>
<th>Route Description</th>
<th>Population</th>
<th>Road Connection</th>
<th>Distance by Rail (existing)</th>
<th>Fastest Rail Passenger Journey Times (existing - hr:min)</th>
<th>Fastest Rail Freight Journey Times (existing - hr:min)</th>
<th>Journey Time by Road (car - hr:min)</th>
<th>Journey Time by Air (hr:min)</th>
<th>Flights per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oslo:</td>
<td>530 000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Oslo – Bergen</td>
<td></td>
<td>E16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bergen:</td>
<td>239 000</td>
<td></td>
<td>484km</td>
<td>6:28</td>
<td>7:25</td>
<td>7:45</td>
<td>0:50</td>
<td>30</td>
</tr>
<tr>
<td>2) Oslo – Kristiansand – Stavanger</td>
<td></td>
<td>E18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drammen:</td>
<td>93 000</td>
<td></td>
<td>41km</td>
<td>0:35</td>
<td>1:00</td>
<td>0:35</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Kristiansand:</td>
<td>76 000</td>
<td></td>
<td>354km</td>
<td>4:25</td>
<td>5:09</td>
<td>4:45</td>
<td>0:45</td>
<td>8</td>
</tr>
<tr>
<td>Stavanger:</td>
<td>114 000</td>
<td></td>
<td>587km</td>
<td>7:42</td>
<td>8:20</td>
<td>7:45</td>
<td>0:50</td>
<td>25</td>
</tr>
<tr>
<td>3) Oslo – Trondheim</td>
<td></td>
<td>E6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lillehammer:</td>
<td>26 000</td>
<td></td>
<td>173km</td>
<td>1:57</td>
<td>2:45</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Trondheim:</td>
<td>156 000</td>
<td></td>
<td>550km</td>
<td>6:36</td>
<td>7:44</td>
<td>7:30</td>
<td>0:55</td>
<td>28</td>
</tr>
<tr>
<td>4) Oslo – Gothenburg</td>
<td></td>
<td>E6</td>
<td>260km</td>
<td></td>
<td></td>
<td>3:30</td>
<td>0:55</td>
<td>5</td>
</tr>
<tr>
<td>5) Oslo – Stockholm</td>
<td></td>
<td>E18 (W/E routes along south coast)</td>
<td>420km</td>
<td></td>
<td></td>
<td>6:30</td>
<td>1:00</td>
<td>28</td>
</tr>
<tr>
<td>Bergen – Haugesund – Stavanger in combination 1 and 2)</td>
<td></td>
<td>E39 (N/S route along west coast)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oslo – Gardermoen (Airport)</td>
<td></td>
<td></td>
<td>48km</td>
<td>0:19 (High Speed Train)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A number of initial observations can be made from the data in the table:

- Air services on the corridors served are generally very frequent (with the exception of Gothenburg-Oslo) – this would provide stiff competition in terms of frequency for air cargo that could only be approached with mixed passenger/freight HSR trains;
- Journey times by air are around one-seventh of the road journey time – coupled with the frequent departures, this indicates a significant potential difference in road and air cargo journey times (which has not, however, crystallised in very large air cargo flows – indicating limited time-sensitivity of the cargo); and
- The current fastest rail freight times are similar to the road journey times – and in excess of 7 hours for most of the corridors.

8.3 Decisive Factors in Mode Choice

At the heart of the market study is the need to establish the critical decision criteria that affect modal choice in the logistic chain. These are well established in freight demand studies – and have been validated in the Norway Freight Model.

The key factors we have considered at a quantitative level are:

- Cost (particularly in relation to the value of the consignment);
- Speed / door-to-door journey time;

In addition, other factors – that are less easy to quantify – are known to be important:

- Reliability;
- Scheduling issues (e.g. the need for early morning arrival of courier packages); and
- Liability – when a number of carriers are involved.

8.4 Existing Study of Swedish Shipper Behaviour

A recent Swedish study has examined decision-making of freight transport customers. The method used was computer-assisted telephone interviews that were conducted with around 100 transport managers. After a few questions about the company and its transport, a Stated Preferences survey (SP) was conducted with ranking and paired choices. The interviews were between 1 and 4 hours long. SP means that it is possible to find out what the company would choose in a hypothetical situation and where willingness to pay can be determined for different factors. The factors that were primarily investigated by means of paired choices were transport cost, transport time, frequency, and risk of delay. Several other factors were also investigated by means of ranking.

The results show that transport cost is a very important factor when choosing a carrier. Actual transport in today’s transport systems is of high quality with few delays and little freight damage. At the same time, the transport market is subject to stiff competition, which is one of the reasons why transport customers are sensitive to price. The threshold for switching carrier is on average a 3.8% lower price, even with everything else unchanged. The companies typically use many transport companies; almost all of them use more than one and over half use more than 10.

A prerequisite for switching to another carrier is probably that the quality achieved is maintained. The transport buyers are prepared to pay a little, but not a lot, for more environment-friendly transport; a 50% reduction in environmental impact is valued at 2% of the transport price. This may seem a low figure, but the companies are very sensitive to price. Approximately 40% of the companies are prepared to change carrier at a price level of less than or equal to 3%, but the average threshold for changing carrier is 3.8%. This means that halving the environmental

56 Freight customers’ valuations of factors of importance in the transportation market’, Sofia Lundberg, Royal Institute of Technology, Stockholm 2006
loading would for most companies not be sufficient for them to change carrier provided everything else is unchanged.

Shorter transport times and higher dispatch frequency are valued at very low levels. A short transport time is on the other hand more important for high-value freight than for low-value freight. The transport managers’ apparent satisfaction with current transport solutions may be due to production and transport being adapted to each other as regards both transport time and frequency. With current production, there is thus no reason to change the transport system other than to wish that transport were cheaper.

**Figure 8.1 – Price Difference to Change Freight Carrier with an Equivalent Service**

<table>
<thead>
<tr>
<th>No. of companies</th>
<th>0.5%</th>
<th>1%</th>
<th>2-3%</th>
<th>4-5%</th>
<th>10%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>35</td>
<td>30</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: Lundberg 2006

This is also shown in the paired choice analysis. A difference of 10% in the risk of delay is equivalent to a willingness to pay of 1%, i.e. price is 10 times more important than a greater risk of delay. A difference of 16% in transport time is equivalent to a difference in transport price of 1%, and a difference in frequency of 15% is equivalent to a willingness to pay of 1%. Price is thus clearly the most important factor, followed by the risk of delay not increasing and then shorter transport time and greater frequency. Transport buyers are renowned for their sensitivity to price and this is borne out by this study and others conducted in the past.

**Figure 8.2 – Stated Preference Ranking of Freight Carrier Decision Criteria**

<table>
<thead>
<tr>
<th>Ranking, price, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation price 5% lower</td>
</tr>
<tr>
<td>Transportation price 3% lower</td>
</tr>
<tr>
<td>No. of delays reduced by 30%</td>
</tr>
<tr>
<td>Transportation’s environmental impact reduced by half</td>
</tr>
<tr>
<td>Transportation time 35% shorter</td>
</tr>
<tr>
<td>Loading time reduced to half</td>
</tr>
<tr>
<td>Amount of damage reduced by 50%</td>
</tr>
<tr>
<td>Transportation service runs twice as often</td>
</tr>
<tr>
<td>Transportation price 1% lower</td>
</tr>
</tbody>
</table>

Note: Standardised to price percentage, Source: Lundberg 2006
Since the choice of companies was reasonably representative compared to transport in the whole of Sweden in different respects, the conclusions ought also to be relatively representative and applicable to transport in Sweden in general – and by extension to Norway.

One of the advantages of the Stated Preferences method is, among others, that it gives answers to what certain changes are worth as percentages and in monetary terms. Another is that a great deal of information can be obtained from each interview, which makes it possible to keep the number of interviews to a minimum. Among its disadvantages are that the study rests upon what the companies say they would do in a given situation. The method also has a tendency at times to give results that overestimate certain of the factors. In this study, price has an extremely high impact, which may indicate that the price factor has been somewhat overestimated. One explanation for this may be that the companies are satisfied with the other factors included in the paired choices (transport time, frequency, and frequency of service).

8.5 Competitor Modes for HSR Freight

The fast/HSR freight logistic chain is likely to include a road leg at both ends of the journey; e.g.: road pick-up – fast/HSR – road delivery.

Relevant transport logistics chains that are likely to compete with this include:

- Road door-to-door;
- Oslo Airport (transhipped international air cargo from beyond Norway and Sweden) – domestic air service – road delivery;
- Gothenburg/Stockholm Airport – international air service - Oslo Airport – national ‘air freight’ by air or road;
- Road – Oslo Airport (domestic air freight) – domestic air service – road; and
- Gothenburg port – fast rail – road (e.g. containers/intermodal).

8.5.1 Air

The aviation industry is a more vital factor for Norway than for most other European countries, due to the long distances between population centres, a tough operating climate and difficult topography. Norwegians fly more domestic air miles than most other Europeans and domestic air services between Oslo and the major cities are frequent.

International air cargo is almost totally to/from Oslo Gardermoen. There is some domestic air freight between Oslo and the other cities on the proposed HSR network, of which a proportion is international air freight transhipped at Oslo – but total domestic air freight flows appear to be quite low (e.g. of the order of 1 truck load per day Oslo-Bergen), which would imply that this is mainly hold cargo on passenger flights.

Although Oslo Airport is on the rail route from central Oslo to Trondheim, it is possible that HSR services to other destinations might also connect with the airport or have an easy connection.

Air freight and express road freight share many characteristics – both are time-sensitive or high-value (or both). In particular, in Europe a proportion of air cargo is regularly moved by road between airports, where this is cheaper or more convenient than transhipment to another airline.

Air cargo movements are constrained by:

- Limited interlining arrangements between airlines;
- Well established ‘groupage’ arrangements (to aggregate small shipments into larger container-loads);
- A number of banned substances;
- Restricted space and weight on aircraft; and
- The need for transhipment to road transport for final delivery – but typically less-than-vehicle loads that require the involvement of a distribution/courier operator.
Table 8.2 – Air Freight and Express Freight

<table>
<thead>
<tr>
<th>Type of traffic</th>
<th>Transport Mode</th>
<th>Loading Unit</th>
<th>Consolidation Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cargo – carried by air</td>
<td>Air – passenger belly-hold or all-freighter</td>
<td>Air cargo containers; pallets</td>
<td>Airport</td>
</tr>
<tr>
<td>Air cargo - carried by road</td>
<td>Truck</td>
<td>Air cargo containers (unusual); pallets; roll cages</td>
<td>Airport</td>
</tr>
<tr>
<td>Express freight – carried by road</td>
<td>Truck; swap-body</td>
<td>Pallets; roll cages</td>
<td>Distribution hub</td>
</tr>
</tbody>
</table>

Source: Adapted from Kuhla 2008

8.5.2 Road

Road transport is the most flexible freight transport mode, providing a direct door-to-door service, which none of the other modes is able to do (with some very specific exceptions).

However, road transport journeys are constrained by:

- Speed limits;
- Traffic congestion, particularly in urban areas;
- Bans on freight vehicles in certain locations at particular times; and
- Weather conditions, particularly snow, ice and fog.

Over longer distances, for example, road transport cannot compete with HSR for speed or ability to operate in bad weather. However, because of the smaller consignment sizes associated with road freight, frequency may be much higher by road than rail – which may off-set any advantages of reduced journey time.

8.5.3 Conventional Rail

Currently Posten Norge moves significant quantities of postal cargo by rail. For HSR to be attractive compared to these rail services HSR freight would have to:

- Be price-competitive;
- Have sufficient capacity; and
- Provide services in a timely way to complement the postal collection, sorting and delivery schedules.

In our consideration of fast/HSR freight, we have excluded a wagonload approach, as it would be difficult to achieve high speeds with the intermediate shunting required. Rather, we have assumed fixed shuttle trains or freight sections on mixed passenger/freight trains.

Intermodal or container traffic might be suitable for ‘fast’ rail services (but not for HSR, as there are issues about aerodynamic streamlining).

8.6 Norway Freight Transport Model

We have used an existing Norway Freight Transport Model (developed for the Work Group for transport analysis in the Norwegian National Transport Plan) to obtain information on current freight flows (split by commodity type) along the proposed HSR corridors.

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57 Terminal requirements due to high speed rail operation, Eckhard Kuhla for European Intermodal Association, Final PROMIT Cluster Workshop 16./17. Oct 2008, Lisbon
We have also used the model to test the likely market reaction to the introduction of fast and HSR freight services.

A more detailed description of this work and the results is given in Appendix C.

8.6.1 Description of the Model

The model includes costs functions for each mode that are based on network times and distances. The data used are about 5 years old and include information on the variation of shipment sizes and frequencies, consolidation of shipments, transhipments at terminals, distribution centres.

The logistics model is a disaggregate model at the level of the firm, the decision making unit in freight transport and ‘explains’ the choice of shipment size and transport chain, including mode and vehicle choice for each leg of the transport chain.

This model structure allows for logistics choices to be modelled at the level of the actual decision-maker, along with the inclusion of decision-maker attributes. The model distinguishes 32 commodity types (see Appendix for details) and uses about 300 zones in Norway and a number of larger zones abroad. The model covers not only domestic flows in Norway, but also Norwegian imports and exports.

The logistics model minimises the total annual logistics costs for of commodity transported between zones, including:

- Order costs;
- Transport, consolidation and distribution costs;
- Cost of deterioration and damage during transit;
- Capital costs of goods during transit;
- Inventory costs (storage costs); and
- Capital costs of inventory.

The transport costs include distance-based link costs (e.g. fuel), time-based link costs (e.g. staff, vehicles), loading and unloading costs, transhipment costs and cargo costs in ports.

The model contains separate cost parameters for 10 types of road vehicles, 28 types of sea vessels, 8 types of train and 2 types of airplane.

The transport chain includes the number of legs in the chain, the transport mode (road, sea, train, ferry and air) and the vehicle type within each leg of the chain and the transhipment locations between the modes - consolidation centres (CC) and distribution centres (DC).

There is no ‘module’ for air freight, but air transport is one of the modes (further distinguishing between 2 types of airplane) that is available in the module for the choice of shipment size and transport chain. The model contains 6 transport chains that include air transport, all of them combinations of road and air transport. It also has 7 chains which contain rail transport (combinations or rail with road and possibly also sea). Air transport has been considered for:

- Consumption food;
- Fresh fish;
- High value general cargo; and

This logistics model for Norway was developed by Significance as part of the Norwegian national freight model systems. A similar, but not identical, logistics model was developed for Sweden. The model is described in more detail in the method report: Significance (De Jong, Ben-Akiva and Baak) (2008) Method report – Logistics model in the Norwegian national freight model system, deliverable 6A for the working group for transport analysis in the Norwegian national transport plan, Significance, The Hague.
• Consumption goods general cargo.

The logistics model also allows for consolidation of goods in the same vehicle or vessel (which reduces costs for a shipper).

Empty vehicle trips are added to the loaded vehicle trips on the basis of the imbalances in transport between zones.

8.6.2 Commodities and ODs Now Served by Air Transport (according to the model)

We undertook a model run for the base case to provide all the transport chains between a sender and a receiver where air transport is used in at least one of the legs of the chain. If one would work with main modes in a transport chain (which this model doesn’t, it distinguishes modes for all the legs), defined in terms of a hierarchy of modes, these chains would be called ‘air transport’.

The model predicts only the following specific OD-relations for air transport:

• Fresh fish: 70,906 t/year; and
• General cargo, high value: 22,909 t/year.

Inspection of these OD flows showed that none of these airport-airport flows were between Norwegian airports at both ends or between a Norwegian and a Swedish airport. All the flows that use air transport in the model are intercontinental import and export flows. When using the costs functions in the Norwegian logistics model, air transport is never the least-cost alternative (also taking into account capital costs on the goods in transit) for domestic flows or flows to/from Sweden.

The above was about flows carried out as air transport. There were no road transport flows between Norwegian airports in the model either (trucking of air cargo) – this is consistent with information provided by airport operator Avinor.

8.6.3 Modal Split between the Relevant City Region Pairs

The total amount of tonnes for each commodity that are transported between two city regions (in both directions (as ‘predicted’ by the model) are presented in the Appendix C. These can be goods produced or consumed in these cities, but also goods that are being transhipped from one transport mode to another at terminals in these regions. The predicted the modal share (in the tonnes) of road and rail have also been identified. This is not the observed modal share, but the prediction of the model for the base year (=2008).

Shipment by sea transport have been excluded because these are not considered to be the flows that might be transferred to HSR.

Commodities with big flows (more than 100,000 tonnes per year) that now are predicted to go by road or rail, according to the model, are:

• Consumption food;
• Beverages;
• Thermo consumption goods;
• Machinery and equipment;
• General cargo, building materials;
• General cargo consumption goods; and
• Wood products.

The transport flows of fresh and frozen fish between the relevant city regions for instance are quite small – these are mainly international flows.
For some goods (e.g. general cargo: other inputs, general cargo: consumption goods, wood products, metal and metal goods), rail has a high market share. However, for many other commodities rail now has no predicted market share.

8.6.4 Calculation of Road/Rail ‘Break-Even’ HSR Speeds and Costs

Using the model, we have compared the costs of a supply chain with rail transport (road-rail-road) to a direct road transport chain, and calculated how fast rail should be to become as ‘cheap’ or attractive as direct road transport. Similarly, for situations with a high rail speed (160 or 200 km/h), where rail is cheaper, we calculate how much rail could raise its price before road becomes cheaper. Speeds like 160 km/h and 200 km/h are more maximum attainable rail speeds than average speeds, but we use these values to show the upper limits.

There is no comparison with the cost of air transport, because the model does not give any air transport flows between Norwegian airports (so these are never the least-cost option, which should be used as the benchmark for HSR).

Generic ‘Break Even’ for Large Shipments (including Containers)

The possibility of generic large shipments was considered, using an example of a shipment of 20 tonnes that moves from a sender to a receiver over 300 km.

We assumed that:

- The effective speed for road is 60 km/h and 30 km/h for rail;
- The road and rail distances are 300 km; and
- It takes 10 km by road transport to get to or from the road-rail terminal.

From the same costs functions we can calculate the rail speed at which rail becomes as expensive as road, using a number of reasonable assumptions (see Appendix C for details).

This calculation suggests that, for commodity 15 ‘general cargo, consumption goods’, at 160 km/h, rail could increase its price by 7% over its current level and still be no more ‘expensive’ than direct road transport. At 200 km/h the ‘break-even’ price for rail would be 10% higher than at present.

The same example, but for commodity 11 ‘general cargo, high value’ yields as outcome that rail cannot be less expensive than road at any rail speed. This is caused by the very high time cost (especially the decline in the value of the goods) for this commodity, in combination with the time that is used for transhipment and for waiting for the next train. If however, there would be a logistics system where the goods would not have to wait at the railway terminal (but arrive just in time) and only 1 hour of transhipment time (half an hour at both ends), road-rail-road would be cheaper than direct road transport already at a rail speed of 82 km/h.

HSR freight was found to be not competitive for commodity 2 ‘consumption food’, under any reasonable assumptions.

The calculation above for commodity 15 assumed that the goods would be transported in a container, which would be loaded onto the train (i.e. intermodal transport). If however, there would be a requirement to unload the container to get the goods onto the train (stripping) and load again into a container for the final 10 km by truck (stuffing), then the transhipment costs of road-rail-road become prohibitive: this chain cannot compete against direct road transport at any rail speed.

If the distance would increase above 300 km, rail chains in the model become more competitive. Also an increase of the shipment size above a full truckload will make rail more competitive.

Generic Small Shipments

For small shipments (e.g. parcels, packages) there are opportunities for rail transport, but this depends very much on the ability of the rail operator to consolidate shipments. For the case of a 50 kg shipment of commodity 15 (general cargo: consumption goods), road-rail-road could at 30 km/h already be cheaper than direct road transport. Here we assumed that the road vehicle used
in both chains would be the LGV (101) and the train type would be an electric wagonload train (vehicle 304) that is 80% loaded. For the LGV we assume that the shipper pays all the vehicle costs by himself (in both transport chains), but for the wagonload train, he pays only in proportion to his use of the capacity of the wagon.

Also for commodity 11 (general cargo: high value goods) and 2 (consumption food), under these circumstances we find that road-rail-road can already beat road transport at 30 km/h.

We conclude that the opportunities for getting parcel load onto the train depend more on the performance of the railway operator as a consolidator (very high performance required) than on the rail speed.

### 8.6.5 Outcomes of Model Runs for HSR Variants

Two HSR variants have been simulated using the logistics model. In the first, the rail speed between the six city pairs is assumed to go up to 160 km/h, and in the other to 200 km/hr. Rail costs are assumed to remain constant.

Again, speeds like 160 km/hr and 200 km/hr are more maximum attainable rail speeds than average speeds, but we use these values to show the upper limits. In the reference case, the rail speed on the links between the Norwegian city pairs is 65 km/hr. Between Oslo on the one hand and Stockholm and Gothenburg on the other hand, the base speeds range between 34 and 56 km/hr.

We compared the outcomes of this to a run for the reference situation, with the current conventional rail speeds between those cities. All three runs refer to the base year, that is, we use the base year PWC matrices. The logistics model not only takes account of modal choice (in terms of transport chains), but also optimises the shipment size.

When the rail speed would become 160 km/hr, the annual number of tonnes by rail transport between the six cities goes up by 1.520 million tonnes (more than doubling). All of this is at the expense of road transport (sea transport kept the same number of tonnes), or at the expense of rail connections elsewhere. The total number of tonnes transported by rail transport in/to/from Norway goes up by 830,000 tonnes (+11%, almost exclusively on domestic O/D flows), indicating that the higher speeds between the six cities could also lead to a re-routing of rail transport in Norway from conventional to fast lines – if sufficient capacity were available. In terms of tonne-km, domestic rail transport would grow by 4.4% (200 million tonne-km) and road transport would decline by 0.5%.

The predicted additional demand for fast rail freight services (at 160km/h) on the corridors is given in the following table; the corridor Oslo-Bergen accounts for over 70% of the increased demand. For comparison, the additional flow predicted on this corridor for fast rail freight at 160 km/h is nearly twice times the ‘base’ rail freight flow (580 000t).

<table>
<thead>
<tr>
<th>City region pair</th>
<th>Predicted increase in rail transport demand (tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oslo-Stockholm</td>
<td>48 584</td>
</tr>
<tr>
<td>Oslo-Gothenburg</td>
<td>6 047</td>
</tr>
<tr>
<td>Oslo-Stavanger</td>
<td>80 873</td>
</tr>
<tr>
<td>Oslo-Bergen</td>
<td>1 086 903</td>
</tr>
<tr>
<td>Oslo-Trondheim</td>
<td>296 844</td>
</tr>
<tr>
<td>Stavanger-Bergen</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1 519 250</strong></td>
</tr>
</tbody>
</table>

Note: Increase in rail transport (both directions) in tonnes/year, 160 km/h variant versus reference case; rail costs are assumed constant.
These figures should be interpreted as ‘upper limits’ for the growth of the rail market in these corridors, as they assume the current rail freight costs.

A large part of the increase in the number of tonnes transported by rail between the city pairs in case the rail speed would be 160 km/hour takes place for commodities 14 ‘general cargo: other inputs’ (+300,000 tonnes) and 15 ‘general cargo consumption goods’ (+800,000 tonnes). Most of this increase (300,000 tonnes for commodity 14 and 700,000 tonnes for commodity 15) occurs on the relation Bergen-Oslo. In order to serve such large volumes, the freight transport capacity of this line (at the speed of 160 or 200 km/h) needs to be very large. Mixed passenger/freight services would not be sufficient here; several dedicated fast freight trains per day would be required.

In the base case, all the rail flows between Bergen and Oslo as origin and destination had a sender in Bergen and a receiver in Oslo (PC is also Bergen-Oslo). But in the 160 km/hr case, there are also rail flows that are part of longer PC chains, such as chains beginning in the Bergen region (Fjell, Vaskdal) that use a chain that includes the fast Bergen-Oslo train to deliver to destinations in Norway and abroad (including other continents).

Furthermore there are increases for commodity 2 ‘consumption food’, 6 ‘other fish’, 9 ‘machinery and equipment’, 11 ‘general cargo, high value goods’, 13 ‘general cargo: building materials’, 19 ‘paper intermediates’, 20 ‘wood products’, 21 ‘paper products’, 28 ‘metals and metal goods’ and 29 ‘aluminium’. For commodities 9, 11 and 21, rail transport did not have any market share for these goods at the current speeds.

The same things happen when the rail speed is assumed to increase to 200 km/hr. In that case, rail gets 1.630 million extra tonnes – indicating a relatively small increase in traffic related to an increase in speed from 160 to 200 km/h.

8.7 Conclusions on HSR Freight Modal Competition

The competing transport modes for HSR freight are those currently used: road, air and conventional rail; it is assumed that coastal shipping is so slow (relatively) that it would not compete with HSR freight.

Air cargo between the cities concerned is relatively modest – despite the high frequency of air connections. This implies a limited market for very high speed rail connections.

The Norway Freight Model suggests the following conclusions, based on scenarios of ‘upper bound’ rail speeds of 160 km/h (‘fast’) and 200 km/h (‘HSR’):

- Based on competition with road transport, fast rail freight services for large shipments (e.g. containers) over 300 km could increase current rail price by 7% (at 160km/h) to 10% (200km/h);
- The opportunities for getting parcel load onto the train depend more on the performance of the railway operator as a consolidator (very high performance required) than on the rail speed;
- If the rail distance increases above 300 km, rail chains in the model become more competitive over road. Also an increase of the shipment size above a full truckload will make rail more competitive;
- Model tests of the HSR corridors, assuming current rail freight charges, identified approximate ‘upper limits’ to the potential for growing the rail market with faster rail speeds showed that:
  - A rail speed of 160 km/h fast rail transport could attract an additional 1.52 million tonnes of cargo (around 4 340 tonnes per day) – more than doubling the rail share between the cities connected by fast rail freight services;
  - A rail speed of 200 km/h increased rail cargo by only around 7%, implying that beyond a certain speed threshold there are diminishing returns of increases in cargo attracted; and
• The corridor with the greatest HSR potential is Oslo-Bergen (around 3,100 tonnes per day).
9. Market Survey

9.1 Introduction
This section documents the comments received from potential users of fast freight services, collected through a survey of targeted organisations. The results of this survey have then been compared with the output of the freight model testing.

The survey approach has been developed together with experts from the Institute of Transport Studies (ITS), University of Leeds (UK), who have also assisted with the interpretation of survey results.

The survey was carried out by our staff based in Sweden and Denmark, during November and early December 2010. Unfortunately this is a peak time for all the organisations concerned, in the run-up to Christmas.

We would like to express our thanks to the contacts in the various organisations that contributed to the survey.

9.2 Approach
Our analysis of the likely service types and markets indicates a number of niches flows, for which there will be a handful of dominant shippers (e.g. the postal service, courier companies, air freight consolidation shippers, etc.).

Previous studies have established that conventional rail freight services are not viable and the focus of the present study is on fast rail freight services provided either by dedicated all-freight HSR trains or mixed passenger/freight HSR trains.

This is a niche freight market – one where speed and reliability of delivery is paramount and where premium pricing may be possible. The key target freight sub-markets identified are:

- Postal cargo;
- Express cargo, including courier shipments; and
- Air freight.

Because the potential market is so constrained, it is likely that key decisions to use (or not to use) fast rail freight services will be taken – for the most part - by a very limited number of organisations. Because of this need for a focussed market focus, the approach selected concentrates on in-depth interviews with key organisations rather than a broad ‘scattergun’ survey approach. It should be underlined that this is a significantly different approach to the process for identifying the market potential for HSR passenger services.

Because of the limited number of potential decision-makers, from the outset we knew that it would be challenging to establish the key factors that would affect modal choice – as these may be quite specific to the particular businesses concerned (e.g. location of distribution hubs).

However, we felt it would be possible - with reasonably detailed consultation - to establish the key parameters that would have to be established for potential key users to consider HSR freight services.

9.3 Survey Strategy
We developed a questionnaire for completion either face-to-face, by telephone or on a self-completion basis. The questionnaire included sections on current shipping costs, key service features (such as frequency, speed and timetable) and ‘willingness-to-pay’. This questionnaire was then applied to a reasonable cross-section of the potential market segment.

The survey strategy is based on the following main activities:

- Identification of the potential key users of HSR freight;
• Definition of an interview ‘script’/questionnaire - in particular identifying the most effective way to uncover key factors or constraints related to potential use of HSR freight services;
• Face-to-face meetings or telephone consultation;
• Follow-up telephone calls/e-mail communication to complete data collection or clarify any comments/data; and
• Comparison of the results of the survey with the ‘expected’ results, based on the spreadsheet demand/cost model and revision of the model, if necessary.

9.4 Identification of Consultees
A list of consultees was prepared to provide a reasonable cross-section of the ‘major players’ in the potential market segments of interest. These included:
• Postal services:
  - Posten Norge
  - Bring
  - Tollpost
• Courier ‘integrators’:
  - DHL
  - TNT
  - UPS
  - DB Schenker
• Freight Forwarders /Air freight Forwarders:
  - Jetpak
  - Dancargo
  - Prime Cargo
  - Roadfeeders
  - Air Cargo Forum (Oslo Airport)
  - DHL Supply Chain
• Rail freight operators in Norway and Sweden:
  - Trafikverket
  - CargoNet
  - Green Cargo
A full list of organisations and contact people is included in Appendix A.

9.5 Confidentiality
It was known from the start that the subject material of the survey was potentially commercially sensitive. All interviewees were given an undertaking that the completed survey forms would remain confidential. For this reason the completed survey responses do not form part of this report.
However, key findings from the survey have been quoted anonymously in this report.

9.6 Questionnaire/Script Design
The final questionnaire format is shown in Appendix B.
The questionnaire was designed (with the help of ITS) so that it could be either distributed for self-completion or could be used as a script for a telephone or face-to-face interview. The questionnaire therefore includes an introductory page describing the background of the Norwegian HSR studies and the potential fast rail freight services that might be available.

In practice all of the contacts preferred to look at the questionnaire before providing a response and completed the questionnaire themselves. In some cases a clarification follow-up call was required to explain comments that had been provided.

The main areas covered were:

- Current shipping operations (including quantification of flows and transport costs, where these could be obtained);
- Decisive factors in choice of transport mode (e.g. price, frequency, speed, reliability, timetable, ease of use, etc);
- Indications of ‘willingness-to-pay’ compared to current road and air cargo transport costs; and
- Scope to make any other related comments.

### 9.7 Survey Implementation

For all of the identified organisations, a contact person was identified (in some cases only after repeated contacts) and the questionnaire form was e-mailed to this person as well as describing the nature and purpose of the information collection activity. Subsequently the questionnaire was either completed by the respondent directly or completed as part of a telephone discussion.

It had been planned to carry out face-to-face interviews but none of the organisations contacted seemed willing to enter into this level of co-operation.

The process of finding relevant contact persons to interview at the target organisations was quite slow (in many cases we were passed again from one contact person to another). This was either due to a lack of interest or because it was a very busy period before Christmas for all of the companies. Even when a relevant contact person was identified it was hard to follow up, with often no reply to e-mail and unanswered phone calls.

People generally found the questionnaire very detailed and difficult to complete - partially due to a lack of information in their own systems.

We sent multiple follow-up e-mails to the contact persons and called them several times to make them understand that this survey was important and that we needed them to contribute.

### 9.8 Survey Results

In practice, there was significant resistance to completing the questionnaire from many of the target organisations. The reasons for this included:

- On-going internal reorganisation: for example Green Cargo;
- Difficulty in finding people with the correct level of knowledge;
- Concerns about confidentiality – several respondents indicated that the information was ‘commercially sensitive’ (a common difficulty with freight surveys); and
- Lack of time due to the season pre-Christmas rush – a peak time for postal services and logistics operators.

#### 9.8.1 Analysis of Key Responses

Some key responses can be mentioned:

- For freight integrators, early morning delivery is essential;
- Reliable delivery times are important, with one respondent judging that a one-hour delay appears to be generally acceptable, once in 10 times; another respondent indicated that only
a 15 minute delay could be accepted and mentioned- previous unreliability of rail due to ‘many’ winter service failures;

- For courier integrators, the ratio of air to road shipments ranged from around 1:5 to around 1:15;
- Several shippers rated the probability of transfer to fast/HSR freight at 50-60%;
- The busiest corridors are Oslo-Bergen and Oslo-Stavanger;
- Individual freight integrators handle 3-10 tonnes of air freight per day; some ship air cargo every hour; some handle up to 900 tonnes of road freight per day to all destinations;
- Domestic air transport costs are about 4 times that of road distribution – around 500 NOK/m$^3$ for road and 2000 NOK/m$^3$ for air;
- For one (major) respondent, we estimate that half of the road traffic on relevant routes could switch to fast rail freight if the road price were matched by the fast rail service;
- Generally there is not much scope to increase the road freight charges: for ‘fast’ freight trains shippers are only prepared to pay a small premium; for HSR freight trains this premium might be 10-20% above the existing road freight cost;
- However, air freight transferring to HSR might pay up to twice the rate that transferring road freight might pay (1000 NOK/m$^3$ versus 500 NOK/m$^3$), although frequency of service would have to be high;
- Although most respondents were fairly negative about their potential to use the service (often because they were happy with their existing arrangements), one major respondent indicated (indirectly) that transfers to fast rail freight services might amount to up to nearly NOK 6 million worth of revenue for the service, with an HSR freight service attracting possibly NOK 7 million of revenue;
- The use of air cargo ULD containers was recommended by one interviewee;
- Refrigeration was noted as being necessary by one respondent;
- Rapid loading/unloading of trains will be necessary plus full tracking capability of cargo packages; and
- Final distribution from stations/terminals would be by small vehicles – there must be adequate parking/transfer capacity.

9.9 Comparison with the results of the Norway Freight Model

Both the survey and the model indicate that there could be substantial demand for fast freight services, if they were priced similarly to current road freight. Both agree that the premium achievable for fast or very fast HSR freight - compared to the current road transport cost - would be relatively small (of the order of 7-20%).

Both the survey and the model yield similar estimates of the potential ‘break-even’ price for fast rail freight services – indicating that, although shippers like the increased speed, they want this benefit for little or no price premium over the road transport cost.

The survey yields some largely qualitative information about the importance of early morning deliveries and reliability.

The surveys suggest some possible switching of air freight on the corridors, which the model was not able to estimate (because of small or non-existent air cargo flows in the base year data).

9.10 Conclusions of the Market Survey

As has been noted, quantitative data received from the survey exercise were limited. However, from the information gathered it is possible to have more confidence in the results of the Norway Freight Model, which predicts substantial potential demand for fast rail freight services. One reason for this is probably the relatively low average speeds that conventional rail freight services
currently achieve – estimated in the Model Reference Case as only 65 km/h between the Norwegian city pairs (and even lower between Oslo and Stockholm/Gothenburg). The assumption of even 160km/h represents a huge step-change in level of service.

However, the lack of potential price premium (except for transferring air cargo) means that fast rail freight services would need to have a similar cost structure to road haulage to be commercially viable.

Several responding organizations stressed the need for early morning deliveries; it is questionable whether the timetable of joint passenger/freight HSR service would deliver such a service.
10. Conclusions and Recommendations

10.1 Introduction

This report has considered the market conditions for fast or high speed rail (HSR) freight services on the Norwegian and Norwegian/Swedish corridors being considered for an HSR network.

The study brief requires consideration of the following:

- Combined freight and passenger trains, including the requirements for stations/terminals and time spent on loading/unloading cargo and any impact on train frequency;
- The market for high speed freight trains, including a study of current freight flows in the corridors (by all means of transport) and an assessment of possible transferable volumes to high speed freight trains;
- Interest among cargo shippers to use fast freight trains and the decisive factors in the choice of mode of transport;
- Assessment of the railway’s advantages and disadvantages compared to road and air transport for freight transport; and
- Willingness to pay for the new service, and expected price for the freight transport, compared with cost levels in other transport modes.

This market analysis has considered:

- The HSR or improved rail ‘concepts’ or scenarios to be tested for the wider passenger HSR studies;
- Experience in other countries of fast or HSR freight services;
- A survey of potential users of such HSR freight services;
- Use of the Norway Freight Model to assess likely market demand;
- A consideration of the costs of providing such freight services; and
- An overall assessment, including financial and non-financial aspects.

10.1.1 ‘Fast’ and ‘High speed’ Rail Freight

The brief for this study refers to both ‘fast’ and ‘high speed’ rail freight services. After considering similar services in other countries, we have defined these services as follows:

- ‘high speed’ rail freight: maximum speed greater than 200km/h; and
- ‘fast’ rail freight: maximum speed greater than around 120-140 km/h.

By comparison, ‘conventional’ rail freight can be considered to have a maximum speed less than around 120-160 km/h – in practice the operating speeds are usually much less than this because of delays introduced by the need for shunting and train assembly (the Norway/Sweden Freight Model suggests current conventional rail freight services on the corridors have an average speed of 65 km/h or less).

10.1.2 Types of Fast Freight Train

The report has considered two broad types of fast/HSR freight service:

- Dedicated freight trains; and
- Mixed passenger/freight trains.
We have assumed, in the light of previous studies that the technical features of the HSR network would be defined primarily by the needs of passenger trains. HSR freight trains would therefore have to have similar characteristics to the passenger trains (for example, in acceleration, axle-load, aerodynamics, etc.). This implies that the HSR freight trains would need to be essentially converted passenger train sets. This will allow the greatest timetabling flexibility.

Given the obvious need to retain the key advantages of HSR freight – speed and reliability – we have assumed that both types of train would be fixed formation. We have concluded that it would be difficult to operate HSR freight services if there was a need to operate with part-trains or ‘wagonload’ traffic – where individual wagons or groups of wagons would have to be shunted together to form complete trains, as this would cause delays that would impact on the timetables.

One advantage of mixed passenger/freight HSR trains is that there is no timetable conflict between freight and passenger services. The main drawbacks are that there would be inevitably a limited capacity available for freight and, moreover, this capacity would subtract from the capacity available for passengers.

10.1.3 Potential High Speed Rail Scenarios

The following scenarios for the development of a HSR network have been considered:

- Scenario A – reference case. This is a continuation of the current railway policy and planned improvements, with relatively minor works undertaken shown in the National Transport Plan from 2010-2019. This forms the ‘do minimum’ scenario to which the other scenarios will be compared;
- Scenario B – upgrade. A more offensive development of the current infrastructure, looking beyond the ‘InterCity’ area;
- Scenario C – major upgrades achieving high speed concepts. This is to be based on an aggressive upgrade of the existing network to provide a step change in journey times; and
- Scenario D – new HSR. This involves the implementation of newly built, separate HSR lines.

We have assumed that scenarios A and B offer no likely possibility of developing fast or HSR freight services. Scenario C offers the possibility of ‘fast’ rail freight services and Scenario D offers the possibility of HSR freight services.

It has been further assumed that the infrastructure developed primarily for fast or HSR passenger services would not have significant spare capacity for freight; therefore, providing this additional capacity would have additional – and probably significant – capital costs (capex).

For example, if HSR single-tracking is selected to minimise capex, achieving a frequency of one passenger train per hour per direction will require passing loops for HSR passenger trains (probably at one or other of the intermediary stations), where one or other of the passing trains will have to be held, and potentially delayed. This would mean that there will probably be very little additional track capacity for HSR freight trains. The operation of freight trains at night may be possible (when the passenger trains are not operating) but this night-time capacity is also required for maintenance work.

It follows then that single-track HSR corridors would be unlikely to be further developed to sustain a significant frequency of HSR dedicated freight trains and only mixed passenger/freight trains would be feasible.

If HSR corridors are double-tracked, it may be easier (and cheaper) to develop capacity for additional train paths for either HSR freight trains or regional passenger trains.
10.2 Overview of Potential Impacts
The main benefit of fast or HSR freight services is clearly increased speed. Also, because of the need to adhere to an HSR timetable for passenger services, the freight services will be more reliable than conventional freight services (where journey times are typically much more flexible).

The downside of HSR freight is that because of the need for quick loading as well as the need for enclosed wagons (for reasons of aerodynamics and avoiding the movement of freight in tunnels), the quantity of freight that can be carried is limited. This would be particularly true for mixed passenger/freight trains.

10.2.1 Benefits of Transfer from Road and Air
The transfer of freight from air or road would have some non-financial and social benefits, in particular:

- Reduction of road accidents, due to the fewer road vehicle trips; and
- Reduced emissions profile - including CO₂ (although it should be noted that high speed trains have higher overall emissions than conventional trains).

One impact of HSR network development may also be some capacity benefit for ‘conventional’ rail freight services (due to the reduction in conventional passenger rail services), although this effect is expected to be relatively small due to the need to continue to serve smaller intermediate stations that would not be served by the HSR passenger service.

10.3 Level and potential size of market interest
Fast rail freight services will compete with parallel air, road and conventional rail freight services. The message we have received from the market is mixed. Several respondents have confirmed that reliable, fast HSR freight services could play a role in their distribution services. However, cost will be a major issue.

Mixed HSR Passenger/Freight Trains
The market survey has shown that there could be demand for a transfer of domestic air freight to HSR freight services if freight rates were around 50% of the current air freight rates and if fast journey times could be guaranteed.

The order of magnitude of air freight on the corridors (tens of tonnes per day) concerned is more suitable for the freight capacity of a mixed passenger/freight train than for a dedicated fast freight train. Moreover, some products, like newspapers and magazines might be transported efficiently to city centres by a mixed passenger/freight service.

The conclusion is that there may be sufficient demand for HSR freight movements carried in an HSR mixed passenger/freight train and such a service may be commercially viable. One essential requirement will be the incorporation of an early morning delivery in the passenger timetable.

Dedicated Fast/HSR Freight Trains
The survey and output from the Norway Freight Model indicate that there is potentially a significant demand (in terms of the current rail freight tonnage moved within Norway) for fast rail freight services for cargo attracted from road by the faster services. However, there is likely to be only a relatively small price premium for this traffic compared with the current cost of road transport.

Demand could therefore potentially outstrip the capacity that could be provided in mixed passenger/freight trains but only if the service could be provided at a similar cost to current road freight services.
However, providing track capacity for dedicated freight trains would be additional to what would be needed for serve the purely passenger market and would, therefore, incur additional – probably significant - capital and operating costs.

We have not been able to assess the potential demand from Posten Norge, which – in any case - has a policy of using rail as much as possible, and presumably would be interested in improvements in their level of service. However, the indications from experience in other countries are that postal services – facing a highly competitive logistics and distribution market – would find it difficult to finance a premium HSR postal rail service.

**Rail-on-Rail Competition**

Fast rail freight services would compete with existing conventional services. There might also be competition between fast rail freight service providers – although this seems unlikely, given the high ‘barriers to entry’ of specialised rolling stock and limited train paths.

**10.4 Willingness to Pay and Price Premium**

As has been identified by the survey and the Norway Freight Model, shippers are not willing to pay a significant premium to transfer from conventional rail to HSR or from road to rail – even with the doubling or tripling of average speeds. Air cargo may transfer at a premium but the quantity of this flow is limited, and would be more consistent with mixed passenger/freight trains.

For an HSR freight service to be commercially feasible, the cost structure must be similar to that of road transport:

- For a shared passenger/freight service this may be possible – but then the quantities of cargo that could be carried would be limited; and
- For a dedicated fast freight train, it seems unlikely that the capital and operating costs would be comparable to road transport, even at the relatively long distances covered by the identified corridors.

Thus, although *conventional* rail freight may be price-competitive over longer distances compared with road haulage (in the sense that less investment may be needed in new rolling stock), it seems unlikely that dedicated fast rail freight trains would be. International experience seems to support this conclusion – the only dedicated HSR freight trains (TGV La Poste) has had to reduce its service due to lack of demand.

It is not possible to be more definitive about this relationship until more detail is available on the specific Norwegian HSR rolling stock and infrastructure costs.

**10.5 Commercial Feasibility**

Air freight is commercially the most attractive market, as a price premium might be possible. However, the size of this market is relatively small and could be adequately served by the limited capacity provided by mixed passenger/freight services.

For larger flows of freight sufficient to justify dedicated HSR freight trains, it would be necessary to attract traffic from road transport, for which there is likely to be little price premium. It is also likely that dedicated fast freight trains would have significant additional capex (both infrastructure and rolling stock) and opex costs.

The introduction of fast/HSR freight services would require investment in:

- Rolling stock;
- Station/terminal facilities; and
- Cargo containers and handling equipment.
Revenue would have to cover the vehicle capital and operating costs before it could make a contribution towards any necessary rail infrastructure costs.

At present it is not possible to determine whether mixed HSR passenger/freight trains or dedicated HSR freight trains would be commercially viable and more analysis would be required to confirm this, based on the on-going rolling stock and alignment work under this project. However, international experience appears to show that an HSR trainload service may not be commercially viable but that a mixed passenger/freight train service – similar to that operating in Germany - may be viable.

10.6 Potential contribution to Business Case and Cost/Benefit Ratio

Because of the relatively small size of the air freight market (where a price premium might be possible), it would make more commercial sense to serve this traffic with mixed passenger/freight services, which would be frequent but would have limited capacity.

For larger flows of freight, dedicated HSR freight trains would be necessary. However their market would depend on attracting traffic from road transport, for which there is likely to be little price premium. It is also expected that dedicated fast freight trains would have significant additional capex and opex costs. For these reasons, we do not expect dedicated HSR freight trains to be commercially viable. More analysis would be required to confirm this, based on the on-going rolling stock and alignment work under Phase 3 of this project.

Other social or environmental impacts would depend on the scale of transfer from air or road transport. For HSR mixed passenger/freight trains, these are expected to be small (because of the relatively small quantities of freight likely to be attracted); for dedicated HSR freight services, these could be larger.

10.7 Impact on Conventional Rail Freight Services

One aspect not considered (as it was outside the scope of the study) was the potential impact on conventional rail freight services of any release of capacity the on the conventional rail network due to the development of additional HSR capacity for passenger services.

It must be assumed that improvements to the rail network will create additional capacity for other conventional services, including freight. This may provide an opportunity to improve some conventional freight services and to increase the market share of rail freight. The Norway Freight Model shows a potentially substantial demand for reduced journey times by rail (based on existing rail charges) and surveys indicate demand for fast rail freight services as long as the rail freight tariffs are not significantly higher than for road freight.

10.8 Conclusions

10.8.1 Market Study Conclusions

The overall assessment of this market study may be summed up as follows:

- International experience shows some examples of fast or HSR freight services that are likely to be technically feasible on the Norwegian fast or HSR network:
  - The single example of a dedicated HSR freight train (TGV La Poste) has operated successfully but is facing a declining market and has (until now) proved unable to diversify into the express courier market;
  - The German example of the Lufthansa-subsidiary express courier business based on the existing fast rail passenger services continues to be successful and has a link to air cargo that might develop further in the future; and
  - However, fast courier services on mixed passenger/freight X2000 services in Sweden were stopped, apparently for commercial reasons.
• There are European proposals for integrated air cargo / HSR freight services that are relevant but are as yet unproven commercially.

• Proposals for improved or HSR passenger services are unlikely to include significant additional capacity for dedicated fast/HSR freight trains – the cost of providing this capacity could be substantial; even developing mixed HSR passenger/freight trains would impose additional costs of longer trains/platforms, etc.

• The level of air freight movements on the HSR corridors that are the subject of this study are low – the busiest is of the order of less than one lorry load per day; however, this cargo might be attracted to HSR freight services at a premium price.

• The level of current freight movements by road that might be attracted to fast or HSR freight services appears to be substantial, however:
  - There is evidence that, although shippers might be attracted by the faster rail speeds, they would not be willing to pay a significant premium for fast rail freight; and
  - Posten Norge is a major potential user, but already is committed to using conventional rail freight (i.e. rather than road).

• The busiest freight corridor (by an order of magnitude) is likely to be Oslo – Bergen.

10.8.2 Study Brief Conclusions

In terms of the specific requirements of the study brief, the following conclusions may be drawn:

• For the loading/unloading of fast freight rail services:
  - Cargo operations for combined freight/passenger trains should take place on the same platform as passenger transfer and broadly within the same time constraints (as shown by the example of ic:kurier in Germany).
  - Cargo handling for dedicated fast freight trains should be undertaken at separate freight terminals, because of the longer loading/unloading times and the operation of required mechanical equipment (as shown by the TGV La Poste operation in France).

• The findings on the market for high speed freight trains are:
  - There are considerable freight flows in the corridors concerned by road, rail, air and coastal shipping; however, only a very small proportion of this traffic might be attracted to fast rail freight services, primarily: air freight, express packages and courier traffic and postal traffic.
  - The most lucrative market (in the sense of potential price premium) would be air freight, but the current total flows of air freight on the corridors is small – of the order of less than one lorry-load per day; possibly half of the air freight might transfer at rail freight rates of about half the current air freight rates.
  - There is a substantial market for fast rail freight services transferring from road (and potentially conventional rail); however the shippers do not appear to be likely to be willing to pay a price premium (over the road transport cost) for this service.
  - An upper limit for this transfer from road transport is a total of around 1.5 million tonnes per year (assuming current rail freight charges); the most popular corridor is expected to be Oslo-Bergen, which might attract 70% of this traffic.

• The decisive factors for cargo shippers in the choice of mode of transport have been identified as:
  - Speed, which would be very significant for air freight and is attractive for current road transport;
- Cost: for existing road freight to transfer to fast freight services, the cost would need to be similar to existing road freight charges;
- Availability of early morning delivery to destination (to allow morning delivery); and
- Reliability: this was a common comment from several interviewees – moreover, some respondents had poor experience of rail reliability.

- Railway’s advantages and disadvantages compared to road and air transport for freight transport may be summed up as follows:
  - For existing users of air freight, the key advantage of fast rail freight would be a significantly lower cost at a comparable speed to air freight; and
  - For existing users of road freight, the key advantage would be the significantly shorter journey times (at a similar cost to road freight).

- Willingness to pay for the new service is characterised as follows:
  - For air freight transferring to fast rail freight, there is a willingness to pay up to half the current cost of air freight (around NOK 2000 per tonne); and
  - For road freight transferring to fast rail freight, there is little willingness to pay more than the current road charge (an expected price of around NOK 500 per tonne).

10.8.3 Risks and Degree of Uncertainty

There is clearly a high degree of uncertainty over the potential level of market demand, as well as the commercial viability of any fast/HSR freight services. This uncertainty may reduce when more details are available of HSR rolling stock and infrastructure costs.

10.8.4 Overall Conclusion

The overall conclusion is that there does seem to be a significant potential demand for fast and HSR freight services; however the commercial conditions of supplying these services remains unclear, due to the lack of firm data on the cost of the required infrastructure and rolling stock at this stage.

In terms of the target markets, it can be concluded that air freight shippers (as opposed to those currently using road and rail transport) would be more interested in HSR freight services (as speed is a significant decision factor). For the much larger current flows of express goods and parcels that use road freight, although the market appears to be interested in significantly faster train speeds than at present (i.e. a ‘fast’ rail freight service, as we have defined it – i.e. under 200km/h maximum speed), there appears to be little additional price premium in moving from ‘fast’ rail freight to ‘high speed’ rail freight. The most promising market in our view, therefore, appears to be the air freight market and the size of this market is comparable with the capacity of fast/HSR mixed passenger/freight trains. However, further study would be required to determine whether these services could be provided in a way that covers the costs involved.

The corridor that seems to have the most potential for the development of dedicated fast freight trains (based on demand predicted by the Norway Freight Model) seems to be Oslo – Bergen. To attract air freight to mixed passenger/freight trains, a key aspect would be an efficient connection with Oslo Airport, the national air freight hub.

It seems unlikely that provision of fast/HSR freight services would generate a significant contribution to the overall HSR business case.

10.9 Recommendations

Given the high degree of uncertainty it is obviously wise to proceed with caution. A key question remains: can fast or HSR freight services be provided within the revenue envelope implied by the
findings on price premium and the — as yet undetermined — structure and level of related infrastructure, rolling stock and operating costs?

Clearly, further study will be required (for example, in Phase 3 of the project) to assess both the commercial viability and cost/benefit outcomes of the following two main options on specific routes:

- Fast mixed passenger/freight trains targeting primarily air freight and very time-sensitive courier shipments, at a premium charge, with a capacity of around 2-5t per train; and
- Fast dedicated freight trains targeting primarily a transfer from road (and potentially conventional rail), with a capacity of 100-200t per train (but at a cost not significantly higher than the road transport cost).

The following process is suggested for such a follow-up study:

- Define the assumptions for availability (if any) of freight paths, capacity and journey times (working with the rolling stock contractor) on each corridor, in line with the assumptions of the passenger services proposed;
- Determine the additional cost of providing a fast freight capability (either mixed passenger/freight or all-freight trains) over passenger-only infrastructure and rolling stock required;
- Forecast demand and revenue to be gained from freight services (possibly using the Norway Freight Model, as we have in this study), in particular examining further the demand for rail freight services with an average speed below 160km/h;
- Compare the revenue with the additional capex and opex costs to determine the overall commercial viability of the freight services; and
- Consider other socio-economic costs and benefits of such services.

In addition, it would have to be considered how any competing demand for capacity for regional passenger services could be treated.

Furthermore, the concept of a fast/HSR dedicated train for courier/post traffic should be followed up with Posten Norge, to examine whether this organisation would be willing to finance — in whole or in part - the capital costs of such an initiative on its own.
A. Organisations Contacted
Table A.1 – Questionnaire: Organisations Contacted and Outcomes

<table>
<thead>
<tr>
<th>Company</th>
<th>Contact person</th>
<th>Questionnaire handed in</th>
<th>Progress/Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Postal Services</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posten Norge</td>
<td>Frode Skallerud Tel +47 97 67 29 96</td>
<td>Yes</td>
<td>Frode has made an effort to get some relevant answers but met no response from the rest of the organization. No-one sees the benefit of such a complex task, and with such a short period before Christmas. The questionnaire was passed up in the organization – no information likely to be available before Christmas. Tried to find info through other channels - though the contact person on the article – ‘Norway Post extends it’s rail services’.</td>
</tr>
<tr>
<td>Tollpost</td>
<td>Communication and marked manager</td>
<td>Yes</td>
<td>They find it somewhat special that Jernbaneverket/we go directly to the users of the goods in connection with the evaluation of high speed trains. The information requested is not easy to obtain and they will not be able to provide answers. Finally they referred to Frode Skallerud from Posten Norge</td>
</tr>
<tr>
<td><strong>Freight Forwarders / Air Cargo</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dancargo</td>
<td>Tor Einar Hansen Tel: 0047-64858822</td>
<td>Yes</td>
<td>Very busy. Difficult to answer the questions – lack of data. They will not fill in the questionnaire.</td>
</tr>
<tr>
<td>Jetpak</td>
<td>Niels Snedstrup Tel: 004795718420</td>
<td>Yes</td>
<td>Questionnaire response received - date 6-12-2010</td>
</tr>
<tr>
<td><strong>Courier ‘Integrators’</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHL</td>
<td>Morten Skurdal Tel: 0047-66928673</td>
<td>Yes</td>
<td>Air cargo and road courier traffic Questionnaire response received – date 22-11-2010</td>
</tr>
<tr>
<td>DHL Supply Chain A.S.</td>
<td>Ketil Lundgaard Tel: 0047-93408000</td>
<td>Yes</td>
<td>Road distribution Questionnaire response received – date 14-12-2010</td>
</tr>
<tr>
<td>UPS</td>
<td>Kristian Resvik Tel: 0046-703097397</td>
<td>Yes</td>
<td>Questionnaire response received - date 23-11-2010</td>
</tr>
</tbody>
</table>
### Distribution operators

<table>
<thead>
<tr>
<th>Company</th>
<th>Contact person</th>
<th>Questionnaire handed in</th>
<th>Progress/Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadfeeders</td>
<td><a href="mailto:lene@roadfeeders.no">lene@roadfeeders.no</a></td>
<td>Yes</td>
<td>Very busy. They will not be able to provide information before Christmas.</td>
</tr>
<tr>
<td>Prime cargo</td>
<td>Vegard Kristiansen</td>
<td>No</td>
<td>Not interested in talking to us at all. Never reached handing in the questionnaire.</td>
</tr>
<tr>
<td>Air Cargo Forum</td>
<td>Arne Lossius</td>
<td>Yes</td>
<td>The manager passed us on to TheNorwegian Logistics and Freight Association. Air Cargo Forum does not have any data themselves.</td>
</tr>
<tr>
<td>Norwegian Logistics and Freight Association</td>
<td>Lennart Hovland</td>
<td>Yes</td>
<td>Norwegian Logistics and Freight Association do not have any data, but are helping us to get to get through to Posten Norge, Bring, Tollpost, and DB Schenker</td>
</tr>
</tbody>
</table>

### Rail operators and track authorities

<table>
<thead>
<tr>
<th>Company</th>
<th>Contact person</th>
<th>Progress/Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trafikverket Sweden</td>
<td>Lars Stenegard</td>
<td>Operators of Norwegian cargo through Sweden: CargoNet, TX Logistik, Hector Rail. Lars had no info on flows.</td>
</tr>
<tr>
<td>Trafikverket Sweden</td>
<td>Hans Wolf</td>
<td>Had no info on cargo flows or volumes. Gave link to Yngve Andeasen, Jernbaneveket, Norway</td>
</tr>
</tbody>
</table>

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112
<table>
<thead>
<tr>
<th>Company</th>
<th>Contact person</th>
<th>Questionnaire handed in</th>
<th>Progress/Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jernbaneverket Norway</td>
<td>Ynve Andreasen +47 916 551 32</td>
<td>No</td>
<td>Unable to contact</td>
</tr>
<tr>
<td>CargoNet Sweden</td>
<td>Hans Backman +46 708 676 751</td>
<td>Yes</td>
<td>Had no information, but if he had it would be confidential. Knew of discussion within GreenCargo about HSR cargo. Gave link to Bjarne Wist, CargoNet Norway</td>
</tr>
<tr>
<td>CargoNet Norway</td>
<td>Bjarne Wist +47 23 15 4545</td>
<td>Yes</td>
<td>Questionnaire sent</td>
</tr>
<tr>
<td>Green Cargo Sweden</td>
<td>Mats Hansson Market Director +46 10 455 4983</td>
<td>No</td>
<td>Had no info on cargo flows, if any it would probably be confidential. Could confirm discussion on HSR cargo but had no material.</td>
</tr>
<tr>
<td>Green Cargo Sweden</td>
<td>Inger Eriksson Strategic Prod development +46 10 455 4963</td>
<td>Yes</td>
<td>Had no info but thought she may find some, so questionnaire sent</td>
</tr>
</tbody>
</table>

In addition several others were on the contact list but were not contactable for various reasons such as sabbatical leave or unanswered telephone.
B. Survey Questionnaire


B.1 INTRODUCTORY BRIEFING

B.1.1 Script: Key Background Points to Communicate (could be sent by e-mail or a copy handed over)

- The study is for Jernbaneverket, on behalf of the Government, to investigate the demand for and costs of High Speed Rail in Norway; and
- This consultation is about the potential market for freight using the improved railway – we are talking to key freight organisations.
- Any information provided will be treated as confidential and will not be shared with other interviewees
- The following connections are being considered
  - Oslo – Bergen;
  - Oslo – Kristiansand – Stavanger;
  - Oslo – Trondheim;
  - Oslo – Gothenburg;
  - Oslo – Stockholm; and
- The new rail freight services might take the form of:
  - Fast dedicated freight (> 160 km/h)
  - High Speed dedicated freight (>200 km/h) – e.g. TGV La Poste
  - High Speed mixed passenger/freight trains (>200 km/h) (e.g. with a freight wagon/vehicle incorporated in the passenger train design).
- There are two ways in which rail freight might benefit from improvements to rail infrastructure.
  - Firstly, any form of high speed passenger investment should provide extra good quality capacity that would provide journey times for conventional freight trains equivalent to today’s passenger services; and
  - Secondly, the high speed trains may themselves be able to carry parcels and urgent freight, possibly on newly constructed lines achieving very fast journey times.
- Both of these possibilities are shown in the table below:

<table>
<thead>
<tr>
<th>Potential ‘fast’ freight concept ¹ (dedicated freight or mixed passenger/ freight)</th>
<th>Potential High Speed freight concept ² (dedicated freight or mixed passenger/ freight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Frequency (08.00 to 18.00)</td>
</tr>
<tr>
<td>Oslo-Kristiansand</td>
<td>04:25</td>
</tr>
<tr>
<td>Oslo-Stavanger</td>
<td>07:42</td>
</tr>
<tr>
<td>Oslo-Bergen</td>
<td>06:28</td>
</tr>
<tr>
<td>Oslo-Trondheim</td>
<td>06:38</td>
</tr>
<tr>
<td>Oslo-Stockholm</td>
<td>06:07</td>
</tr>
<tr>
<td>Oslo-Gothenburg</td>
<td>03:55</td>
</tr>
<tr>
<td>Bergen-Stavanger</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:

¹ Based on Fastest Passenger Service 2010
² Based on dedicated High Speed lines (Concept D)
### B.1.2 Section 1. Company / Interviewee Details

<table>
<thead>
<tr>
<th>Company/Organisation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brief Description of Company Activities</td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>Interviewee Name</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td></td>
</tr>
<tr>
<td>Phone No.</td>
<td></td>
</tr>
<tr>
<td>E-mail</td>
<td></td>
</tr>
<tr>
<td>Date(s) of interview</td>
<td></td>
</tr>
<tr>
<td>Type of interview (phone, face-to-face)</td>
<td></td>
</tr>
</tbody>
</table>
B.1.3 Section 2. Existing Freight Flows (Omit if not a cargo-based organisation)

*Script: Can you give us an overview of your current freight activity in Norway with examples using road, air and rail transport (if possible)? (e.g. commodities, quantities, major origins/destinations).*

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Transport Mode (include road, air and rail, if possible)</th>
<th>Quantity (Daily, Monthly or Annually) (truckloads, tonnage, units)</th>
<th>Major Origins/Destinations</th>
<th>Feasible to use high speed rail freight?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Express Packages</td>
<td>Road</td>
<td>10 truckloads per day – approx 30,000t per year</td>
<td>Oslo hub – Bergen distribution centre</td>
<td>Possibly</td>
</tr>
</tbody>
</table>
### Potential Transfer to High Speed Rail Freight

*(Omit if not a cargo-based organisation)*

*Script:* We are interested in cargo flows that might be attracted to the higher speed rail services from road, air or conventional rail services to the improved services shown in the table in the introduction: so probably this will relate to longer-distance, higher-value, time-sensitive goods. Can you identify 2 or 3 specific flows of existing traffic that has these characteristics?

<table>
<thead>
<tr>
<th>Potential HSR Traffic</th>
<th>Flow 1</th>
<th>Flow 2</th>
<th>Flow 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport Mode</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Commodity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Origin / Destination</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quantity (Daily, Weekly or Monthly)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Frequency of the transport service used (i.e. by the main carrier)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Any special arrangements that are needed (e.g. refrigeration, bonded, early morning delivery)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Current journey time</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>What HSR freight journey time would be attractive?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>How important are reliable delivery times? What delay is acceptable on 1 in 10 occasions?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Potential HSR Traffic

<table>
<thead>
<tr>
<th></th>
<th>Flow 1</th>
<th>Flow 2</th>
<th>Flow 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate current transport cost (per tonne, truck, shipment)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If the journey times shown in the table for “Fast rail freight” were possible using rail freight, roughly how much would you be willing to pay to use such a service?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If the journey times shown in the table for “High Speed rail freight” were possible using rail freight, roughly how much would you be willing to pay to use such a service?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, do you think this traffic could be attracted to HSR freight? What probability?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any other relevant comments or information?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**B.1.5 Section 4: Other Issues Relating to High speed Freight**

*Script:* Can you tell us about any other issues that might be relevant to the implementation of fast or high speed freight. Possible issues are listed below.

<table>
<thead>
<tr>
<th>Possible Questions</th>
<th>Response / Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading/unloading infrastructure (e.g. freight terminals – existing or new? Location required?)</td>
<td></td>
</tr>
<tr>
<td>Need for specialised containers? Air freight ULDs suitable? Handling technology?</td>
<td></td>
</tr>
<tr>
<td>Rolling stock (e.g. special features required – enclosed vehicles for aerodynamics)? Existing or new?</td>
<td></td>
</tr>
<tr>
<td>Legal issues / Liability?</td>
<td></td>
</tr>
<tr>
<td>Any other comments / areas of concern?</td>
<td></td>
</tr>
</tbody>
</table>
C. The Norway Freight Model
C.1 **Description of the model**

Until a few years ago, the national model system for freight transport in Norway was lacking logistic elements (such as variation of shipment sizes and frequencies, consolidation of shipments, transhipments at terminals, distribution centres). A project was set up for the Work Group for transport analysis in the Norwegian National Transport Plan to develop a new logistics module. This logistics model for Norway was developed by Significance as part of the Norwegian national freight model systems.

The method report (Significance, 2008) describes the model in detail. Below we give a short description of the model. A similar, but not identical, logistics model was developed for Sweden. De Jong and Ben-Akiva (2007) and Ben-Akiva and de Jong (2008) contain descriptions of these models.

C.1.1 **The model structure**

The new Norwegian freight model system, including the logistics model, can be described as an aggregate-disaggregate-aggregate (ADA) model system. In the ADA model system, the production to consumption (PC) flows and the network model are specified at an aggregate level for reasons of data availability. Between these two aggregate components is a logistics model that explains the choice of shipment size and transport chain, including mode and vehicle choice for each leg of the transport chain. This logistics model is a disaggregate model at the level of the firm, the decision making unit in freight transport. Figure C.1 is a schematic representation of the structure of the freight model system. The boxes indicate model components. The top level of Figure C.1 displays the aggregate models. Disaggregate models are at the bottom level.

![ADA model structure](image)

**Figure C.1 - ADA model structure of the (inter)national/regional freight transport model system**

The model system starts with the determination of flows of goods between production (P) zones and consumption (C) zones (retail goods for final consumption; and further processing of goods for intermediate consumption). Wholesale activities can be included at both the P and the C end, so actually the matrices are production-wholesale-consumption (PWC) flows. These models are commonly based on economic statistics (production and consumption statistics, input-output tables, trade statistics) that are only available at the aggregate level, with zones and zone pairs (e.g. in the case of multi-regional input-output tables) as the observational units. In ADA, a new logistics model takes as input the PC flows and produces OD flows for network assignment. The logistics model itself consists of three steps:

- Disaggregation to allocate the flows to individual firms at the P and C end;
- Models for the logistics decisions by the firms (e.g. shipment size, use of consolidation and distribution centres, modes, loading units, such as containers); and
• Aggregation of the information per shipment to origin-destination (OD) flows for network assignment.

This model structure allows for logistics choices to be modelled at the level of the actual decision-maker, along with the inclusion of decision-maker attributes. The allocation of flows in tonnes between zones (step A) to individual firms is based on observed proportions of firms in local production and consumption data, and from a register of business establishments. The logistics decisions in step B are derived from minimization of the full logistics costs (including transport costs). The aggregation of OD flows between firms to OD flows between zones provides the input to a network assignment model, where the zone-to-zone OD flows are allocated to the networks for the various modes. The model distinguishes 32 commodity types:

1. bulk food
2. consumption food
3. beverages
4. fresh fish
5. frozen fish
6. other fish
7. thermo input
8. thermo consumption
9. machinery and equipment
10. vehicles
11. general cargo: high value goods
12. general cargo: live animals
13. general cargo: building materials
14. general cargo: other inputs
15. general cargo: consumption goods
16. timber-sawlogs
17. timber-pulpwood
18. pulp
19. paper intermediates
20. wood products
21. paper products
22. mass commodities
23. coal, ore and scrap
24. cement, plaster and cretaceous
25. non-traded goods
26. chemical products
27. fertilizers
28. metals and metal goods
29. aluminium
30. raw oil
31. petroleum gas
32. refined petroleum products

Furthermore, it uses about 300 zones in Norway and a number of larger zones abroad. The model covers not only domestic flows in Norway, but also import and export of Norway.

C.1.2 The cost functions

The logistics model minimises the total annual logistics costs $G$ of commodity $k$ transported between firm $m$ in production zone $r$ and firm $n$ in consumption zone $s$ of shipment size $q$ using logistic chain $l$, which are defined as:

$$G_{rskmnl} = O_{kq} + T_{rskql} + D_k + Y_{rskl} + I_{kq} + K_{kq}$$  \(1\)

Where:
G: total annual logistics costs
O: order costs
T: transport, consolidation and distribution costs
D: cost of deterioration and damage during transit
Y: capital costs of goods during transit
I: inventory costs (storage costs)
K: capital costs of inventory

The transport costs ‘T’ include distance-based link costs (e.g. fuel), time-based link costs (e.g. staff, vehicles), loading and unloading costs, transhipment costs and cargo costs in ports.

The cost calculation depends on time and costs between any set of zones by each mode (if the mode is available for that zone-pair), that come from skims of the networks and on default cost function parameters by vehicle type and/or by commodity type. The model contains separate cost parameters for 10 types of road vehicles, 28 types of sea vessels, 8 types of train and 2 types of airplane. The 8 train types are:

- Electric combi train
- Electric timber train
- Electric system train (dry bulk)
- Electric wagon load train
- Diesel combi train
- Diesel timber train
- Electric system train (wet bulk)
- Diesel wagon load train

The 2 types of airplane are:

- Medium sized freight plane
- Large freight plane

C.1.3 The choices in the logistics model

The logistics model takes PWC flows between zones as given, allocates these flows to individual firms at both ends of the flow of goods and then determines the optimal shipment size and the optimal transport chain. The transport chain includes the number of legs in the chain, the transport mode (road, sea, train, ferry and air) and the vehicle type within each leg of the chain and the transhipment locations between the modes - consolidation centres (CC) and distribution centres (DC).

There is no ‘module’ for air freight, but air transport is one of the modes (further distinguishing between 2 types of airplane) that is available in the module for the choice of shipment size and transport chain. The model contains 6 transport chains that include air transport, all of them combinations of road and air transport. It also has 7 chains which contain rail transport (combinations or rail with road and possibly also sea). Air transport is only possible for:

- Consumption food;
- Fresh fish;
- High value general cargo; and
- Consumption goods general cargo.

The logistics model also allows for consolidation of goods in the same vehicle or vessel (which reduces costs for a shipper). The question then is whether there will be sufficient other cargo on an OD leg (especially a CC-DC leg, such as port-port). The issue of whether at some transhipment location there will be sufficient other cargo (going in the right direction) for consolidation is treated by looking at the total amount of goods within certain commodity types.
that will be sent from a transfer point (e.g. a port) to another transfer point. The degree of consolidation is then determined in an iterative process.

Empty vehicle trips are added to the loaded vehicle trips on the basis of the imbalances in transport between zones.

C.1.4 Model input and output
The input of the model consists of: PWC flows (at the zone to zone level), information on the firms in each zone, distances and transport times from the networks, terminal locations and cost function parameters.

As output, the model produces tables of tonnes, tonne-km, vehicles by commodity and mode or vehicle type, as well as OD matrices of tonnes or vehicles by vehicle type.

C.2 Commodities and ODs are now served by air transport according to the model
We carried out a model run for the base case to provide all the transport chains between a sender and a receiver where air transport is used in at least one of the legs of the chain. If one would work with main modes in a transport chain (which this model does not, it distinguishes modes for all the legs), defined in terms of a hierarchy of modes, these chains would be called ‘air transport’.

Only for the commodities 4 and 11 the Norwegian logistic model generates air transport on specific OD-relations:

<table>
<thead>
<tr>
<th>Nr</th>
<th>Commodity</th>
<th>Tonnes/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Fresh fish</td>
<td>70906</td>
</tr>
<tr>
<td>11</td>
<td>General cargo, high value</td>
<td>22909</td>
</tr>
</tbody>
</table>

Inspection of these OD flows showed that none of these airport-airport flows were between Norwegian airports at both ends or between a Norwegian and a Swedish airport. All the flows that use air transport in the model are intercontinental import and export flows. When using the costs functions in the Norwegian logistics model, air transport is never the least-cost alternative (also taking into account capital costs on the goods in transit) for domestic flows or flows to/from Sweden.

The above was about flows carried out as air transport. There were no road transport flows between Norwegian airports in the model either (trucking of air cargo).

C.3 Modal split between the relevant city region pairs
In the tables below, we give the total amount of tonnes that according to the model are transported between two city regions (in both directions), for each commodity. These can be goods produced or consumed in these cities, but also goods that are being transshipped from one transport mode to another at terminals in these regions (in other words, these are OD flows not PC flows).
<table>
<thead>
<tr>
<th>City region pair</th>
<th>Oslo-Stockholm Road/rail flow (t)</th>
<th>Rail share (%)</th>
<th>Oslo-Gothenburg Road/rail flow (t)</th>
<th>Rail share (%)</th>
<th>Oslo-Stavanger Road/rail flow (t)</th>
<th>Rail share (%)</th>
<th>Oslo-Bergen Road/rail flow (t)</th>
<th>Rail share (%)</th>
<th>Oslo-Trondheim Road/rail flow (t)</th>
<th>Rail share (%)</th>
<th>Stavanger-Bergen Road/rail flow (t)</th>
<th>Rail share (%)</th>
<th>Total Road/rail flow (t)</th>
<th>Rail share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commodity 1: bulk food</td>
<td>1258</td>
<td>0</td>
<td>1337</td>
<td>0</td>
<td>1515</td>
<td>0</td>
<td>na</td>
<td>1441</td>
<td>0</td>
<td>1411</td>
<td>0</td>
<td>14065</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 2: consumption food</td>
<td>4808</td>
<td>0</td>
<td>5216</td>
<td>0</td>
<td>70698</td>
<td>17</td>
<td>106987</td>
<td>10</td>
<td>184043</td>
<td>0</td>
<td>5492</td>
<td>0</td>
<td>377244</td>
<td>6</td>
</tr>
<tr>
<td>Commodity 3: beverages</td>
<td>3276</td>
<td>0</td>
<td>5622</td>
<td>0</td>
<td>44286</td>
<td>0</td>
<td>71956</td>
<td>0</td>
<td>16487</td>
<td>0</td>
<td>658</td>
<td>0</td>
<td>142285</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 4: fresh fish</td>
<td>0</td>
<td>na</td>
<td>0</td>
<td>na</td>
<td>147</td>
<td>0</td>
<td>3297</td>
<td>0</td>
<td>177</td>
<td>0</td>
<td>1558</td>
<td>0</td>
<td>5180</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 5: frozen fish</td>
<td>0</td>
<td>na</td>
<td>0</td>
<td>na</td>
<td>642</td>
<td>0</td>
<td>2747</td>
<td>88</td>
<td>830</td>
<td>0</td>
<td>279</td>
<td>0</td>
<td>4499</td>
<td>54</td>
</tr>
<tr>
<td>Commodity 6: other fish</td>
<td>150</td>
<td>0</td>
<td>63</td>
<td>0</td>
<td>1151</td>
<td>55</td>
<td>1554</td>
<td>0</td>
<td>5963</td>
<td>82</td>
<td>1487</td>
<td>0</td>
<td>10368</td>
<td>54</td>
</tr>
<tr>
<td>Commodity 7: thermo inputs</td>
<td>0</td>
<td>na</td>
<td>0</td>
<td>na</td>
<td>6875</td>
<td>0</td>
<td>1734</td>
<td>0</td>
<td>851</td>
<td>0</td>
<td>4272</td>
<td>0</td>
<td>13732</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 8: thermo consumption goods</td>
<td>541</td>
<td>0</td>
<td>501</td>
<td>0</td>
<td>29995</td>
<td>0</td>
<td>102632</td>
<td>0</td>
<td>307458</td>
<td>0</td>
<td>2769</td>
<td>0</td>
<td>443896</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 9: machinery and equipment</td>
<td>4478</td>
<td>0</td>
<td>42836</td>
<td>0</td>
<td>3044</td>
<td>0</td>
<td>54033</td>
<td>0</td>
<td>15997</td>
<td>0</td>
<td>1643</td>
<td>0</td>
<td>122031</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 10: vehicles</td>
<td>2352</td>
<td>0</td>
<td>5265</td>
<td>0</td>
<td>4040</td>
<td>0</td>
<td>89</td>
<td>0</td>
<td>16676</td>
<td>0</td>
<td>736</td>
<td>0</td>
<td>29158</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 11: general cargo, high value goods</td>
<td>801</td>
<td>0</td>
<td>2329</td>
<td>0</td>
<td>6230</td>
<td>0</td>
<td>3232</td>
<td>0</td>
<td>1521</td>
<td>0</td>
<td>130</td>
<td>0</td>
<td>14243</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 13: general cargo, building materials</td>
<td>198</td>
<td>0</td>
<td>766</td>
<td>0</td>
<td>57069</td>
<td>100</td>
<td>118</td>
<td>100</td>
<td>65630</td>
<td>51</td>
<td>5</td>
<td>0</td>
<td>123787</td>
<td>73</td>
</tr>
<tr>
<td>Commodity 14: general cargo, other inputs</td>
<td>1494</td>
<td>97</td>
<td>3459</td>
<td>0</td>
<td>32</td>
<td>54</td>
<td>3048</td>
<td>99</td>
<td>9578</td>
<td>99</td>
<td>13</td>
<td>0</td>
<td>17623</td>
<td>79</td>
</tr>
<tr>
<td>Commodity 15: general cargo, consumption goods</td>
<td>6529</td>
<td>0</td>
<td>14200</td>
<td>0</td>
<td>322169</td>
<td>99</td>
<td>538631</td>
<td>92</td>
<td>104303</td>
<td>49</td>
<td>23521</td>
<td>0</td>
<td>1009351</td>
<td>86</td>
</tr>
<tr>
<td>Commodity 19: paper intermediates</td>
<td>260</td>
<td>100</td>
<td>6102</td>
<td>0</td>
<td>18714</td>
<td>100</td>
<td>284</td>
<td>90</td>
<td>16512</td>
<td>33</td>
<td>730</td>
<td>0</td>
<td>42601</td>
<td>58</td>
</tr>
<tr>
<td>Commodity 20: wood products</td>
<td>1110</td>
<td>62</td>
<td>3358</td>
<td>1</td>
<td>41207</td>
<td>100</td>
<td>33573</td>
<td>100</td>
<td>63665</td>
<td>91</td>
<td>5304</td>
<td>0</td>
<td>148216</td>
<td>90</td>
</tr>
<tr>
<td>Commodity 21: paper products</td>
<td>2922</td>
<td>0</td>
<td>17687</td>
<td>0</td>
<td>4704</td>
<td>0</td>
<td>27139</td>
<td>0</td>
<td>17861</td>
<td>0</td>
<td>0</td>
<td>na</td>
<td>70313</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 26: chemical products</td>
<td>3170</td>
<td>0</td>
<td>4674</td>
<td>0</td>
<td>99</td>
<td>0</td>
<td>1050</td>
<td>0</td>
<td>27030</td>
<td>0</td>
<td>2801</td>
<td>0</td>
<td>38825</td>
<td>0</td>
</tr>
<tr>
<td>Commodity 28: metals and metal goods</td>
<td>2104</td>
<td>14</td>
<td>3966</td>
<td>0</td>
<td>20706</td>
<td>100</td>
<td>50122</td>
<td>66</td>
<td>10189</td>
<td>91</td>
<td>5230</td>
<td>0</td>
<td>92317</td>
<td>69</td>
</tr>
<tr>
<td>Commodity 32: refined petroleum products</td>
<td>10404</td>
<td>0</td>
<td>4567</td>
<td>0</td>
<td>298</td>
<td>0</td>
<td>691</td>
<td>0</td>
<td>799</td>
<td>0</td>
<td>2230</td>
<td>0</td>
<td>18990</td>
<td>0</td>
</tr>
</tbody>
</table>
The table also gives the modal share (in the tonnes) of road and rail. This is not the observed modal share, but the prediction of the model for the base year (2008). Air transport is not used in the model between these regions. Sea transport is relevant for commodity 1 (bulk food), 5 (frozen fish), 22 (mass commodities), 23 (coal, ore and scrap), 24 (cement, plaster and cretaceous), 25 (non-traded goods) and especially 32 (refined petroleum products), but this is not included in the tables, because these are not the flows that might be transferred to HSR. Commodities 12 (live animals), 16 (timber-sawlogs), 17 (timber-pulpwood), 18 (pulp), 22 (mass commodities), 23 (coal, ore and scrap), 24 (cement, plaster and cretaceous), 25 (non-traded goods), 27 (fertilizers), 29 (aluminium), 30 (raw oil) and 31 (petroleum gas) are not included in the tables below, because there are no or hardly any flows of these goods between the city regions by rod or rail transport.

Commodities with big flows (more than 100,000 tonnes per year) that now go by road or rail, according to the model, are:

- Consumption food;
- Beverages;
- Thermo consumption goods;
- Machinery and equipment;
- General cargo, building materials;
- General cargo consumption goods; and
- Wood products.

The transport flows of fresh and frozen fish between the relevant city regions for instance are quite small.

For many commodities rail now has a share of zero (on the basis of the costs minimisation in the logistics model):

- Bulk food;
- Beverages;
- Fresh fish;
- Thermo inputs;
- Thermo consumption goods;
- Machinery and equipment;
- Vehicles;
- General cargo: high value goods;
- Paper products;
- Chemical products; and
- Refined petroleum products.

For some other goods (e.g. general cargo: other inputs, general cargo: consumption goods, wood products, metal and metal goods), rail has a high market share.

### C.4 Calculation of Break-Even HSR Speeds and Costs

In this section we compare the costs of a chain with rail transport (road-rail-road) to a direct road transport chain, and calculate how fast rail should be to become as ‘cheap’ or attractive as direct road transport. For situations with a high rail speed (160 or 200 km/h), at which rail is cheaper,
we calculate how much rail could raise its price before road becomes cheaper. Speeds like 160 km/h and 200 km/h are more maximum attainable rail speeds than average speeds, but we use these values to show the upper limits.

There is no comparison with the cost of air transport, because the model does not give any air transport flows between Norwegian airports (so these are never the least-cost option that should be used as the benchmark for HSR).

C.4.1 Large Shipments (including Containers)

We use an example of a shipment of 20 tonnes that moves from a sender to a receiver over 300 km.

For commodity 15 (general cargo, consumption goods), which had large flows between the city pairs), the transport cost using road vehicle 106 (articulated semi, containers) from the model would be 3875 NOK. Using road-rail-road with vehicles 106 and 301 (electric combi train) these costs are 4595 NOK. These calculations do not include costs that are the same for both chains for the given shipment size (order cost, initial loading, final unloading, inventory cost), and assume that the shipper pays for the full lorry or train wagon (no consolidation). Moreover we assumed that the effective speed for road is 60 km/h and 30 km/h for rail, and that the road and rail distances are 300 km and that it takes 10 km by road transport to get to or from the road-rail terminal.

From the same costs functions we can calculate the rail speed at which rail becomes as expensive as road:

$$3875 = 99.8 \times (300/s) + 3597 \quad (2)$$

99.8 NOK is the rail costs per hour, including the time costs of the goods in transit (capital cost and decline in value during transit) and 3597 is the non-rail time-dependent cost of the road-rail-road chain. This gives a 'break-even speed' of rail of 108 km/h. If the effective rail speed would be 160 km/h, rail could increase its price by 91 NOK (7%) and still be no more 'expensive' than direct road transport. At 200 km/h the break-even price for rail would be 128 NOK (10%) higher.

The same example, but for commodity 11 (general cargo, high value) yields showed that rail cannot be less expensive than road at any rail speed. This is caused by the very high time cost (especially the decline in the value of the goods) for this commodity, in combination with the time that is used for transhipment and for waiting for the next train. If however, there would be a logistics system where the goods would not have to wait at the railway terminal (but arrive just in time) and only 1 hour of transhipment time (half an hour at both ends), road-rail-road would be cheaper than direct road transport already at 82 km/h.

We also performed this calculation for commodity 2 (consumption food), also a large flow for the relevant city pairs. Again the time costs are quite high here, and there is a big cost difference between the road and the road-rail-road chain, in favour of the former. Even if there would be no waiting time and only 1 hour of transhipment time, a train speed of 364 hr/km would be required to reach a point of indifference between the road-rail-road chain and the road chain.

We did not do this calculation for fresh fish (commodity 5), that together with the three commodities above are the goods that may be transported by air transport in the model, because there are hardly any Origin/Destination flows for this commodity between the cities.

The calculation above for commodity 15 assumed that the goods would be transported in a container, which would be loaded onto the train. If however, there would be a requirement to unload the container to get the goods onto the train (stripping) and load again into a container for the final 10 km by truck (stuffing), then the transhipment costs of road-rail-road become prohibitive: this chain cannot compete against direct road transport at any rail speed.

We also made a cost calculation for commodity 15 assuming that this would not use containers. Now the direct road transport uses vehicle 105 (articulated semi, closed) and the road-rail-road chain uses the same road vehicle and an electric wagonload train (vehicle 304). Also in this case,
the transhipment costs become too large to make the road-rail-road chain attractive at any train speed.

If the distance would increase above 300 km, rail chains in the model become more competitive. Also an increase of the shipment size above a full truckload will make rail more competitive.

C.4.2 Small shipments

For small shipments (e.g. parcels, packages) there are opportunities for rail transport, but this depends very much on the ability of the rail operator to consolidate shipments. For the case of a 50 kg shipment of commodity 15 (general cargo: consumption goods), road-rail-road could, at 30 km/h, already be cheaper than direct road transport. Here we assumed that the road vehicle used in both chains would be the LGV (101) and the train type would be an electric wagonload train (vehicle 304) that is 80% loaded. For the LGV we assume that the shipper pays all the vehicle costs by himself (in both transport chains), but for the wagonload train, he pays only in proportion to his use of the capacity of the wagon.

Also for commodity 11 (general cargo: high value goods) and 2 (consumption food), under these circumstances we find that road-rail-road can already beat road transport at 30 km/h.

We conclude that the opportunities for getting parcel load onto the train depend more on the performance of the railway operator as a consolidator (very high performance required) than on the rail speed.

C.5 Outcomes of Model Runs for HSR variants

Two HSR variants have been simulated using the logistics model. In the first, the rail speed between the six city pairs is assumed to go up to 160 km/hr, and in the other to 200 km/hr. We compare the outcomes of this to a run for the reference situation, with the current conventional rail speeds between those cities. All three runs refer to the base year, that is, we use the base year PWC matrices. The logistics model not only takes account of modal choice (in terms of transport chains), but also optimises the shipment size. A difference with the above cost calculations for large shipments is that it includes consolidation: flows with a lot of other cargo provide opportunities for consolidation (whereas in the section on large shipments we assumed that a shipper had to pay the whole vehicle). This is therefore more similar to the above costs calculations for small shipments.

Again, speeds like 160 km/hr and 200 km/hr are more maximum attainable rail speeds than average speeds, but we use these values to show the upper limits. In the reference case, the rail speed on the links between the Norwegian city pairs is 65 km/hr. Between Oslo on the one hand and Stockholm and Gothenburg on the other hand, the base speeds range between 34 and 56 km/hr.

When the rail speed would become 160 km/hr, the annual number of tonnes by rail transport between the six cities goes up by 1.520 million tonnes (more than doubling). All of this is at the expense of road transport (sea transport kept the same number of tonnes), or at the expense of rail connections elsewhere. The total number of tonnes transported by rail transport in/to/from Norway goes up by 830,000 tonnes (+11%, almost exclusively on domestic OD flows), indicating that the higher speeds between the six cities could also lead to a re-routing of rail transport in Norway from conventional to fast lines. In terms of tonne-km, domestic rail transport would grow by 4.4% (200 million tonne-km) and road transport would decline by 0.5%.

The predicted additional demand for fast rail freight services (at 160km/h) on the corridors is given in the following table; the corridor Oslo-Bergen accounts for over 70% of the increased demand. For comparison, the additional flow predicted on this corridor for fast rail freight at 160 km/h is nearly twice times the ‘base’ rail freight flow (580 000 tonnes).
Table C.1 - Predicted Increase Rail Demand, 160 km/h Variant

<table>
<thead>
<tr>
<th>City region pair</th>
<th>Predicted increase in rail transport demand (tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oslo-Stockholm</td>
<td>48 584</td>
</tr>
<tr>
<td>Oslo-Gothenburg</td>
<td>6 047</td>
</tr>
<tr>
<td>Oslo-Stavanger</td>
<td>80 873</td>
</tr>
<tr>
<td>Oslo-Bergen</td>
<td>1 086 903</td>
</tr>
<tr>
<td>Oslo-Trondheim</td>
<td>296 844</td>
</tr>
<tr>
<td>Stavanger-Bergen</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1 519 250</strong></td>
</tr>
</tbody>
</table>

Note: Increase in rail transport (both directions) in tonnes/year, 160 km/h variant versus reference case.

A large part of the increase in the number of tonnes transported by rail between the city pairs in case the rail speed would be 160 km/hour takes place for commodities 14 (general cargo: other inputs; +300,000 tonnes) and 15 (general cargo consumption goods; +800,000 tonnes). Most of this increase (300,000 tonnes for commodity 14 and 700,000 tonnes for commodity 15) occurs on the relation Bergen-Oslo. In order to serve such large volumes, the freight transport capacity of this line (at the speed of 160 or 200 km/hr) needs to be very large. Mixed passenger/freight services would not be sufficient here; several dedicated fast freight trains per day would be required.

In the base case, all the rail flows between Bergen and Oslo as origin and destination had a sender in Bergen and a receiver in Oslo (PC is also Bergen-Oslo). But in the 160 km/hr case, there are also rail flows that are part of longer PC chains, such as chains beginning in the Bergen region (Fjell, Vaskdal) that use a chain that includes the fast Bergen-Oslo train to deliver to destinations in Norway and abroad (including other continents).

Furthermore there are increases for commodity 2 (consumption food), 6 (other fish), 9 (machinery and equipment), 11 (general cargo, high value goods), 13 (general cargo: building materials), 19 (paper intermediates), 20 (wood products), 21 (paper products), 28 (metals and metal goods) and 29 (aluminium). For commodities 9, 11 and 21, rail transport didn't have any market share for these goods at the current speeds.

The same things happen when the rail speed would go up to 200 km/hr. In that case, rail gets 1.630 million extra tonnes – indicating a relatively small increase in traffic related to an increase in speed from 160 to 200 km/h.

C.6 References


