Norway High Speed Rail Assessment Study: Phase III

Freight Market Analysis

Final Report

25 January 2012

Plan Design Enable

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This document has 61 pages including the cover.

Document history

Job number: 5101627			**Document ref: Final Report**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	Draft for Client Review	WL	TH	AJC	WL	20/01/12
Rev 2.0	Final Report	WL	TH	AJC	WL	25/01/12

Client signoff

Client	Jernbaneverket
Project	Norway HSR Assessment Study - Phase III
Document title	Norway HSR Assessment Study - Phase III: Freight Market Analysis, Final Report
Job no.	5101627
Copy no.	
Document reference	Norway HSR Assessment Study - Phase III: Freight Market Analysis, Final Report, 25 January 2012

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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, efficiency 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 Norway HSR Assessment Study has been divided into three phases.

- In Phase I, 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 II was 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 II used and enhanced existing information, models and data. New tools were created where existing tools were not suitable for assessing HSR. Phase II was completed in March 2011.
- In Phase III the tools and guiding principles established in Phase II have been used to test scenarios and develop alternatives on the different corridors.

1.2. Purpose of this Report

This Phase III report presents the analysis of the potential market for freight in the context of the introduction of HSR. The issue of freight has been examined in two phases of the study. The opportunity for both high-speed and fast rail freight – that is above 200 kph and above 120 kph respectively, was completed during Phase II of the study. This concluded that there was unlikely to be any significant demand for freight above 200 kph.

In Phase III, the analysis concentrated on fast (intermodal) freight exclusively as the sector identified as having the greatest market potential. It concentrated exclusively on trains capable of running at 120 kph on the high speed lines, with that speed calculated to be the minimum required to not unduly impact on passenger trains running at maximum speeds between 250 and 330 kph.

Three approaches were used to understand the market potential:

- Demand modelling,
- Consultation; and
- Comparison with international experience.

1.3. Structure of this report:

The remainder of this report is structured as follows:

- Section 2 covers the modelling process;
- Section 3 covers the consultation undertaken;
- Section 4 covers the survey of International experience; and
- Section 5 summarises the conclusions.

2. Demand Modelling Results

Three main opportunity areas for high speed freight were examined:

- Transfer from air (high speed only);
- Postal services; and
- Transfer from other modes (all speeds above 120 kph).

2.1.1. Transfer from air: market potential

Air freight is – in tonnage terms – very small when compared to the totals for road and sea transport even though it represents an obvious part of the potential market for high speed rail (HSR) freight. The total air cargo market on the seven identified HSR corridors on average is around one truck load per day, and therefore is highly unlikely to ever form a central component for the business case for HSR.

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 be orientated around serving Oslo airport (which is different to but not incompatible with the passenger market based at it is on Oslo Central station). Most of the cargo is carried in scheduled passenger services. Air freight handled at Oslo Airport has been broadly constant over the last 10 years at between 70,000 to 100,000 tonnes per annum, with a peak in 2007 followed by a decline in more recent years. The large majority of air freight is carried on scheduled passenger services – nearly 92% in 2009. As is common in most of Europe, much inter-Europe “air” freight transport is actually transported by road. With 46 airports spread all over Norway, Avinor handles close to 96% of Norwegian air traffic. Avinor report that 43% of air freight arriving at Oslo Airport is transported onwards by road, the rest is transferred to domestic air services. Therefore to compete with air, rail would need to either provide dedicated high speed trains (which are not feasible given the volumes below) or have space within the proposed passenger service. This would mean running all trains via Oslo Airport and having sufficient time and facilities to (un)load trains at those destinations (as well at the terminal stations). Such a transfer would require a shift by freight users in their current logistics arrangements to reduce double handling costs.

Avinor has also provided detailed statistics on the annual freight (mail and air freight) in tonnes between cities most likely to be served by HSR by route, as shown in Table 1. There has been a slight decrease in the total amount of goods from 2007-2009 between all the listed cities but the single 'busiest' connection (Oslo-Gothenburg) has remained constant throughout with a third of the total volume on the selected routes (2,415 tonnes in 2009) but this is equivalent to less than a lorry load per day (based on a 350-day year).

Table 1. Air Freight Traffic on Selected Routes

Routes	Air Freight Tonnes 2007	Air Freight Tonnes 2008	Air Freight Tonnes 2009
Oslo – Gothenburg	3,182	2,975	2,415
Oslo – Bergen	1,786	1,398	1,406
Oslo – Stockholm	1,815	1,401	1,143
Oslo – Stavanger	1,440	1,252	929
Oslo – Trondheim	1,488	1,126	754
Oslo – Kristiansand	494	435	299
Stavanger – Bergen	427	336	277

This means that for high speed freight to succeed it will need to target other markets.

2.1.2. Postal market potential

Posten Norge distributes to roughly two million households and businesses in Norway. 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. 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. Therefore there is likely to be little direct growth from having faster rail services. This is particularly the case in a market where the number of letters is falling.

To a large extent this fall in classic postal volumes is being offset by a growth in non-letter express mail and packages. However this does not present a separate opportunity for rail freight. National post offices are not always considered to be part of the express freight industry, probably due to their special status and historical background as state-owned monopolies, but the services offered by them 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 as their newer services face the same market as their private counterparts. As 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.

Therefore, the market for exclusive postal service is highly unlikely to form a central component for the business case for HSR. This does not mean that HSR will not help retain and strengthen the position of rail as compared to other modes in the longer term. For high speed freight to succeed it will need to target other markets, including express packages.

2.1.3. Transfer from other modes

The initial modelling results for high speed freight on rail indicated that there was little market potential for freight at speeds at or above 200 kph. However, in order to test this, the freight demand models were re-calibrated with a lower assumed speed of 120 kph (compared with a typical speed of closer to 65 kph today). The rail journey speed for the 6 lines goes from 52.9-65.0 kph in the reference case to 120 kph on all 6 lines in the policy case. This has been modelled as a reduction in the time between the rail terminals and within the rail terminal by about 50% (although it could be argued that rail terminal times should not be reduced even though they form a relatively low percentage of the total rail transit times). Apart from this, there is also time required for road transport from origin to first rail terminal and from last rail terminal to destination, so the total reduction in time typically was modelled as between roughly 30% – 45% subject to the route.

The net extra tonnage by route can be seen below in Table 2, with change in freight kilometres in Table 3:

Table 2. Change in Freight Volumes by Corridor

Route (both directions)	Absolute difference with base (tonnes per year)
Oslo-Stockholm	30,024
Oslo-Gothenburg	2,611
Oslo-Stavanger	56,104
Oslo-Bergen	435,739
Oslo-Trondheim	150,720

Table 3. Change in Freight km by Corridor

Route (both directions)	Absolute difference with base (tonne kms per year)
Oslo-Stockholm	17,329,131
Oslo-Gothenburg	869,329
Oslo-Stavanger	29,096,308
Oslo-Bergen	188,294,298
Oslo-Trondheim	86,952,671

Please note that only products typically carried on intermodal services are included above as single commodity, bulk trains (such as iron ore, coal, oil or aggregate) are not capable of sustaining running speeds of 120 kph and therefore will not be able to take direct advantage of the high speed line. The modelling results above also include international traffic where such traffic enters/leaves Norway.

Although these results are presented by route, a national model was used. At the next stage of HSR development a more detailed route model would need to be constructed to test the particular impact of local markets. The national model was calibrated against the national rail tonnage total of around 29,000 million tonnes per annum. Please note though that this total includes all rail freight (including large commodity specific trains) and that the attribution of the tonnage against routes and the growth on those routes was modelled. One example of this can be seen on the Stavanger – Bergen route. Currently all mode traffic volumes are low and rail is zero, as there is no direct route. The modelled result for this route is zero but in reality there would be opportunity for rail freight to capture a very high percentage of the freight between these destinations, but only if an aggregator was willing to price at lower than below the total cost savings in order to effectively corner a niche market. In assessment terms therefore the total (tonnes and tonne kms), as shown in Table 4, are more significant than indicated by the results per route.

Table 4. Total Change in Freight per Year

All routes (both directions)	Absolute difference with base
Tonnes per year	675,217 tonnes
Tonne kms per year	c.335,540,000 tonne kms

These numbers compare with the following tonnes in the base as per Table 5. The same need to use the total tonnage rather than the tonnages disaggregated by route also applies, although the disaggregated results are also shown for information:

Table 5. Base Freight Volumes per Year

Route (both directions)	Base tonne kms year
Oslo-Stockholm	2,963 tonnes
Oslo-Gothenburg	0 tonnes
Oslo-Stavanger	470,514 tonnes
Oslo-Bergen	579,952 tonnes
Oslo-Trondheim	171,337 tonnes
Total	1,224,496 tonnes

From the difference between the “Tonnes per year” in Table 4 above and the “Total” in the Base Freight Volumes per Year in Table 5 we can see that the reduction in running times (direct and indirect) therefore generates a 55% increase in total tonnes across all corridors. This appears to be high but is on a low base and equates to only 2,000 tonnes per day. On the single busiest route this equals 1,244 tonnes per day (on 350 days per year) – which equates to about three trains per day carrying less than a full trailing load. One of the problems for rail freight is that on some routes rail already enjoys a very high market share, subject to the definition used. For example, up to 60% of freight on the corridors between Oslo and Bergen and Oslo and Trondheim is transported by rail.

As a result of the reduction in speeds, rail freight operating costs fall. This is made possible by the improved utilisation of the rolling stock (locomotives, wagons, and on-vehicle staff). In this model the total rail costs have been assumed to fall by between 22% and 29% depending on the route, which is lower than the reduction in running times. A 35% - 45 % reduction in running times does not relate to a 35% - 45% reduction in costs because not all asset types are time proportional – i.e. the amount of energy used (if anything) slightly increases with faster trains.

In this model the total reduction in costs (direct and indirect) to end users is between 2.2% and 2.9%. This is lower than the 22% - 29% reduction in rail haulage costs because the vast majority of the total costs on intermodal carriage by rail are not rail related.

In this model it was assumed that 100% of the cost savings have assumed to be passed to the client. It might be argued that some should be paid to those funding the high speed infrastructure for extra costs that would be incurred from the construction of the new rail line. This issue is significant as running freight trains on the high speed line will have a negative infrastructure cost impact. Freight trains will require:

- Extra infrastructure (mainly passing loops) over and above that required for the regulation with local passenger services to allow freight trains to be regulated with high speed passenger trains;
- Extra maintenance to repair the wear caused by freight trains which because of the high axle weights will be greater per train than for passenger trains (and particularly expensive because of the high inspection and high ride quality required for passenger trains); and
- Earlier requirement for renewal of infrastructure. These costs have not been quantified at this stage but may need to be in any further work.

No increase in reliability was assumed. This is because at this stage in the project, particularly while the use of the residual lines remains unclear, no metric for changes to the reliability of freight traffic can be reasonably calculated particularly on a multi-corridor level. However, one of the key findings of the consultation exercise below was that reliability was perceived to be more important than speed. Therefore if there is a further phase of development and should more detailed route specific freight forecast modelling be required it is recommended that this factor is included.

More detail on the modelling results can be found in Appendix A.

3. Consultation

Two separate consultation exercises were undertaken, firstly for HSR freight and secondly for fast freight. In addition the results from previous, more detailed, consultations were used to calibrate the demand model.

The key responses from the first consultation were:

- For many freight integrators an early morning delivery is essential (i.e. overnight haulage);
- Reliable delivery times are important;
- The shippers typically rated the probability of transfer of some freight to HSR freight at 50-60%;
- The tonnages and products carried by the individual freight integrators vary significantly;
- 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;
- There is a reluctance to pay a premium for HSR freight trains, with the exception of freight moving from air; and
- Most shippers were happy with their existing arrangements.

The key responses from the second consultation were:

- Two of the three potential users of fast rail freight services (carrier/forwarder/shipper) that we interviewed positive that they would use it for some of their traffic;
- However, should the infrastructure have to be paid for with premium pricing then the market potential would be severely reduced;
- The markets with greatest potential are for containers and rail carrying road trailers;
- All of the three operators interviewed argued that the model assumptions that costs would fall are ambitious and that cost increase in maintenance, power and personnel would outweigh the savings from increased asset utilisation; and
- Although this may be market positioning there must remain a significant risk against the forecast increase in freight.

The results from the two separate consultations, therefore, are compatible. They also match a more detailed study from Sweden, used to calibrate the model, which also emphasised the relative importance of reliability and price over speed. Critically the consultation responses are compatible with the modelling results and therefore reinforce the overall conclusions.

In summary this means that whilst high speed has a perceived benefit, it does not address the main concern of the rail freight industry. However, it is worth noting that if the high speed lines result in long distance passenger services being displaced from the existing network that this would could benefit the existing rail freight market by freeing capacity. This would in turn improve reliability, possibly allow for overnight services and potentially lead a different maintenance regime (with a different, potentially lower, cost base).

More detail on the results of the second consultation can be found in Appendix B. More detail on the results of the first consultation can be found in the freight report contained within the Phase II suite of documents published by JBV.

4. International Experience

In order to check the modelling and the consultation experience, a survey was undertaken of international case studies. A number of examples of successful and unsuccessful HSR/fast freight were identified. The most successful included:

- 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.

It is worth noting, however, that TGV La Poste has recently reduced the frequency of its services, due to falling postal volumes, and a recent TGV Fret initiative has not been developed, apparently due to lack of interest from other potential users.

On a more positive note, other relevant initiatives such as the air/rail freight proposals from Euro-Carex and Air Cargo Express, have been launched to try to set up rail services to carry express and freight shipments between major European airports. These are typically based on using converted or modified passenger rolling stock. The prospects for diverting express and freight shipments in Europe from air and road transport to more environmentally-friendly HSR services are therefore promising at a macro level. However these services remain largely aspirational as they have been caught up in financial and political problems. There are therefore no reasons why fast rail freight services would not be technically feasible; but the prospect of commercial success, particularly for dedicated HSR freight trains, remains elusive and nowhere in Europe has the construction of high speed passenger lines been accompanied by a significant growth in higher speed rail freight traffic.

It is worth noting that with the exception of the older German high speed lines, most new continental European high speed lines have been specifically designed with the intention that freight will *not* be carried, although freight benefits from the new construction because paths are freed for freight on the conventional network. The UK Channel Tunnel Rail Link , now renamed High Speed 1 (HS1), was 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 existing HSR lines, with the exception of France, where some TGVs converted for postal service operate on the TGV network.

It is also worth noting that as the speed for freight increases, the applicability of the physical constraints usually applied to the carriage of freight are reduced. The TGV Poste and other higher speed freight trains are typically operated by trains with operational characteristics similar to passenger trains and therefore are not constrained from passenger routes on operational grounds. Some of the innovative services in Sweden and across Europe use other passenger trains converted for freight traffic. They are able to do so because the freight market that requires the fastest transit time typically is light and premium priced. European experience would suggest therefore that fast freight using passenger converted trains will not be automatically precluded should any lines be designed for passenger (i.e. non-conventional freight) only use. Even intermodal trains (whether containers or pallets in a curtain-sider) can be light loaded to overcome vertical gradient constraints.

In summary, therefore, an international comparison would seem reinforce the conclusions of the modelling and the consultation exercise; that there is a potential market for higher speed freight on freight lines but that the business case has proved difficult to sustain.

5. Summary and Issues

5.1.1. Limitations of the model

It is worth noting that in this report the modelling has been undertaken on a macro level. Most rail freight, even intermodal rail freight, is route sensitive. The modelling used the National Norwegian Freight Model. Whilst this gives a national result it is clear that there are significant variances between routes. Using a national model is the only practical option when the number of alternatives is large, as it has been for this phase of the study. Should there need to be a further phase of work it is recommended that freight modelling be undertaken on a route specific basis and also examine the potential impact of a range of changes in market conditions into the future.

5.1.2. Summary

In summary, there seems to be some potential for freight to be switched to rail through the construction of HSR. This is despite the relatively high current levels of rail freight in Norway when compared with other modes, even though not high in absolute terms.

Whilst some higher speed rail freight traffic will be generated by the construction of a high speed line, the absolute number of freight trains is likely to be low. However, the indirect impact on the potential for conventional rail freight (or even higher speed rail freight) on the existing network could be at least as significant.

The modelling, consultation exercise and survey of international experience were compatible and all had similar conclusions; that is, whilst there is a potential market for higher speed rail freight, there is no evidence that rail freight will pay for the high speed line through premium pricing, or be anything more than a small component of the main passenger high speed business case. In order to construct a business case for freight the incremental costs would need to be evaluated. This will be better undertaken at the next phase of work, where the costs can be route specific and the potential freight flows understood in more detail, accounting for changes in future conditions that might affect market response.

5.1.3. Opportunity for optimisation

Other key issues are the fit of rail freight with the design of the high speed alignment, the need for renewals and the use of the residual network. On the Østerdalen alternative, over the steepest section of track, freight uses the existing line which diverts from the direct route proposed for the high speed passenger trains. This allows a steeper gradient to be used for the high speed line, avoiding significant cost. Examination of whether there are more examples of this type of opportunity may be worth considering in any future phase of work.

Perhaps more significant is the opportunity afforded to freight on the residual lines. If some existing passenger services are diverted from the existing lines to the high speed line there will be an opportunity to use the capacity released to run more freight trains and/or run the existing freight traffic faster/more reliably.

Finally, the addition of freight traffic on the high speed line will have an impact not only on the design of the lines themselves but also on their maintenance and renewal (even if mitigated by the use of converted passenger vehicles). Therefore, the concentration of freight on the residual lines either for sections (as per the Østerdalen alternative) or for longer sections should be considered.

Appendices

Appendix A. Outcomes of model runs on the demand for faster freight trains in Norway

A.1. Background

This appendix describes the outcomes of further runs with the Norwegian freight transport model, concerning the likely demand in Norway for freight trains (container and wagonload) that run at 120 km/hour. At the end of this appendix we draw conclusions on the basis of both the outcomes of the model runs and the outcomes of the interviews with firms on fast train services in Norway, as reported in our memo 1 in this same project.

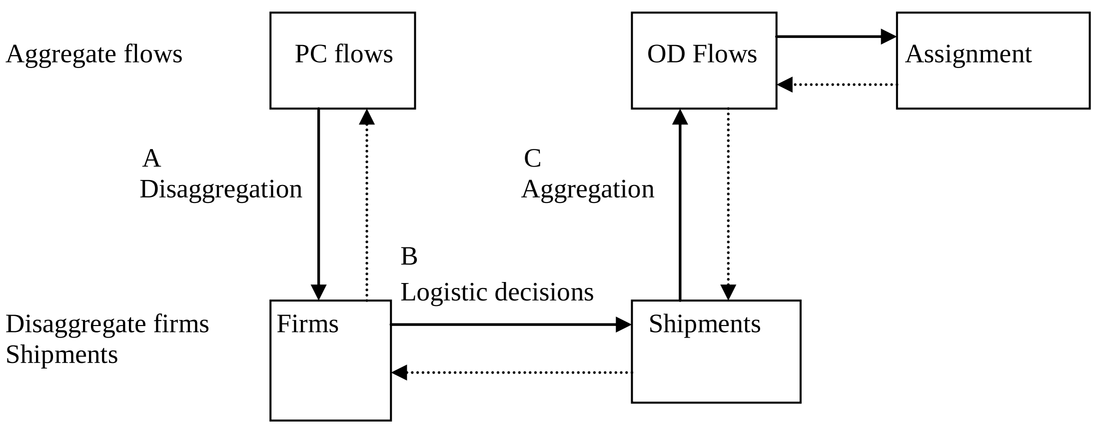
A.2. Description of the transport model used

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.

A.2.1. 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 1 is a schematic representation of the structure of the freight model system. The boxes indicate model components. The top level of Figure 1 displays the aggregate models. Disaggregate models are at the bottom level.

Figure 1. ADA 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 are 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 the imports and exports of Norway.

A.2.2. 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:

$$G_{rskmnql} = O_{kq} + T_{rskql} + D_k + Y_{rskl} + I_{kq} + K_{kq} \qquad (1)$$

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, eight types of train and two types of aeroplane. The eight 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 two types of aeroplane are:

- Medium sized freight plane
- Large freight plane

A.2.3. 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 two types of aircraft) that is available in the module for the choice of shipment size and transport chain. The model contains six transport chains that include air transport, all of them combinations of road and air transport. It also has seven 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.

A.2.4. 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-kilometres, vehicles by commodity and mode or vehicle type (per year), as well as OD matrices of tonnes or vehicles by vehicle type (also per year).

A.3. Model runs carried out

Significance performed runs with the same version of the Norwegian national freight transport model as used for the earlier runs for 160 and 200 km/hour. In this follow-up study, the following runs were carried out:

- 120 km/hour on the line Bergen-Oslo (for container and wagonload freight transport), and current speeds on all other lines;
- 120 km/our on the line Gothenburg-Oslo (for container and wagonload freight transport), and current speeds on all other lines;
- 120 km/our on the line Bergen-Stavanger (for container and wagonload freight transport), and current speeds on all other lines;
- 120 km/our on the line Stavanger-Oslo (for container and wagonload freight transport), and current speeds on all other lines;
- 120 km/our on the line Stockholm-Oslo (for container and wagonload freight transport), and current speeds on all other lines;
- 120 km/hour on the line Trondheim-Oslo (for container and wagonload freight transport), and current speeds on all other lines; and
- Reference case (base): current speeds on all lines.

The reduction in rail transport time in the model will reduce the time-dependent transport costs (related to staff, vehicles) for rail as well as the capital costs for goods during transit (see eq. 1), but not the distance-dependent rail transport costs.

For all the above variants, we calculated the number of tonnes and tonne-km transported by rail and other modes per commodity type in total and by city pair. This can be compared to the reference situation (all lines at current speed), for which we did a new run as well (it gave the same results as before).

A.4. Model outcomes for all Norwegian freight transport

Table 6 below gives the tonnes and tonne-kilometres (tkm) per year for the total goods flows by mode in/to/from Norway, compared to the reference case. The numbers in this table therefore refer to the changes in the transport volumes, brought about by the speed increase on some line. A value of 0 means that for this cell the faster trains do not lead to any changes: the amount of transport by some mode (at the national scale) stays exactly the same. This is what we observe when the line Bergen-Stavanger is speeded up: this does not lead to any additional rail transport. Also speeding up the line Oslo-Gothenburg hardly leads to any noticeable changes in the overall modal split.

The scenario that gives the biggest increase in total rail tonnage is when Trondheim-Oslo would become 120 km/hr, followed by Bergen-Oslo. In these cases road transport does not loose tonnes, because a shift from road only transport to road-rail-road transport chains increases the number of tonnes lifted unto lorries. The road distances (tkm, also vehice kilometres) however will decrease as we see in the bottom half of Table 1. For the Bergen-Oslo at 120 km/hour case, the number of tkm by rail goes down, in spite of the speeding up of rail transport. This is possible because of a shift from longer train routes to the Bergen-Oslo line, which on average is a shorter distance.

The relative changes in the number of tonnes or tkm by mode in total Norwegian freight transport are very small. The biggest changes occur when the railway line Trondheim-Oslo would be speeded up, but this increases the number of tonnes transported by rail in Norway by only 0.5% and the tonne kilometres by rail in Norway by only 0.4%. For Trondheim-Oslo and Bergen-Oslo road transport tkm decreases by between -0.1 and -0.2%. For speeding up the other lines, the impacts on total road transport are even smaller. So at the national scale, even the lines that attract the largest demand, only witness very small rail market increases and even smaller reductions in the use of road transport.

In Annex 1 are the tables that are similar to Table 1, but now by commodity group. We only present results here for commodity groups where the model leads to changes in the tonnes or tkm by mode. Many commodities are not included in these tables because the transport of these commodities is not affected at all by the introduction of fast trains. The main changes take place for consumption food and various sorts of general cargo.

Table 6. Outcomes for all freight transport in/to/from Norway, by mode

Total	Absolute difference with base					Relative difference with base				
	10^3 Tonnes per year					10^3 Tonnes per year				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	113	0	110	0	**223**	0.03%	0.00%	0.38%	0.00%	**0.03%**
Gothenburg-Oslo	-1	0	1	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	40	0	38	0	**78**	0.01%	0.00%	0.13%	0.00%	**0.01%**
Stockholm-Oslo	0	0	25	0	**25**	0.00%	0.00%	0.09%	0.00%	**0.00%**
Trondheim-Oslo	139	-2	136	0	**273**	0.04%	0.00%	0.47%	0.00%	**0.03%**
	10^3 TonneKms per year					10^3 TonneKms per year				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-52,173	69,966	-12,546	0	**5,247**	-0.16%	0.01%	-0.06%	0.00%	**0.00%**
Gothenburg-Oslo	613	60	773	0	**1,446**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	124	0	-490	0	**-366**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-15,780	0	19,336	0	**3,556**	-0.05%	0.00%	0.09%	0.00%	**0.00%**
Stockholm-Oslo	-11,711	0	13,537	0	**1,826**	-0.04%	0.00%	0.07%	0.00%	**0.00%**
Trondheim-Oslo	-57,686	-26,849	73,325	0	**-11,210**	-0.18%	0.00%	0.36%	0.00%	**0.00%**

A.5. Model outcomes for the city pairs

In 0 are results for each specific scenario (speeding up the railway line between two cities) for the changes in tonnes and tkm by mode in the flows between those specific two cities. We are thus looking at the same scenarios as in Table 6, but now we investigate not the effects on the whole country, but only for the transport flows in the corridor where rail transport is improved.

Table 7. Outcomes for city pairs where speeding up of rail takes place, by mode

OD (both directions)	Absolute difference with base				Relative difference with base			
Total	Tonnes per year				Tonnes per year			
Scenario	Lorry	Sea	Rail	Total	Lorry	Sea	Rail	Total
Oslo-Stockholm	-8,344	0	30,024	**21,680**	-18.82%	0.00%	1114.86%	**37.56%**
Oslo-Gothenburg	-170	0	2,611	**2,441**	-0.14%	0.00%	0.00%	**0.43%**
Oslo-Stavanger	-5,281	0	56,104	**50,823**	-3.23%	0.00%	11.92%	**7.10%**
Oslo-Bergen	-56,366	0	435,739	**379,373**	-13.22%	0.00%	75.13%	**17.09%**
Oslo-Trondheim	-41,479	0	150,720	**109,241**	-5.91%	0.00%	87.97%	**12.30%**
Bergen-Stavanger	0	0	0	**0**	0.00%	0.00%	0.00%	**0.00%**
	TonneKms per year				TonneKms per year			
Scenario	Lorry	Sea	Rail	Total	Lorry	Sea	Rail	Total
Oslo-Stockholm	-4,303,386	0	17,329,131	**13,025,746**	-18.76%	0.00%	1122.48%	**32.78%**
Oslo-Gothenburg	-52,942	0	869,329	**816,386**	-0.14%	0.00%	0.00%	**0.48%**
Oslo-Stavanger	-2,908,988	0	29,096,308	**26,187,320**	-3.24%	0.00%	11.94%	**7.01%**
Oslo-Bergen	-27,936,491	0	188,294,298	**160,357,807**	-13.29%	0.00%	75.49%	**12.98%**
Oslo-Trondheim	-20,342,613	0	86,952,671	**66,610,058**	-5.91%	0.00%	87.84%	**14.47%**
Bergen-Stavanger	0	0	0	**0**	0.00%	0.00%	0.00%	**0.00%**

For the city-pair relations the changes brought about by the faster train services can be more substantial than at the national scale. The biggest absolute gain (compared to the reference case) both in tonnes and in tkm takes place on the Oslo-Bergen line, with Oslo-Trondheim coming second at a considerable distance. Only a minor part of this is substitution away from road transport and sea transport is hardly affected. Most of the growth on the faster lines comes from other rail connections. In relative terms, the gain for Oslo-Trondheim is bigger than for Oslo-Bergen (and even larger for Oslo-Stockholm, but here the reference volumes are very small).

In Appendix 2 are similar tables, but now by commodity group. We only present results for commodity groups where non-zero changes take place relative to the reference case. We find that the main changes take place for the same commodity groups as discussed in section 4.

A.6. Summary and conclusions

The Norwegian national freight transport model was used to evaluate six different scenarios, in each of which a specific railway line between two cities in Norway (or Sweden) was upgraded to have an operating speed of 120 km/hour (and speeds on all other lines remained the same). The outcomes of these model runs in terms of tonnes and tonne-kilometres by mode were compared against those of the reference scenario, without any speeding up of rail services.

A.6.1. Model outcomes at the national level

We find that at the national level, the changes that result from the faster trains are quite small. This is consistent with earlier runs for high speed trains running at 160 or 200 km/hour, where we also simulated high speeds on all six lines simultaneously (even this did not lead to a large decrease in road transport tonne-kilometres).

There are several reasons why at this national level (all freight transport in/to/from Norway), higher speeds for rail only have a very small impact on total rail transport tonnes and tonne-kilometres and on the modal split :

- For some city pairs the total freight market (all modes) is small: this is the case (according to the model) for Oslo-Stockholm, Stavanger-Bergen, and Oslo-Stavanger;
- For some the total market is not small, but the current rail market share is (road transport is dominant), and very large changes of the rail market share would be required to make a difference at the national scale. This is the case for Oslo-Gothenburg, but for many commodity types there is no rail transport between any of the cities studied at all (sometimes also because of a non-existing or small total market for that commodity for some city pair); and
- The response to faster trains in terms of shift from other modes to rail is quite modest. In several studies the influence of the factor transport time for users or potential users of rail transport (even if not system trains for heavy bulks, but container and wagonload train are considered) has been found to be relatively small. In the interviews with firms in this project (see memo 1) we also found that the most important decision-factors in freight mode choice are cost and transport time reliability. Transport time itself landed in third place. Improvements in costs and reliability are potentially more effective. This third explanation is relevant for all city pairs studied.

The last argument above also has to do with the fact that higher operating speeds for trains often do not lead to short lead times. This happens because:

- There is a need for (road) transport from the sender to a railway terminal and from another railway terminal to the receiver, as well as of at least two additional transhipments (except for firms with their own rail sidings);
- There may be considerable time involved in shunting and marshalling and waiting at railway terminals;
- Rail transport often uses the system of overnight deliveries, where the time available for rail transport ranges up to one night and faster than a full night transport does not really pay off; and
- Passenger trains often get priority over freight trains (which also is a reason for operating freight trains during the night, when there are fewer passenger trains).

A.6.2. Model outcomes at the local/regional level

At the local/regional scale, we do see substantial effects for some of the city pairs (notably Oslo-Bergen and Oslo-Trondheim). The same two relations are mentioned most often as most attractive in the interviews (see memo 1), together with Oslo-Stavanger. The faster train services on a particular line lead to considerable regional shifts within the train system. Also at this level, the impact on other modes, such as road transport is very limited.

Model outcomes at both spatial levels and interviews outcomes; Both the model runs and the interviews carried out (see memo 1) indicate that the commodity types that will be most affected are food products and possibly also general cargo.

Now that we have carried out model runs for high speeds (160 and 200 km/hour) and fast train (120 km/hour) on six corridors in Norway (partly also in Sweden), as well as interviews on fast trains with firms supplying or using rail services in Norway, we can conclude that even large increases in rail speeds have a limited impact on total rail use and on the modal split. Many of the relevant markets are quite small in terms of the number of tonnes transported. On other markets road transport is highly dominant. Increasing rail speeds may not be the most effective way to compete with road transport. Where rail has a competitive advantage, it is on costs and on being able to offer a large capacity. The most important decision factors for mode choice in freight transport markets where rail has a potential are transport costs (here rail often is less expensive than road transport) and reliability of transport time (here road transport often scores considerable better than rail, although road congestion is increasing).

A.6.3. Further recommendations

That said, a number of the firms interviewed in this project expressed concerns regarding the existing rail capacity constraints and perceived poor train service reliability in Norway. One can therefore argue that if some passenger services were shifted to a new high speed line (and the capacity freed up by that shift was not filled by new passenger services) that there should be an opportunity to increase freight performance and capacity, and this should in turn deliver incremental market growth. Such an approach would more closely match the responses of the firms/organisations that were consulted than raising the train speeds to 120 km/hour or more.

Appendix A1: Outcomes for all freight transport in/to/from Norway by mode and commodity group

(results for commodity groups only presented where differences relative to the reference case occur)

Consumption food	**Absolute difference with base**					**Relative difference with base**				
	10^3 Tonnes					**10^3 Tonnes**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	25	0	25	0	**50**	0.76%	0.00%	9.80%	0.00%	**1.34%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	23	0	23	0	**46**	0.70%	0.00%	9.02%	0.00%	**1.23%**
Stockholm-Oslo	0	0	2	0	**2**	0.00%	0.00%	0.78%	0.00%	**0.05%**
Trondheim-Oslo	16	0	16	0	**32**	0.49%	0.00%	6.27%	0.00%	**0.86%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-11,416	0	10,538	0	**-878**	-1.92%	0.00%	3.24%	0.00%	**-0.06%**
Gothenburg-Oslo	56	0	-197	0	**-141**	0.01%	0.00%	-0.06%	0.00%	**-0.01%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-11,051	0	11,582	0	**531**	-1.86%	0.00%	3.56%	0.00%	**0.03%**
Stockholm-Oslo	-724	0	811	0	**87**	-0.12%	0.00%	0.25%	0.00%	**0.01%**
Trondheim-Oslo	-7,143	0	8,372	0	**1,229**	-1.20%	0.00%	2.57%	0.00%	**0.08%**

Frozen fish	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	Lorry	Sea	Rail	Air	Total	Lorry	Sea	Rail	Air	Total
Bergen-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
	10^3 TonneKms					10^3 TonneKms				
Scenario	Lorry	Sea	Rail	Air	Total	Lorry	Sea	Rail	Air	Total
Bergen-Oslo	-57	10	-120	0	**-167**	-0.01%	0.00%	-0.02%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**

Other fish	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	0	0	-1	0	**-1**	0.00%	0.00%	-0.17%	0.00%	**-0.03%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-172	3,342	-2,742	0	**428**	-0.03%	0.27%	-0.29%	0.00%	**0.02%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-48	0	47	0	**-1**	-0.01%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**

Machinery and equipment	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	5	0	3	0	**8**	0.13%	0.00%	1.49%	0.00%	**0.19%**
Gothenburg-Oslo	-1	0	1	0	**0**	-0.03%	0.00%	0.50%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	2	0	0	0	**2**	0.05%	0.00%	0.00%	0.00%	**0.05%**
Stockholm-Oslo	-1	0	0	0	**-1**	-0.03%	0.00%	0.00%	0.00%	**-0.02%**
Trondheim-Oslo	4	-2	1	0	**3**	0.11%	-1.32%	0.50%	0.00%	**0.07%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-121	0	759	0	**638**	-0.01%	0.00%	0.24%	0.00%	**0.01%**
Gothenburg-Oslo	557	60	970	0	**1,587**	0.03%	0.00%	0.31%	0.00%	**0.04%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	1,633	0	-1,029	0	**604**	0.09%	0.00%	-0.33%	0.00%	**0.01%**
Stockholm-Oslo	215	0	-246	0	**-31**	0.01%	0.00%	-0.08%	0.00%	**0.00%**
Trondheim-Oslo	3,648	-26,845	-946	0	**-24,143**	0.20%	-1.21%	-0.30%	0.00%	**-0.55%**

General cargo: high value goods	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	0	0	1	0	**1**	0.00%	0.00%	100.00%	0.00%	**0.14%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	1	0	2	0	**3**	0.14%	0.00%	200.00%	0.00%	**0.41%**
Stockholm-Oslo	0	0	1	0	**1**	0.00%	0.00%	100.00%	0.00%	**0.14%**
Trondheim-Oslo	1	0	2	0	**3**	0.14%	0.00%	200.00%	0.00%	**0.41%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-264	0	246	0	**-18**	-0.07%	0.00%	26.89%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-413	0	891	0	**478**	-0.11%	0.00%	97.38%	0.00%	**0.11%**
Stockholm-Oslo	-264	0	313	0	**49**	-0.07%	0.00%	34.21%	0.00%	**0.01%**
Trondheim-Oslo	-683	0	820	0	**137**	-0.19%	0.00%	89.62%	0.00%	**0.03%**

General cargo: building materials	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	1	0	1	0	**2**	0.01%	0.00%	0.08%	0.00%	**0.02%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	2	0	1	0	**3**	0.02%	0.00%	0.08%	0.00%	**0.02%**
Stockholm-Oslo	0	0	8	0	**8**	0.00%	0.00%	0.63%	0.00%	**0.06%**
Trondheim-Oslo	40	0	40	0	**80**	0.36%	0.00%	3.15%	0.00%	**0.63%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-406	-2	507	0	**99**	-0.04%	0.00%	0.03%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-626	0	871	0	**245**	-0.06%	0.00%	0.05%	0.00%	**0.01%**
Stockholm-Oslo	-4,289	0	4,915	0	**626**	-0.41%	0.00%	0.29%	0.00%	**0.02%**
Trondheim-Oslo	-19,216	0	23,224	0	**4,008**	-1.82%	0.00%	1.38%	0.00%	**0.12%**

General cargo: other inputs	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	Lorry	Sea	Rail	Air	Total	Lorry	Sea	Rail	Air	Total
Bergen-Oslo	1	0	1	0	**2**	0.02%	0.00%	0.08%	0.00%	**0.03%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	1	0	0	0	**1**	0.02%	0.00%	0.00%	0.00%	**0.01%**
Trondheim-Oslo	5	0	4	0	**9**	0.11%	0.00%	0.34%	0.00%	**0.13%**
	10^3 TonneKms					10^3 TonneKms				
Scenario	Lorry	Sea	Rail	Air	Total	Lorry	Sea	Rail	Air	Total
Bergen-Oslo	-81	66,147	-54,932	0	**11,134**	-0.02%	5.84%	-6.37%	0.00%	**0.47%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	124	0	-490	0	**-366**	0.03%	0.00%	-0.06%	0.00%	**-0.02%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	-65	0	107	0	**42**	-0.02%	0.00%	0.01%	0.00%	**0.00%**
Trondheim-Oslo	-1,692	-4	2,042	0	**346**	-0.43%	0.00%	0.24%	0.00%	**0.01%**

General cargo: consumption goods	**Absolute difference with base**					**Relative difference with base**				
	10^3 Tonnes					**10^3 Tonnes**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	50	0	47	0	**97**	0.40%	0.00%	1.41%	0.00%	**0.53%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	7	0	8	0	**15**	0.06%	0.00%	0.24%	0.00%	**0.08%**
Stockholm-Oslo	-1	0	9	0	**8**	-0.01%	0.00%	0.27%	0.00%	**0.04%**
Trondheim-Oslo	36	0	36	0	**72**	0.29%	0.00%	1.08%	0.00%	**0.39%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-25,117	469	19,507	0	**-5,141**	-1.77%	0.01%	0.63%	0.00%	**-0.05%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-3,489	0	4,441	0	**952**	-0.25%	0.00%	0.14%	0.00%	**0.01%**
Stockholm-Oslo	-4,259	0	4,928	0	**669**	-0.30%	0.00%	0.16%	0.00%	**0.01%**
Trondheim-Oslo	-17,204	0	21,011	0	**3,807**	-1.21%	0.00%	0.68%	0.00%	**0.04%**

Paper intermediates	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	1	0	0	0	**1**	0.02%	0.00%	0.00%	0.00%	**0.02%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	4	0	3	0	**7**	0.10%	0.00%	0.21%	0.00%	**0.11%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-9	0	8	0	**-1**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-257	0	351	0	**94**	-0.07%	0.00%	0.02%	0.00%	**0.00%**
Stockholm-Oslo	31	0	-32	0	**-1**	0.01%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	-1,612	0	1,971	0	**359**	-0.46%	0.00%	0.10%	0.00%	**0.01%**

Wood products	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	2	0	3	0	**5**	0.02%	0.00%	0.17%	0.00%	**0.03%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	3	0	3	0	**6**	0.02%	0.00%	0.17%	0.00%	**0.04%**
Stockholm-Oslo	1	0	4	0	**5**	0.01%	0.00%	0.23%	0.00%	**0.03%**
Trondheim-Oslo	26	0	27	0	**53**	0.21%	0.00%	1.53%	0.00%	**0.36%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-932	0	1,056	0	**124**	-0.05%	0.00%	0.05%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-1,074	0	1,545	0	**471**	-0.06%	0.00%	0.07%	0.00%	**0.01%**
Stockholm-Oslo	-1,938	0	2,219	0	**281**	-0.11%	0.00%	0.10%	0.00%	**0.00%**
Trondheim-Oslo	-12,729	0	15,158	0	**2,429**	-0.74%	0.00%	0.71%	0.00%	**0.04%**

Paper products	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	0	0	1	0	**1**	0.00%	0.00%	1.82%	0.00%	**0.04%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	1	0	1	0	**2**	0.04%	0.00%	1.82%	0.00%	**0.09%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	3	0	3	0	**6**	0.13%	0.00%	5.45%	0.00%	**0.26%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-49	0	44	0	**-5**	-0.01%	0.00%	0.07%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-420	0	498	0	**78**	-0.07%	0.00%	0.80%	0.00%	**0.01%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	397	0	-85	0	**312**	0.07%	0.00%	-0.14%	0.00%	**0.05%**

Metals and metal goods	Absolute difference with base					Relative difference with base				
	10^3 Tonnes					10^3 Tonnes				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	14	0	14	0	**28**	0.23%	0.00%	0.67%	0.00%	**0.25%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	0	0	1	0	**1**	0.00%	0.00%	0.05%	0.00%	**0.01%**
Trondheim-Oslo	2	0	2	0	**4**	0.03%	0.00%	0.10%	0.00%	**0.04%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-6,716	0	6,166	0	**-550**	-1.17%	0.00%	0.20%	0.00%	**0.00%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	-35	0	139	0	**104**	-0.01%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	-418	0	522	0	**104**	-0.07%	0.00%	0.02%	0.00%	**0.00%**
Trondheim-Oslo	-717	0	880	0	**163**	-0.12%	0.00%	0.03%	0.00%	**0.00%**

Aluminium	**Absolute difference with base**					**Relative difference with base**				
	10^3 Tonnes					**10^3 Tonnes**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	15	0	15	0	**30**	0.58%	0.00%	2.07%	0.00%	**0.63%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	2	0	2	0	**4**	0.08%	0.00%	0.28%	0.00%	**0.08%**
	10^3 TonneKms					**10^3 TonneKms**				
Scenario	**Lorry**	**Sea**	**Rail**	**Air**	**Total**	**Lorry**	**Sea**	**Rail**	**Air**	**Total**
Bergen-Oslo	-6,833	0	6,417	0	**-416**	-1.84%	0.00%	0.41%	0.00%	**-0.01%**
Gothenburg-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Bergen-Stavanger	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stavanger-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Stockholm-Oslo	0	0	0	0	**0**	0.00%	0.00%	0.00%	0.00%	**0.00%**
Trondheim-Oslo	-735	0	878	0	**143**	-0.20%	0.00%	0.06%	0.00%	**0.00%**

Appendix A2: Outcomes for city pairs where speeding up of rail takes place, by mode and commodity group

(results for commodity groups only shown where differences relative to the reference case occur)

OD (both directions)	**Absolute difference with base**				**Relative difference with base**			
Consumption food	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-903	0	1,457	**554**	-19%	0%	0%	**12%**
Oslo-Gothenburg	0	0	147	**147**	0%	0%	0%	**3%**
Oslo-Stavanger	-4,579	0	23,540	**18,961**	-8%	0%	201%	**27%**
Oslo-Bergen	-9,639	0	25,839	**16,200**	-10%	0%	244%	**15%**
Oslo-Trondheim	-6,820	0	16,060	**9,240**	-4%	0%	37168%	**5%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-467,881	0	841,295	**373,414**	-19%	0%	0%	**15%**
Oslo-Gothenburg	0	0	49,042	**49,042**	0%	0%	0%	**3%**
Oslo-Stavanger	-2,525,078	0	12,208,086	**9,683,008**	-8%	0%	201%	**25%**
Oslo-Bergen	-4,756,666	0	10,950,061	**6,193,395**	-10%	0%	248%	**12%**
Oslo-Trondheim	-3,361,772	0	9,283,965	**5,922,193**	-4%	0%	37471%	**7%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
Other fish	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	-90	0	90	**0**	-17%	0%	14%	**0%**
Oslo-Bergen	-327	0	13,696	**13,369**	-21%	0%	0%	**860%**
Oslo-Trondheim	0	0	0	**0**	0%	0%	0%	**0%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	-48,249	0	46,400	**-1,849**	-17%	0%	14%	**0%**
Oslo-Bergen	-155,279	0	5,953,385	**5,798,106**	-21%	0%	0%	**786%**
Oslo-Trondheim	0	0	0	**0**	0%	0%	0%	**0%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
Machinery and equipment	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	1,827	**1,827**	0%	0%	0%	**41%**
Oslo-Gothenburg	-170	0	2,464	**2,294**	0%	0%	0%	**5%**
Oslo-Stavanger	0	0	2,239	**2,239**	0%	0%	0%	**74%**
Oslo-Bergen	0	0	5,069	**5,069**	0%	0%	0%	**9%**
Oslo-Trondheim	0	0	6,543	**6,543**	0%	0%	0%	**41%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	1,057,083	**1,057,083**	0%	0%	0%	**46%**
Oslo-Gothenburg	-52,942	0	820,287	**767,345**	0%	0%	0%	**6%**
Oslo-Stavanger	0	0	1,164,007	**1,164,007**	0%	0%	0%	**69%**
Oslo-Bergen	0	0	2,121,955	**2,121,955**	0%	0%	0%	**8%**
Oslo-Trondheim	0	0	3,769,384	**3,769,384**	0%	0%	0%	**48%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
General cargo: high value goods	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	538	**538**	0%	0%	0%	**67%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	1,720	**1,720**	0%	0%	0%	**28%**
Oslo-Bergen	0	0	594	**594**	0%	0%	0%	**18%**
Oslo-Trondheim	0	0	1,429	**1,429**	0%	0%	0%	**94%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	312,897	**312,897**	0%	0%	0%	**76%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	890,476	**890,476**	0%	0%	0%	**26%**
Oslo-Bergen	0	0	245,577	**245,577**	0%	0%	0%	**15%**
Oslo-Trondheim	0	0	820,239	**820,239**	0%	0%	0%	**110%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
General cargo: building materials	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-198	0	10,815	**10,617**	-100%	0%	0%	**5363%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	-1	0	3,507	**3,506**	-9%	0%	6%	**6%**
Oslo-Bergen	0	0	1,332	**1,332**	0%	0%	1127%	**1127%**
Oslo-Trondheim	-9,534	0	40,431	**30,897**	-29%	0%	121%	**47%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-102,754	0	6,282,476	**6,179,721**	-100%	0%	0%	**6014%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	-741	0	1,817,012	**1,816,271**	-9%	0%	6%	**6%**
Oslo-Bergen	0	0	581,063	**581,063**	0%	0%	1163%	**1163%**
Oslo-Trondheim	-4,676,160	0	23,460,638	**18,784,478**	-30%	0%	122%	**54%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	**Absolute difference with base**				**Relative difference with base**			
General cargo: other inputs	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-47	0	687	**640**	-95%	0%	48%	**43%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Bergen	-14	0	299,953	**299,939**	-32%	0%	9982%	**9842%**
Oslo-Trondheim	-38	0	3,740	**3,702**	-32%	0%	40%	**39%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-24,396	0	395,616	**371,220**	-95%	0%	48%	**43%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Bergen	-6,760	0	130,370,294	**130,363,534**	-32%	0%	10532%	**10355%**
Oslo-Trondheim	-18,768	0	2,150,253	**2,131,485**	-32%	0%	40%	**39%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
General cargo: consumption goods	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-6,467	0	8,574	**2,107**	-99%	0%	0%	**32%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	-611	0	14,187	**13,576**	-37%	0%	4%	**4%**
Oslo-Bergen	-35,401	0	55,825	**20,424**	-81%	0%	11%	**4%**
Oslo-Trondheim	-18,341	0	36,951	**18,610**	-34%	0%	72%	**18%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-3,332,189	0	4,928,154	**1,595,965**	-99%	0%	0%	**47%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	-334,921	0	7,336,843	**7,001,922**	-37%	0%	4%	**4%**
Oslo-Bergen	-17,618,040	0	23,589,912	**5,971,872**	-81%	0%	11%	**3%**
Oslo-Trondheim	-8,975,973	0	21,301,412	**12,325,439**	-34%	0%	72%	**22%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
Paper intermediates	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	787	**787**	0%	0%	303%	**303%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	1,611	**1,611**	0%	0%	9%	**9%**
Oslo-Bergen	-18	0	18	**0**	-61%	0%	7%	**0%**
Oslo-Trondheim	-1,599	0	4,297	**2,698**	-15%	0%	77%	**16%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	457,626	**457,626**	0%	0%	308%	**308%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	833,420	**833,420**	0%	0%	9%	**9%**
Oslo-Bergen	-9,021	0	7,923	**-1,098**	-62%	0%	7%	**-1%**
Oslo-Trondheim	-786,208	0	2,482,260	**1,696,051**	-15%	0%	77%	**20%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	**Absolute difference with base**				**Relative difference with base**			
Wood products	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-420	0	4,232	**3,812**	-100%	0%	613%	**343%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	6,706	**6,706**	0%	0%	16%	**16%**
Oslo-Bergen	0	0	3,277	**3,277**	0%	0%	10%	**10%**
Oslo-Trondheim	-3,673	0	30,928	**27,255**	-62%	0%	54%	**43%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-215,622	0	2,420,767	**2,205,145**	-100%	0%	613%	**361%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	3,496,603	**3,496,603**	0%	0%	16%	**16%**
Oslo-Bergen	0	0	1,365,061	**1,365,061**	0%	0%	10%	**10%**
Oslo-Trondheim	-1,807,120	0	17,733,915	**15,926,795**	-63%	0%	54%	**44%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
Paper products	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	944	**944**	0%	0%	0%	**20%**
Oslo-Bergen	0	0	340	**340**	0%	0%	0%	**1%**
Oslo-Trondheim	0	0	7,206	**7,206**	0%	0%	0%	**40%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	**0**	**0**	**0**	**0**	0%	0%	0%	**0%**
Oslo-Gothenburg	**0**	**0**	**0**	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	**0**	**0**	**490,125**	**490,125**	0%	0%	0%	**19%**
Oslo-Bergen	**0**	**0**	**143,743**	**143,743**	0%	0%	0%	**1%**
Oslo-Trondheim	**0**	**0**	**4,153,045**	**4,153,045**	0%	0%	0%	**48%**
Bergen-Stavanger	**0**	**0**	**0**	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
Metals and metal goods	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-309	0	1,107	**797**	-17%	0%	371%	**38%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	1,560	**1,560**	0%	0%	8%	**8%**
Oslo-Bergen	-10,967	0	15,185	**4,218**	-67%	0%	45%	**8%**
Oslo-Trondheim	-592	0	1,604	**1,011**	-64%	0%	17%	**10%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	-160,544	0	633,218	**472,674**	-17%	0%	370%	**43%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	813,336	**813,336**	0%	0%	8%	**8%**
Oslo-Bergen	-5,390,725	0	6,548,707	**1,157,981**	-68%	0%	45%	**5%**
Oslo-Trondheim	-286,897	0	919,449	**632,551**	-64%	0%	17%	**11%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

OD (both directions)	Absolute difference with base				Relative difference with base			
Aluminium	**Tonnes**				**Tonnes**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Bergen	0	0	14,611	**14,611**	0%	0%	1081%	**838%**
Oslo-Trondheim	-882	0	1,531	**649**	-49%	0%	0%	**36%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
	TonneKms				**TonneKms**			
Scenario	**Lorry**	**Sea**	**Rail**	**Total**	**Lorry**	**Sea**	**Rail**	**Total**
Oslo-Stockholm	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Gothenburg	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**
Oslo-Bergen	0	0	6,416,616	**6,416,616**	0%	0%	1081%	**814%**
Oslo-Trondheim	-429,715	0	878,113	**448,398**	-49%	0%	0%	**51%**
Bergen-Stavanger	0	0	0	**0**	0%	0%	0%	**0%**

Appendix A3: Outcomes for costs by commodity group

The first table is for all commodities together. After that we present tables for commodity groups where differences relative to the reference case occur. The numbers refer to all freight transport in/to/from Norway.

Logistic costs are the total costs, which includes the transport costs, but also costs like inventory and capital costs.

Costs	**Absolute difference with base**		**Relative difference with base**	
Total	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	-613	-308	0.00%	0.00%
Oslo-Gothenburg	449	309	0.00%	0.00%
Oslo-Stavanger	-5,763	-4,445	0.00%	0.00%
Oslo-Bergen	-10,421	-9,963	-0.01%	-0.01%
Oslo-Trondheim	-2,073	-1,380	0.00%	0.00%
Bergen-Stavanger	12	12	0.00%	0.00%

Costs	**Absolute difference with base**		**Relative difference with base**	
Consumption food	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	-21	29	0.00%	0.00%
Oslo-Gothenburg	26	5	0.00%	0.00%
Oslo-Stavanger	-1,490	-366	-0.05%	-0.02%
Oslo-Bergen	-1,341	-608	-0.05%	-0.03%
Oslo-Trondheim	-250	-72	-0.01%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Frozen fish	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	0	0	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	0	0	0.00%	0.00%
Oslo-Bergen	238	-401	0.01%	-0.02%
Oslo-Trondheim	0	0	0.00%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Other fish	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	0	0	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-6	-5	0.00%	0.00%
Oslo-Bergen	-1,009	-1,007	-0.05%	-0.05%
Oslo-Trondheim	-38	-37	0.00%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Machinery and equipment	Logistic costs	Transport costs	Logistic costs	Transport costs
Scenario	(10^3 NOK)	(10^3 NOK)		
Oslo-Stockholm	-105	-48	0.00%	0.00%
Oslo-Gothenburg	423	304	0.00%	0.00%
Oslo-Stavanger	-104	-106	0.00%	0.00%
Oslo-Bergen	-71	54	0.00%	0.00%
Oslo-Trondheim	799	376	0.01%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
General cargo: High value goods	Logistic costs	Transport costs	Logistic costs	Transport costs
Scenario	(10^3 NOK)	(10^3 NOK)		
Oslo-Stockholm	-31	-31	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-146	-146	-0.01%	-0.01%
Oslo-Bergen	-79	-46	0.00%	0.00%
Oslo-Trondheim	-35	-36	0.00%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
General cargo: Building materials	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	-73	-24	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-392	-348	-0.01%	-0.01%
Oslo-Bergen	-33	6	0.00%	0.00%
Oslo-Trondheim	-356	-140	-0.01%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
General cargo: Other inputs	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	-38	-36	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	0	0	0.00%	0.00%
Oslo-Bergen	-3,636	-3,636	-0.14%	-0.17%
Oslo-Trondheim	-116	-82	0.00%	0.00%
Bergen-Stavanger	12	12	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
General cargo: Consumption goods	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	-236	-149	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-2,863	-2,832	-0.04%	-0.05%
Oslo-Bergen	-3,920	-3,920	-0.06%	-0.07%
Oslo-Trondheim	-1,190	-866	-0.02%	-0.02%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Paper intermediates	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	-15	-10	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-276	-214	-0.01%	-0.01%
Oslo-Bergen	-7	-3	0.00%	0.00%
Oslo-Trondheim	-167	-97	-0.01%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Wood products	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	-43	-6	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-299	-290	0.00%	0.00%
Oslo-Bergen	-176	-124	0.00%	0.00%
Oslo-Trondheim	-477	-378	-0.01%	-0.01%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Paper products	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	0	0	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-53	-10	0.00%	0.00%
Oslo-Bergen	-24	44	0.00%	0.00%
Oslo-Trondheim	-106	72	0.00%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Metals and metal goods	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	0	0	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	-134	-128	0.00%	0.00%
Oslo-Bergen	-251	-253	-0.01%	-0.01%
Oslo-Trondheim	-127	-109	0.00%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Costs	Absolute difference with base		Relative difference with base	
Aluminium	**Logistic costs**	**Transport costs**	**Logistic costs**	**Transport costs**
Scenario	**(10^3 NOK)**	**(10^3 NOK)**		
Oslo-Stockholm	0	0	0.00%	0.00%
Oslo-Gothenburg	0	0	0.00%	0.00%
Oslo-Stavanger	0	0	0.00%	0.00%
Oslo-Bergen	-112	-69	-0.01%	0.00%
Oslo-Trondheim	-10	-11	0.00%	0.00%
Bergen-Stavanger	0	0	0.00%	0.00%

Appendix B. Outcomes of interviews with firms on the demand for faster freight trains in Norway

B.1. Background and objective

Atkins has carried out a study for the Norwegian Rail Transport Authority on the potential for high speed trains in Norway. Within this study Significance carried out various analyses on freight transport demand for high speeds freight trains between specific city pairs at 160 and 200 km/hour using the Norwegian national freight transport model. At the moment the average train speed between those Norwegian city pairs is 65 km/hour (as taken from the input of the model). The outcomes of these analyses were included in the Atkins report on high speed rail freight.

In a reaction to the outcomes of this report, Railconsult (Oslo) advocated that a (maximum) rail speed of 120 km/hour for container and wagonload trains would be worth testing. Such speeds are possible with conventional freight rail cars on new or modernised railway lines. So, if Norwegian railway lines would be constructed or upgraded to allow high speed passenger trains, and freight trains at 120 km/hour could be accommodated in the train schedule, these ambitions could technically be realised. It might also be possible to construct or build other railway lines (non-high speed for passengers) that permit freight trains at 120 km/hour. Dedicated heavy freight trains (system trains, special timber trains) will remain to have a lower speed than 120 km/hour and the corridors where these trains will be active should take the requirement of these trains into account. Railconsult argued that after a certain period the market will choose these faster solutions and on most modernised and new lines, the running speed of freight trains will become 120 km/hour.

Railconsult expects that the rail freight transport market will choose 120 km/hour. To corroborate this, we carried out further runs with the Norwegian transport model, concerning the likely demand in Norway for freight trains (container and wagonload) that run at 120 km/hour. The outcomes of these runs are reported in a separate Significance memo (memo 2 within this same project).

Other evidence on this issue can be obtained by interviewing decision-makers in freight transport about their expectations on the supply and demand of future rail freight transport services.[1] In this memo we report on the outcomes of interviews with firms in Norway (and some in Sweden) on the demand for freight rail trains that run at 120 km/hour.

B.2. Research method

A script was developed for semi-structured in-depth interviews with firms, including shippers and forwarders that have a demand for transport services and freight railway operators that supply such services. We had a target number of ten completed interviews. Starting from the list of contacts provided to us, nine (the target number was ten) such interviews were successfully carried out. In section 3 of this memo we report on the response rates.

The respondents were key decision-makers within these firms on the provision or purchase of rail services in Norway. The interviewers were staff members (researchers) of Significance, with expertise on freight and logistics and interviews in the freight sector. These interviews were all done over the phone, in English.

The selection of the respondents was done together with Railconsult and Atkins (partly based on a list of firms/contact persons from the earlier stage of the project), who together provided 21 names of firms/organisations with their contact persons (postal service providers, courier integrators, distribution operators, shippers and rail operators). The list provided also contained an air cargo forwarder and a rail track authority. These were considered not to be in scope for this investigation, leaving a total of nineteen firms/organisations to be contacted. For most of these we had one contact name, for some there was no contact (and we phoned the general company number, trying to find the right contact) and for a few there were two contacts names.

The interviews focussed on:

- Which rail speeds will be possible in the future?;
- For which commodities and types of trains and corridors would higher speeds be likely?;
- Whether there would be demand for and supply of these faster services?; and
- If so, in how many years from now?

Draft summaries of the outcomes of each interview were first sent to the respondents, so that these could be checked, confirmed and revised where needed. After that, the outcomes of all nine interviews (anonymised) are reported in this project memorandum to Atkins. In the following section, the results from the nine (ten?) interviews are synthesised. The summaries of each individual interview can be found in Appendix 1 to the memo (please note that the information on the name of the firms/organisation and the contact person was removed, for reasons of anonymity).

B.3. Synthesis of outcomes of the interviews

Nineteen firms/organisations (23 contact persons in total) out of 21 were first contacted by phone to make an appointment for an interview. Five firms/organisations were not interested in participating; in other cases the contact person was not available or too busy. In total nine interviews could be carried out successfully. The response rate therefore is almost 50%, which is considered a very good response nowadays for interviews with firms.

The interviews lasted 15-20 minutes and were also carried out over the phone.

The interview consists of four sections (and room for final comments at the end):

- Company/interviewee details (these are not reported here, on the grounds that anonymity was promised; we only report on the types of firms interviewed);
- Existing freight flows of the firms;
- Decision factors for transport mode choice;
- Potential for fast freight trains (the interviews focussed on this section).

Below, we report on the outcomes for each section.

B.3.1. Section 1: the firms interviewed

We interviewed:

- One shipper;
- Three rail operators; and
- Five carriers/forwarders (especially courier integrators and postal service providers).

This is not a representative sample of carriers/forwarders in Norwegian freight transport, but rather a selection of firms that is **more likely** than other firms to use fast train services.

B.3.2. Section 2: existing freight flows

The type of goods transported
The answers to this question given by the nine firms interviewed were as follows:

- Consumer goods;
- Grocery goods;
- Timber and iron ore;
- All types of goods, with focus on parcels (2x);
- All types of goods (3x); and
- Many types of goods including fish, grocery goods and beverages.

Modes used (transport chains)

The nine firms used the following transport chains (modes used in a sequence to move the goods from sender to receiver). Multiple answers by the same respondent were possible here.

- Road (4x);
- Road-rail-road (4x);
- Road-rail (2x);
- Rail-road (2x);
- Rail (5x);
- Road-sea (2x);
- Rail-sea-road (ro-ro);
- Sea-rail-road;
- Road-air (2x); and
- Air (international and domestic).

Eight of the nine firms interviewed currently provides or uses rail transport in Norway.

Types of trains used

Multiple answers were possible here as well. The nine firms interviewed gave the following responses:

- Container trains (8x);
- Trains with trailers or trucks (3x);
- Dedicated system trains (timber, iron ore) (2x);
- Wagonload trains (2x); and
- Mixed trains.

Use of own rail sidings of access to/egress from the railway station/terminal

Sidings/terminals are mostly owned by the rail operator; but there are also operators without sidings that use sidings of their clients.

Access to and egress from these terminals is usually organised by the clients of the rail operator, not by the rail operator. This is carried out by truck (or sometimes van for parcels).

B.3.3. Section 3: decision factors for transport mode choice

Eight respondents provided a ranking of importance for the influence of transport cost, time, reliability and frequency of services (one of these also added the environment) for mode choice in freight transport. One firm couldn’t give this ranking, because the mode choice is taken by its clients.

When we do an unweighted summation of the rankings provided by the eight firms (seven of which are involved in rail transport in Norway as user or provider) we get the following order of importance (from most to least important):

- Transport cost;
- Transport time reliability;
- Transport time; and
- Frequency of services.

In their motivation for the ranking, several respondents indicated that transport time itself is not so important because many rail transports take place during the night. What matters than is timely delivery in the morning (and transport cost), not a shorter transport time. For such night transports over not too long distances (domestic), fast freight trains would not provide much added value (unless these would lead to savings in operating costs), since it would simply lead to longer waiting at the destination.

Transport costs are important, partly because the rail freight market is competitive, the clients of the rail freight services (and their clients in turn) also usually operate on competitive markets and there is a big competitor for rail transport in the form of road transport. The competition with road transport also leads to higher reliability requirements for rail transport.

The requirements by the sender or receiver of the goods in terms of timely delivery were stressed by multiple firms (especially the couriers).

B.3.4. Section 4: Potential for fast freight trains

This section was the main focus of the interview.

Current rail speed

We obtained the following answers to the question what the current rail speed was for the transports by or for the firms interviewed (from the eight firms in our sample that now use or provide rail transport):

- The current rail speeds in Norway are perceived to be low (2 respondents);
- 60-70 km/hour, including stopping, shunting, marshalling and waiting;
- 60-80 km/hour, including stopping, shunting, marshalling and waiting (driving speed of 80-100 km/hour);
- 80-90 km/hour driving speed, usually without transshipments; then no stopping, shunting, marshalling or waiting is involved; key lead time is overnight distribution;
- 71 km/hour on average (Oslo-Narvik, via Sweden);
- About 70 km/hour including waiting time; many trains are loaded in Oslo and then go without marshalling or shunting to the inland terminals; and
- Around 60 km/hour, including stopping, shunting, marshalling and waiting (driving speed of 80-110 km/hour).

Several respondents complained about the quality of the tracks or stressed that it is an old system. Another respondent not only complained about the old tracks but also about insufficient double tracks, both leading to insufficient reliability.

Expectations on rail speed

From the nine respondents we obtained the following answers on their expectations of rail speed in the near and more distance future:

- No improvements of the rail system are expected in the coming five years (4x). In the longer term, faster trains are expected/may be possible (4x);
- Expectation of low speeds in the coming five years since the network is getting busier (2x), and return to current speeds in the longer run;
- The current network doesn't allow higher running speeds (current trains often could do 120 km/hour, depending on locomotive, wagons and weight of the cargo); and
- Some improvements of the rail system are expected in the coming five years, leading to 20% higher speeds. In the longer term, faster trains are expected.

Commodities for which transport by fast train is attractive

We asked for which commodities transport by fast train (operating speed of 120 km/hour) might be attractive and got the following responses:

- All types of products (4x), but especially food, such as fish;
- Especially fresh food, like fish, fruit, meat and milk;
- Food, retail cargo, perishable goods (but not for ordinary goods, since these are transported during the night and can only be distributed in the morning; fast trains are more attractive for longer distance transport, but these flows are not very large); and
- No specific commodities, but useful for long distance transport (esp. cross-border to Sweden, Germany and Italy).

This was a general question about how the respondent viewed the market for fast train services, not about the use of such services by the firm itself.

Type of trains required for such fast services

Then we enquired about the types of trains for which such fast speeds would be attractive. The firms replied as follows (multiple answers possible):

- This would be attractive for all types of trains (3x; one respondent of these: as long as these are modern trains);
- Container trains (5x); and
- Trains with trailers or trucks (2x).

This was also a general question about how the respondent viewed the market for fast train services, not about the use of such services by the firm itself.

One firm specifically stated that speeding up is not needed for dedicated system trains (e.g timber).

Corridors where fast trains would be attractive

According to the firms interviewed the corridors where fast trains would be attractive are (multiple answers possible):

- Oslo-Bergen (7x);
- Oslo-Kristiansand-Stavanger (7x);
- Oslo-Kristiansand (not to Stavanger);
- Oslo-Trondheim (6x);
- Oslo-Gothenburg (5x);
- Oslo-Stockholm (4x); and
- Circular route including Bergen-Haugesund-Stavanger in combination with Oslo-Bergen and Oslo-Kristiansand-Stavanger (3x).

Again this was a general question about how the respondent viewed the market for fast train services, not about the use of such services by the firm itself.

Two respondents remarked that the circular route is definitely NOT an attractive option for fast trains. On the other hand one respondent said this would be the key connection, presumably mainly referring to Oslo-Bergen and Oslo-Stavanger.

Would your organisation use fast trains (by price scenario)?

Then we asked whether the six shippers/carriers/forwarders among the nine firms interviewed would use fast trains, for the following price scenarios:

- Same price as now;
- 5 % more expensive;
- 15 % more expensive;
- 10 % cheaper than now; and
- 25 % cheaper than now.

The answers we obtained were:

- Probably not if these services would be 15% more expensive than the current prices; but maybe at 5% higher prices. But this all depends on transport time reliability improvements for rail and would only be feasible for long distance transport;
- Probably switch to fast rail transport at 15% higher price than now, definitely at 5% higher price;
- Probably switch from road to fast rail transport at 15% higher price than now, definitely at 5% higher price;
- Probably if these services would be 15% more expensive than the current prices;
- Maybe if these services would be 5% more expensive than the current prices; definitely if provided at the current price; and
- Only if the services would be offered for the same price as lorry transport.

The three rail operators got another question, namely whether the operation of fast trains would lead to, lower transport costs. All three rail operators said that with faster trains the maintenance and electricity costs would go up and the personnel costs would go down, and that in the end the costs would remain about the same.

If so for which commodities, routes/OD pair, type of train and time horizon?

All nine firms were asked for which commodities, routes and train types they would use fast trains and on which time horizon that would take place. The answers were as follows:

- For fish (there are time limits per transport here), Oslo-Narvik, not now but maybe in the longer term;

- All types of goods, all domestic routes to/from Oslo from previous section, all types of trains and right now if this would be possible;
- Fresh food, maybe clothing, Oslo-Narvik, Oslo-Trondheim, Oslo-Kristiansand-Stavanger; Oslo-Gothenburg and Oslo-Europe (via Denmark), container trains (esp. 2 TEU containers), as soon as high speed tracks can be used;
- Food, perishable goods, retail cargo, Oslo-Kristiansand, train type doesn't matter, on 6-9 months notice;
- Oslo-Stavanger, Oslo-Bergen, Oslo-Trondheim, Oslo-Gothenburg an Oslo-Malmö, in the long term;
- All kind of goods, Oslo-Bergen, Oslo-Kristiansand-Stavanger, Oslo-Trondheim, container and ro-ro trains, right now if this would be possible;
- Oslo-Bergen and Oslo-Kristiansand-Stavanger (other corridors do not have enough freight volume) in the long run (more than ten years from now); and
- All kind of goods, Oslo-Bergen, Oslo-Kristiansand-Stavanger, Oslo-Stockholm, in the longer run.

B.3.5. Final comments

There was also room for final comments by the respondent.

One firm remarked that the introduction of high speed rail in Norway could lead to a growth in the market share of rail in freight transport, maybe even by 15%.

Another firm remarked that increasing the rail speed should not be the priority in Norway. The major issue is to improve the existing rail infrastructure (more electrification, more possibilities for passing trains and more double tracks).

A firm said that building the case for high speed rail for freight was difficult. It would be better to have dedicated cargo lines (now the network is mostly for mixed traffic with passenger trains, and freight trains frequently have to give priority to those).

One respondent said it would be better to increase the speed of the whole rail system (maybe only a little bit) instead of focussing on a few high speed lines.

B.4. Summary and conclusions

B.4.1. The firms interviewed

Three firms that provide rail freight services in Norway and six firms that are (potential) users of rail freight transport were interviewed to get their view on future rail speeds and the demand for rail freight services operating at 120 km/hour. The focus is on container and wagonload train, since for dedicated heavy trains (system trains, timber trains) 120 km/hour is neither feasible nor attractive.

This is not a representative sample of carriers/forwarders in Norwegian freight transport, but rather a selection of firms that is **more likely** than other firms to use fast train services.

B.4.2. Potential demand for trains at 120 km/hour

All but one of the (potential) users of fast rail freight services (carrier/forwarder/shipper) that we interviewed are rather positive: they would use it for some of their transports if this would be offered at the current price or a slightly (5%; some also at 15%) higher price. The only firm in this category that was more sceptical made clear that the future use of fast rail services would critically depend on reliability improvements.

B.4.2.1. Cost and price of fast freight train services

All three rail operators interviewed thought that the operating costs for fast trains would be about the same as for the current services. Maintenance and electricity costs would go up and the personnel costs would go down, and in the end the costs would remain about the same. The expectation of Railconsult that the rail operating costs would go down considerably when fast trains would be introduced is not shared by the rail operators interviewed.

B.4.2.2. Potential demand and cost/price

This finding of constant operating costs implies that offering faster services at no or only a limited price premium seems possible, as long as there will be no fee for the use of the new or upgraded infrastructure, that made the higher speed possible, in the costs for the rail operators and the prices that the users of rail freight services pay. Under these conditions there seems to be a market (but not necessarily a large one, we will come back to this in memo 2 on the model runs) for these services at a price setting based on the expected operating costs. However, if the price for these fast rail services would also contain a substantial contribution to the costs of speeding up the rail infrastructure, the fast rail services would no longer be competitive.

B.4.2.3. Effect on modal split

Fast trains might induce substitution away from road transport. One of the respondents was very positive about this possibility and one or two more would consider such shifts. In memo 2 we will examine whether there will be substantial shift away from road transport when fast trains would be operating in specific corridors, using a transport model.

B.4.2.4. Train types, commodity types, corridors

The types of trains for which fast speeds are attractive are container trains and trains with trailers or trucks.

In terms of commodities there is a focus on food products, though several respondents stated this could be attractive for all types of goods.

The corridors that may be interesting for fast rail are the lines from Oslo to the west coast, and maybe also to other countries. Except for the six lines that were studied in the previous high-speed rail study, two respondents also mentioned Oslo-Narvik and another mentioned Oslo-Malmö as fast rail connections that would be interesting for them. A fast train connecting Kristianstad to Stavanger is identified as a connection with a very low potential demand.

B.4.2.5. Importance of transport time

We asked the firms for an importance ranking for the influence of transport cost, time, reliability and frequency of services for decision-making on mode choice in freight transport. An unweighted summation of these rankings gives the following order of importance (from most to least important):

- Transport cost;
- Transport time reliability;
- Transport time; and
- Frequency of services.

We observe that among the firms interviewed (which were firms providing rail services or potential clients of such services, with a focus on container and wagonload rail) transport time only comes third as a decision-making factor. Transport cost and reliability are more important factors, which is explained by the competitiveness of the transport markets (tough price competition, and also competition on reliability, also with road transport). So providing faster trains, the topic of this investigation, will be valued positively by the firms, but not as much as proportional improvements in costs and/or reliability. Some respondents complained about the current level of transport time reliability in Norwegian rail freight and argued that improvements in this are needed more than higher train speeds.

B.4.3. Night-time deliveries

The rail operators (and one of the users of rail transport services) also stress that many current rail transports are done by dedicated system trains that do not require speeding up or trains that operate during the night. For the latter transports, faster trains will mainly lead to longer waiting times in the morning at the destination. This leaves rail transport that takes place during the day, and long-distance rail transport that takes several days, as potential market for faster trains. The rail operators think that other improvements to the rail system other than speeding it up are more important (electrification, places for passing trains, double track, dedicated freight tracks), especially to increase transport time reliability.

B.4.4. Preliminary conclusion

The findings show that, at least, among the firms that are most likely to be interested in fast (120 km/hour) freight trains in Norway, there is a demand for such services. In the next memo (on the model runs), we will investigate whether this market will be large or small. The willingness to pay for these services among the firms interviewed seems sufficient to pay the likely operating costs, but it is doubtful whether freight services can recoup some of the investment costs in rail infrastructure that are needed to make 120 km/hour possible. Transport time in rail transport (even when the focus is on container and wagonload trains) is a less important decision factor than transport cost and transport time reliability. Cost-efficient improvements in reliability might, therefore be more attractive than just speeding up rail transport.

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