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Energy saving potential in the fish export from Norway

A report from Phase 2 of the European Commission SAVE -project XVII/4.1031/Z/97-229: "Energy saving in transport of goods – a pilot project in rural natural resource based industries"

by

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Summary:

The main objective of the project is to develop and implement actions, strategies and measures for improved energy efficiency in transport of goods. This report describes the pilot actions, which have been carried out in Phase 2 of the project. The report focuses on:

- Energy use in today's transport of fish (the year 1999)
- Pilot actions and necessary conditions for implementation of the actions
- Actual and potential energy saving effects of the pilot actions
- Possible transferability of the actions and strategies to other industrial sectors

The result shows that it is possible to reach a 5 % reduction in the energy use in the lorry transport at company level actions containing information and motivation measures among the drivers. For the whole fish export from Norway transported on lorry, a 5 % reduction in fuel consumption would give an energy saving effect of about 12.000 tonnes fuel or about 115 mill kWh a year.

A transfer from today's road transport of fish, from Norway to the European continent, to rail transport could give a reduction in energy consumption up to 60-70 % on some routes. For all Norwegian fish export to the European continent such modal shift could give a reduction of energy use at about 70.000 tonnes fuel or nearly 700 mill kWh.

In year 2000 Waagan Transport was the only transport company using the Åndalsnes-Oslo railline for fish transport. In year 2001 other transport companies also started fish transport on this railline. Our case company has apparently started a process among the transport companies resulting in a substantial reduction in energy use in transport of goods. In NSB Cargo this effect is mentioned as "the Waagan effect".

Other publications from the project : Andersen, O., O. Uusitalo, P. Ahlvik, H. Hjortsberg, K. Groven and E. Brendehaug. *Energy in transport of goods. Nordic Examples.* VF-Rapport 6/99.Vestlandsforsking, Sogndal.

Andersen, O., U. Suutari, H. Hjortsberg, K. Groven and E. Brendehaug. *Measures and actions in regional policies for energy saving.* VF-Rapport 3/2001.Vestlandsforsking, Sogndal.

Andersen, O., O. Uusitalo, U. Suutari, J. Lehtinen P. Ahlvik, H. Hjortsberg, K. Groven and E. Brendehaug. *Energy saving in transport of goods - a pilot project in rural natural resource based industries***.** VF-Rapport 4/2001. Vestlandsforsking, Sogndal.

Andersen, O., U. Suutari, J. Lehtinen, A. Permala, P. Ahlvik, H. Hjortsberg, B. Sävbark, K. Groven, E. Brendehaug and K.G. Høyer. *Pilot actions for energy saving in transport of goods. Nordic Examples.* VF-Rapport 2/2001. Vestlandsforsking, Sogndal.

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Contents

List of Tables

List of Figures

1. Introduction

This report is part of the European Commission DG XVII –project "Energy saving in transport of goods - a pilot project in rural natural resource based industries" coordinated by Western Norway Research Institute (WNRI) with participation from Technical Research Centre of Finland (VTT) and Ecotraffic Research and Development in Sweden.

Natural resource based production has always been a major segment of the industrial structures of Norway. Transportation of goods to and from these industries accounts for large shares of the total transport volumes. This is also the situation in the fish industry, the Norwegian case in this project.

1.1 Objectives

The main objective of the project is to develop and implement actions, strategies and measures for improved energy efficiency in transport of goods. This report describes the pilot actions, which have been carried out in Phase 2 of the project. Phase 1 served as the basis for the implementation of the pilot actions and strategies, while Phase 3 deals with measures in regional policies.

The report focuses on:

- Energy use in today's transport of fish (the year 1999)
- Pilot actions and necessary conditions for implementation of the actions
- Actual and potential energy saving effects of the pilot actions
- Possible transferability of the actions and strategies to other industrial sectors

1.2 Method

The projectplan was to develop and implement pilot actions and strategies to increase the energy efficiency in transport of fish, in three different ways:

- To reduce the *fuel consumption* in today's lorry based transport
- To increase the *load factor* in today's lorry based transport
- To achieve a transferral of goods from lorries to the more energy efficient rail and ship transport

The project design is based on a case-methodology, as described by Yin (1994). A transport enterprise transporting fish from western Norway to the continent, is chosen as the Norwegian case-company. A wide range of actions and strategies has been implemented in the case company and their effects on energy efficiency have been determined. Based on the present situation in the case company, the main focus of the study has been on transferral of goods from road to rail, and reduction in fuel consumption.

Methodologically, the actions and their implementation are based on *structural interviews* with employees at the different levels in the company and through *constructive dialogue* between company employees and researchers. This has given a basis for systematising experiences and results both through formal evaluation and participatory observation.

The project design is in part based on the classic experiment: Measuring the effect by manipulating one variable while other variables remain constant. As transport companies are facing shifting circumstances maintaining stable experiment conditions has become a major methodological challenge.

Four transport routes were selected as objects for implementation of actions and strategies, and in order to evaluate the energy use. The routes were chosen based on the following principles:

- The study needs stability over time for measurement of the energy use, to implement actions and to evaluate the effects on the same routes. Unstable routes are not suitable for the study.
- Chosen transport route should carry a sufficiently quantity of fish
- Different fish products and routes with different destination structure ought to be covered.

The energy use (in kWh/tonnekm) was measured before actions were implemented. The situation in the basis year (before actions) was used for comparison to assess the effects of the pilot actions.

One main problem has consisted of variation in the routes. Two of the first four selected routes have later been discontinued due to changes in customer contracts. The case company explains the increasing unstable situation in the transport sector the last year by the change from long term contracts between the exporter and the transport companies, to a spot market situation.

In order to obtain comparable data for measurement of reduction in *fuel consumption* in today's lorry based transport, we have used a design which take into account variable factors. The requirements for the comparison was:

- The same lorries and identical total weight were used
- The same drivers were used
- Only lorries, which had completed their "running-in" period (after 30.000 km), were used.

In order to minimise the effects of seasonal differences in weather condition the recordings were done in autumn 1999 and autumn 2000.

In order to measure the effect of transferral of goods from road to rail, we have compared the distances where transport mode has changed during the project period. The test design for this effect differs from the test used for assessment of effects of driving style. Here, the energy use in tonnekm by the lorry transport by all drivers is averaged. This is compared with the energy use in tonnekm for the same distance by rail.

2. Energy use in the today's lorry transport

2.1 Description of the case company, Waagan Transport AS

The following presentation is based on information from the manager of Waagan Transport (WT), Per Waagan. The company was founded in 1969, limited company since 1976. The head office is situated in Vegsund (since 1988), 15 km off Ålesund in Møre og Romsdal county. The trucks driving for the company have three types of ownership: 1) leased from Volvo, 2) owned by WT and 3) contracted trucks. The use of the two last categories is decreasing.

The company was originally based on transportation of furniture. Today, WT also distributes general goods (routes in Møre og Romsdal). For the wholesale dealer BAMA, the company also distributes fruit and vegetables. Since 1985, WT has been transporting fish with refrigerator vans, mainly Norwegian salmon to Europe.

2.1.1 Domestic offices and offices abroad

Branch offices are located in Ørsta (since 1989) and Molde (since 1994), both in Møre og Romsdal County. WT has a fine-meshed distribution system for general cargo between Møre og Romsdal and other parts of Norway, and in particular within Møre og Romsdal county.

The export department of WT has a freight network all over Europe. A subsidiary company in Denmark, earlier EB Transport in Skagen, has cold storage facilities since 1994 for sorting and forwarding deliveries of Norwegian salmon (since 1994). WT also has a freight terminal in Padborg, on the border between Denmark and Germany.

2.1.2 Quality certification

WT was ISO 9002-certified in 1994. The manager of the company however considers this only to have limited effects in the market, while the process of establishing certification implied substantial costs for the firm. The experience in the company is that very few customers are willing to pay extra for using a certified transport company.

2.2 Data compilation

The energy consumption in lorry transport of fish from Western Norway to the continent has been measured. Two types of data were compiled from the case company:

1) Energy use on four different transport routes (described in more detail below).
2) Average energy use in various transport routes from Western Norway to the continent.

In the project, four routes were selected. The criteria for selecting the special routes have been described earlier in chapter 1. The routes are described below. A map of each route and more detailed description of the routes is shown in attachment 1. The four case routes are (Kleppe, 1998-2000):

A) Fresh and frozen herring from western Norway to Poznan in Poland. The route is lorry transport from Ålesund to Trelleborg (in Sweden), ferry to Rostock, and lorry transport the last distance through Frankfurt an der Oder (on the Polish border) to Poznan.

B) Dried cod from western Norway to Torino in Italy. The present route is lorry transport from Ålesund to Gothenburg, ferry from Gothenburg to Kiel, lorry transport from Kiel to Manching, rail transport (lorry on rail) from Manching to Brenner, and lorry transport on the last distance to Torino.

C) Fresh saith filet from western Norway to Bremerhaven. The route is lorry transport from Ålesund to Moss (south-eastern Norway), ferry from Moss to Hirtshals (Denmark), and lorry transport from Hirtshals to Bremerhaven.

D) Fresh (and frozen) white fish from western Norway to Boulogne-sur-Mer in France. The route is lorry transport from Ålesund to Oslo, ferry to Kiel, and lorry transport on the last distance.

The routes are described in more detail in the attachment.

The energy consumption was measured using the on-board Volvo Road Relay system. This is an electronic log that measures parameters such as distance, time, fuel consumption, speed, idle- and economy driving. The drivers had the responsibility for operating the data-system themselves after being instructed by the company manager. In addition to the electronic data from the Road Relay system, the drivers completed a written log for each trip with information regarding:

- Cargo weight
- Driving route
- Weather
- Fuel tanking
- Traffic situation (traffic jams etc.)

The manual log gave important information for interpretation of the data from the Road Relay system. For instance, the fuel consumption could be controlled with the log. In most cases, the differences between the Road Relay system and the manual log were within ± 1-3 percent.

2.3 Energy efficiency

In the two tables below we have summarised the energy use from the measurements. The first table gives data from the four routes, and the other table gives data from general measurements.

Table 1: Energy use in lorry fish transport from western Norway to the continent.

Case-route	Payload, trip[1] average (tonnes)	Energy efficiency, average (kWh/tonnekm)	Empty driving, average (km)	Total distance per trip, average (km)	Number of trips on which the calculations are based
A	18	0,22	i.d.	3700	3
B	22	0,16	i.d.	4600	1
C	16	0,22	83	2500	5
D	17	0,20	104	3650	3

i.d.=incomplete data

The table shows the average energy use on down trip and return trip for four routes (data collected 1999-2000). For case A and B data for empty driving were incomplete. The low

[1] "Down trip" is used to express the trip from loading place in Western Norway to the destination on the continent. "Return trip" is used for the trip from the European continent to Norway. "Trip" is used to express the sum of down trip and return trip.

specific energy use in case B can be explained by the higher load factor for this case route. Note that the data in case B is only based on one trip.

General measurement during a longer period driving with variable routes is shown in table 2. These also indicate energy efficiency in the range 0,20-0,22 kWh per tonnekm. Payload is however not available for the individual trips, but an average value is assumed (17 tonnes).

Table 2: Average energy use in lorry fish transport from Western Norway to the continent.

Km, total	Number of measurements	Period	kWh/tonnekm	Driver number[2]
59000	1	Winter -99/00	0,224	1
55000	1	Summer –99	0,206	2
78000	7	1999-2000[1]	0,20-0,21	3 & 4

[1] Spring, summer and autumn in 1999 and 2000.
[2]A specific number is designated for each driver (to be able to analyse the effect of driver style)

In the four cases routes described earlier in this chapter the load factor is generally lower on return trip than down trip. Hence the energy use per tonnekm is lower on the down trip compared to the return trip. The figure below illustrates this.

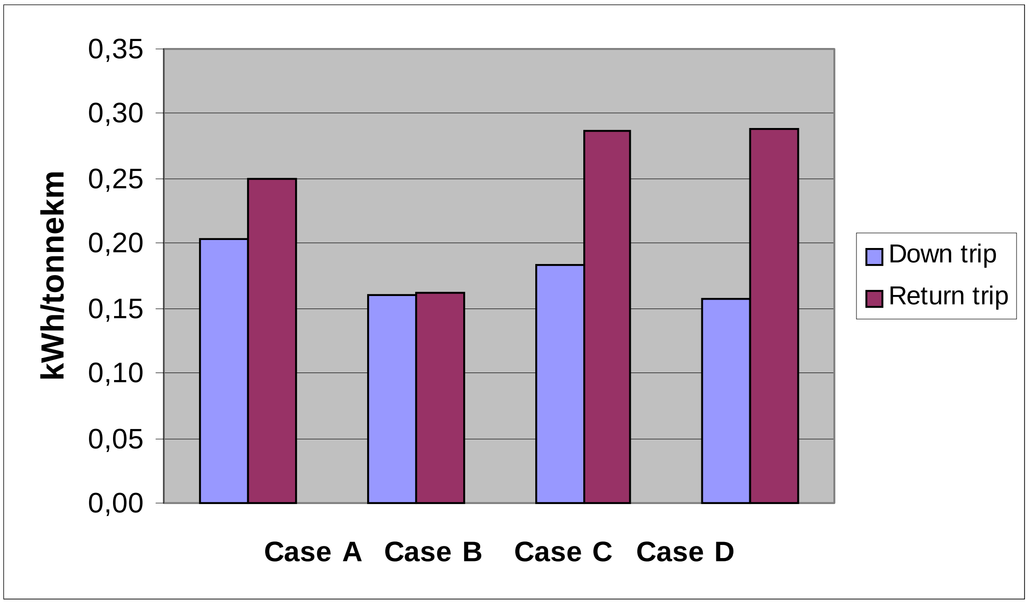


Figure 1: Energy use per tonnekm on down trip and return trip for four different routes.

In figure 1 data is collected during 1999-2000. In case B the load factor is 100 percent on return trip. The difference in energy efficiency on down trips between case C and D is difficult to explain. Topography is a possible explanation. Driving distance on the European continent in Route C is relatively shorter than the corresponding distance for route D.

In case A the higher energy use per tonnekm in the down trip could partly be explained by the driving style on this down trip. In the manual log for this particular route, the driver has entered: "hard driving".

[2] A specific number is designated for each driver (to be able to analyse the effect of driver style)

Energy use by the ferries contributes to a substantial part of the total energy use. In case B and case D the ferries are responsible for nearly half of the total energy use due to the long ferry distances in these cases. The figure below shows this.

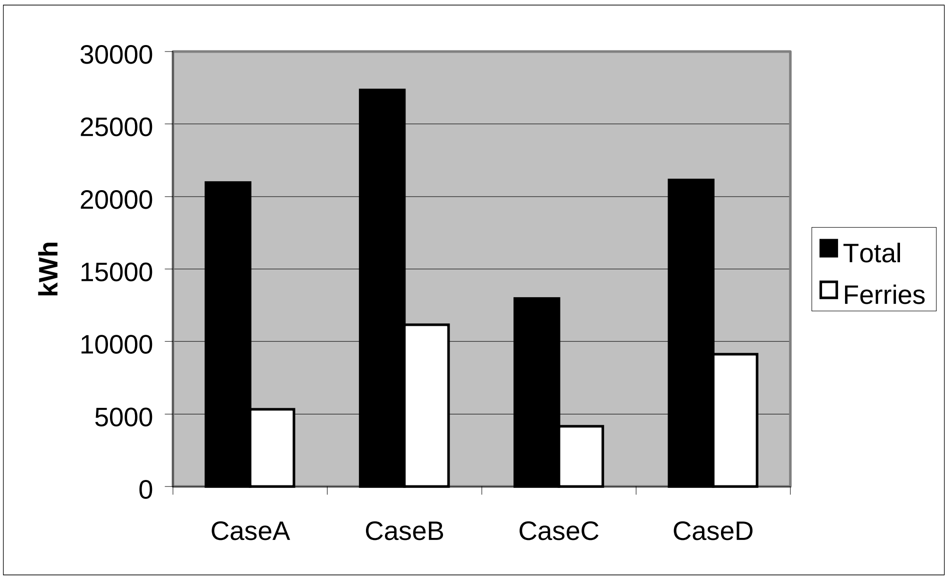


Figure 2: *Energy use by the four cases of transport of fish round trips between Norway and the European continent. Total energy use and energy use by ferries.*

2.3 Effect of driving style, load factor and topography

Trips made by different drivers on the same distance and with the same load factor, have been compared in an attempt to assess the effect of different driving style. The most striking effect is shown in figure below. Each distance is marked with a single point.

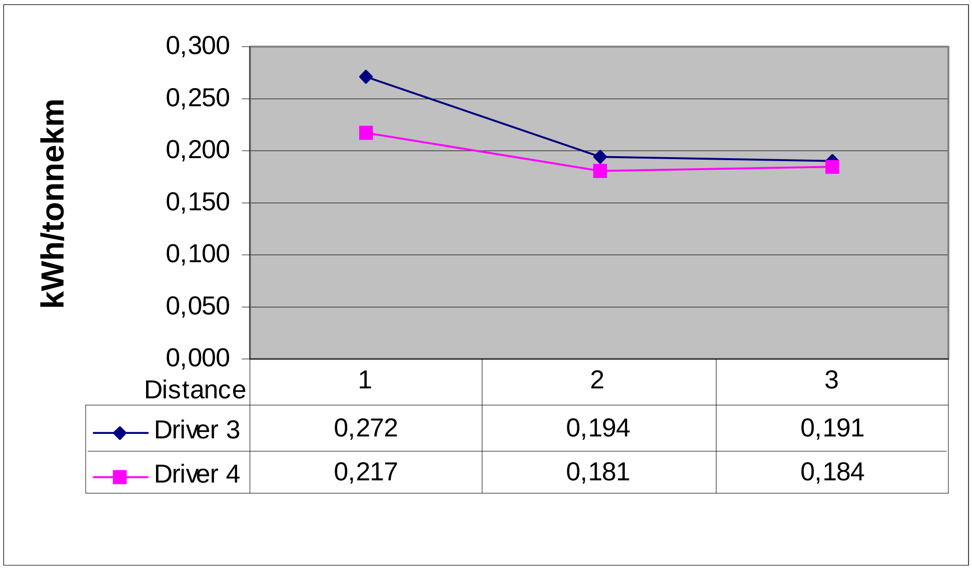


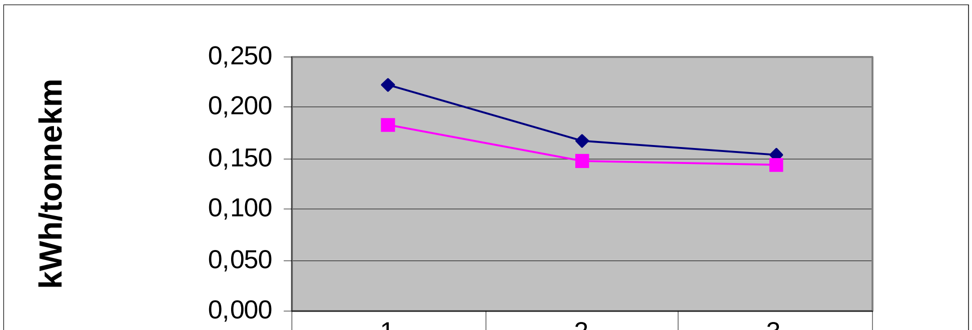
Figure 3: *Effect of driving style on energy efficiency.*

In Figure 3 the graphs show the same routes and truck weight, different driver and truck. The distances are: 1= Ålesund-Otta, 2= Otta-Trelleborg, 3=Trelleborg-Poznan.

Driver 3 had 25 percent higher energy use per tonnekm than driver 4 on the first distance, Ålesund-Otta, at the route carrying herring to Poznan. Driver 4 practises traditional driving, while driver 3 has explained the result with “hard driving”. This example shows a large difference in energy use due to differences in driving style. In addition to this difference Hjortsberg and Ahlvik (2001) have found that eco-driving compared with traditional driving results in approximately 10 percent reduction in energy use. Focusing driving style within the enterprise could therefore make substantial energy savings.

From Otta to Oslo, the second distance, the difference between the drivers is reduced to 4 percent. According to the logbook this difference could be explained by rain and traffic jam for driver 3, where driver 4 had good weather and no traffic problems. The result on the last distance, Trelleborg to Poznan, with nearly the same energy use, could support this explanation.

As we have shown before, the energy efficiency is usually lower on return trips. This is caused by lower load factor. There are differences in energy efficiencies due to variations in load factor, even with smaller differences in load factor. The figure below shows the energy use per tonnekm for two down-trips by the same driver and truck.

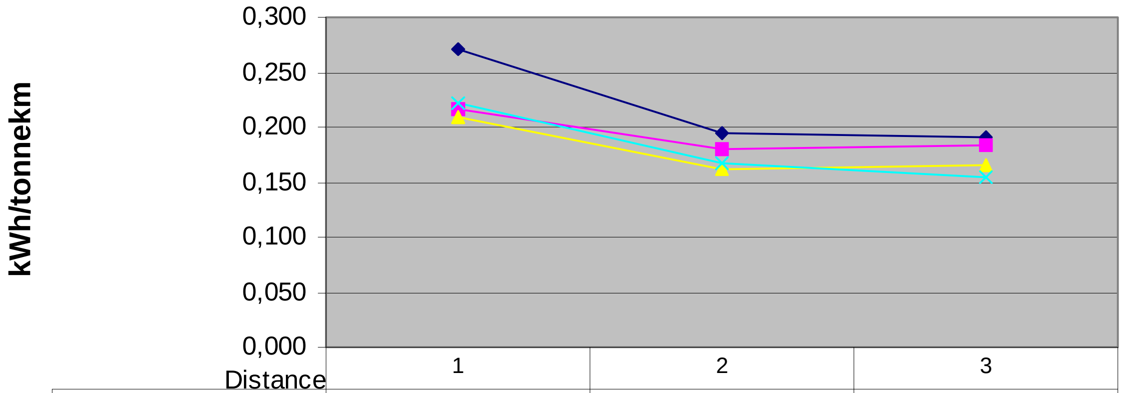


Distance	1	2	3
Payload 21 tonnes	0,223	0,166	0,154
Payload 25 tonnes	0,183	0,147	0,144

Figure 4: Effect of difference in load factor on energy efficiency.

In figure 4 the graphs show the same driver and lorry on the two down trips. The down trip with payload 25 tonnes took place under good driving conditions while the other (21 tonnes payload) had partly rain on distance one and two. This could also contribute to the difference in energy efficiency. Driving in Western Norway with hilly topography gives larger differences in energy efficiency between the two trips. This illustrates the importance of high load factor especially for driving in mountainous regions.

Our data indicates lower energy efficiency when driving on the eastern parts of the European continent compared with driving in western parts, but the data set is too limited to draw such a conclusion. The figure below shows energy efficiency by different routes and drivers.



Distance	1	2	3
21 tonnes to Poznan	0,272	0,194	0,191
21 tonnes to Poznan	0,217	0,181	0,184
22 tonnes to Torino	0,210	0,162	0,165
21 tonnes to BSM	0,223	0,166	0,154

Figure 5: Energy efficiency by different routes and drivers.

In figure 5 the distances are: 1=Ålesund-Otta, 2=Otta-Oslo and 3= different distances on the continent. The figure shows close energy efficiency for three of the drivers on the first distance, Ålesund to Otta. In connection to figure 3 we have explained the large difference in energy efficiency for one of the drivers to Poznan. The difference at distance 2, Otta to Oslo, could partly be explained by higher load factor for the lorry to Torino. In addition the two drivers to Poznan had rain on this distance while the other drivers had nice and dry weather.

2.4. Summary

The measurement of the energy use in the four case lorry routes can be summarised as follows:

- The data on energy efficiency in fish transport from western Norway to the European continent shows an average energy use for down- and return trip of approx. 0,22 kWh per tonnekm.
- The return trips have lower energy efficiency, than the down trips due to lower load factor. If the load capacity had been fully utilised on return trips, the overall energy efficiency could be improved to about 0,18 kWh per tonnekm.
- Even with relatively good utilisation of load capacity today there is a potential for further energy efficiency improvements by increasing the load factor.
- Different driving style could have a great influence on fuel use and thereby energy efficiency. One observation shows that non-economic driving could increase fuel consumption with 25 percent.
- The energy saving potential in today's lorry transport is largest in areas with rugged topography.

3. Description of actions and the conditions necessary for their implementation

In the report from phase 1 of this project we have described potential pilot actions (Andersen & al., 1999). Here we present the selected actions that we planned to implement during the project period: actions to reduce fuel consumption, actions to increase load factor and actions to the transfer of transport mode. We also describe the necessary conditions for implementation of the actions.

3.1 Actions to reduce fuel consumption

The presentation of the actions is structured as: 1) Driver information and motivation and 2) Already implemented actions. We also present the energy saving work in another company, Nistad transport.

3.1.1 Driver information and motivation

The case company Waagan Transport has earlier focused on driving style to reduce fuel consumption. In the early 1990's the company was encouraging its drivers to drive economically. For example it was banned to let the engine run "idle" for extended time periods. In 1994, at the time when a computer information system were installed in the trucks, drivers at Waagan Transport were competing in minimising the fuel consumption. According to manager Per Waagan, there is a difference between older and younger drivers when it comes to awareness of fuel costs: For instance, younger lorry drivers are prone to neglect the importance of avoiding idle running when the car is standing still.

Expansion of the company during the last years has made it more difficult to control driving pattern at the individual level. In connection with renewing the truck fleet in 1996, Volvo requested a driving course for all drivers in the company. About 80 percent of the drivers completed the energy-economy course (Waagan, P., 1998-2000).

The company was willing to continue this work. The plan was first to establish a driving course for some of the drivers in order to measure the effects on fuel consumption. Subsequently, a new driving course for all the drivers in the company was to be held. The course intended to focus on energy efficient driving with these subjects:

- Develop the driving style
- Reduce driving resistance
- Avoid idle driving
- Route planning
- Choose the most energy efficient top and average speed.

The course was to be carried out in co-operation with VOLVO. VOLVO was willing to take the responsibility for teaching the drivers in the spring of 2000 (Nordvik, 1999-2000). For different reasons, described in 3.4.2, the course has not been offered. To compensate this we have made efforts to use experiences from another transport company working with energy saving issues. This is described in the section 3.1.3 below.

3.1.2 Actions already implemented in the company

The management at WT emphasises the importance of providing the best engine technology available. The company renews the lorry fleet every second year, and selects the most energy efficient engine, trailer type and cooling system. The lorries are being replaced after 150.000-

170.000 km. Other actions already implemented in the company are (Waagan, P., 1998-2000):

- Removal of extra equipment on the lorries which causes air resistance (e.g. signs on roof).
- Changes of air and diesel filter at regular intervals, by WT's own garage.
- The garage employees perform lorry cleaning (removal of ice, snow and dirt) as often as possible to avoid ear resistance increased weight of the lorries. The frequency of the cleaning varies somewhat, from cleaning after every trip to cleaning every fortnight.

3.1.3 Nistad Transport company

This presentation is based on information from Arne Nistad, manager of Nistad Transport company. The company is located in western Norway and also carries foodstuff for the industry, but not fish. The company has 19 lorries used in long distance transport and shorter distribution- and supply transport.

In April 2000 the company started a developing process with the aim of reducing energy consumption in lorry transport by 5 % during one year. The information and motivation work included actions such as:

- Energy saving course for all drivers
- Examinations
- Motivation and competence developing processes in groups of drivers

Participation in this process is mandatory for all drivers. An important element is to organise the drivers in three groups according to where they live. Fuel reduction aims are established for each whole group and not individually. This gives a constructive competition between the groups to reduce fuel consumption, and focus on teamwork.

The company has reached their initial goal regarding energy saving. Measurements during the first year indicate an average fuel reduction of about 5 %. Energy saving effect differs from driver to driver, the largest measured effect is 20 %. Large reductions have been measured both for long distance transport and for shorter distribution and supply transport. This corresponds to the findings in the Swedish case, where a test showed that changes in driving style, ("eco-driving"), could decrease fuel consumption up to 10 % in lorries (Hjortsberg and Ahlvik, 2001).

In addition to lower fuel cost, the energy saving work has had positive economical effects by reducing maintenance on the lorries and reduced wheel and tire wear. Nistad Transport company has plans for further work on these issues in the years to come.

3.2 Actions to increase load factor

Actions to increase load factor have been on the agenda in discussions with WT, and it was concluded to investigate the possibilities of co-operation with other transport companies to better utilise load capacity on return trips. However, only limited improvement possibilities in this area have been identified.

3.3 Actions to the transfer of goods mode

Transfer of goods from road to rail has been implemented as an important strategy in WT during the project period. This has given the project an unique position to measure the energy saving effects from this transferral. Another action has been to streamline the custom routines for paying taxes on the ships from Norway to the continent, making this form of transport more attractive to use.

3.3.1 From road to rail

This sub-chapter is based on information obtained from Per Waagan (Waagan Transport) and Knut Brunstad and Kjell Owrehagen from Norwegian Railways (NSB). Before the project period WT had been in contact with NSB trying to establish transfer of goods from road to rail on the route between Åndalsnes and Oslo. The SAVE project gave an opportunity to address this issue again, and in a broader context. Western Norway Research Institute therefore suggested for Waagan Transport to contact NSB again concerning the possibility of transporting semitrailers on rail from Åndalsnes to Oslo.

This effort was successful, and during the winter 1999/2000 negotiations between WT and NSB gave results. On February 14th 2000 a contract was signed for transport of trailers on rail from Åndalsnes to Oslo, a distance of about 450 km. According to the agreement, WT was to use NSB transport services for all cargo between Møre og Romsdal county to Oslo or through Oslo. In August 2000 the first of these transports was taking place.

This intermodal transport is based on "huckepack" technology giving opportunities to combine all means of transportation: road-, rail- and sea-transportation. The first distance from the west coast of Norway, mainly the western part of Møre og Romsdal county, is done by truck to Åndalsnes. The distance from the WT terminal (close to Ålesund) to Åndalsnes is 110 km. In Åndalsnes the semitrailers are placed on rail to Oslo. The train has two departures per day from Åndalsnes to Oslo at 06.30 and 21.00 and two return departures from Oslo. The trip takes nine hours each way. The maximum payload at the Rauma railway is approx. 550 tonnes per train, limited by the steep climb up the valley Romsdal. Each train carries 8-10 semitrailers in addition to ordinary containers.

About 50 percent of WT's total transport volume towards Eastern Norway, exports included, is by the year 2000/2001 carried by train to Oslo. In autumn 2000 the fish transport from Oslo to the European continent was transported both on rail and road. Transport of dried cod from Western Norway to Italy by train started in the middle of November year 2000. From Oslo this transport takes 48 hours to Verona in Italy, from where the fish is transported by lorries to the final customers.

Frozen herring and mackerel to Boulogne-sur-Mer are transported with rail from Western Norway to Oslo and with boat from Oslo to Rotterdam, from where the lorries bring the fish to the customers in BSM. In France efforts are made at present to permit implementation of the huckepack-system on rail. In this way WT has developed an intermodal transport chain based on truck, train and ferry from the western coast of Norway to the continent.

3.3.2 Barriers at the customs control

WT has re-negotiated the customs control at the Colorline ships. The aim was to streamline the routines for paying the customs duties and taxes. On some of the routes the customs control has constituted a barrier to the use of ship transport. WT has succeeded in their efforts to solve this problem, and the customs control procedures have been improved. Thereby this barrier has been overcome (Waagan, K., 2000).

3.3 Necessary conditions for implementing actions

Necessary conditions for implementing actions are described according to this structure:

- Generally necessary conditions
- Conditions to reduce fuel consumption in today lorry's transport
- Conditions to the transferral between transport modes

3.4.1 Generally necessary conditions

In the 1980's Waagan Transport tried to develop energy efficiency as a part of an environmentally image used in marketing to obtain competitive advantages. However, they found no potential for translating such goodwill into a transport payment premium. Their customers did not want to pay more for a more environmentally friendly transport service (Waagan, P., 1998-2000).

To reduce the energy use beyond the level required by public laws and regulations, a commercial company such as WT needs an economical motivation. Increase in income or reduction in costs could provide such motivation. Reduction in energy use could also be a strategy to make a positive image and thereby enabling the company to keep their market share. Necessary conditions for turning energy efficiency into a business strategy are therefore actions that bring the company in position to:

- Reduce costs, or
- Increase income, or
- Get other competitive advantages (e.g. positive image)

3.4.2 Conditions to reduce fuel consumption

Based on the experience from this project, the following question seems important when implementation of actions in a case company is concerned: Are the actions, and the implementation processes, suitable or compatible with the main processes going on in the company? If not, it seems to be very difficult to implement new actions and strategies.

Another important experience is that combining implementation of actions with measurements of the same actions at the same time is difficult in the transport sector. This is a sector where rapid changes occur, and the time available for implementation of such development processes is limited. The intention was to implement a driving course to develop energy efficient driving, and the effects of the course were to be measured. This objective required measurements made before and after the driving course. The measurements before implementing the action were time- and resource consuming for the case company in 1999. Being ready to start the driving course in the spring of 2000, the company had practical problems: It was difficult to gather the drivers at one place at the same time for a course without reducing the custom service, and it would be expensive to teach them one by one. In the meantime two of the drivers got sick for a long time, and two others changed to newer lorries. The plan for measuring the effect of the training course was therefore not carried out.

For the reasons indicated above, the implementation process took much time, and for some period the project overlapped with another main process in the company: developing transferral of goods from road to rail. This process changed the conditions for implementation of a driving course drastically. The distance with probably the greatest energy saving potential, the hilly and steep Norway, was reduced substantially. In addition, the company changed their organisation to a large extent in important ways by hiring transport services from other companies.

A third factor which influenced the conditions for reducing the energy use is, according to the case company, a new phenomenon the last years: All types of fish transports are rush deliveries and have to be delivered exactly on time. The customers of the fish-exporter are emphasising short delivery times. These are not the best conditions for choosing the most energy efficient driving style. This situation could also sometimes make it difficult to choose the most energy-friendly transport route. Delayed deliveries from the exporter to the transport company reinforce this problem.

To sum up the project experiences: Important conditions for reduction of fuel consumption in today's lorry transport are:

- Actions and strategies have to be adapted to other main processes going on in the company
- The hard competition in the transport sector makes it difficult to spend enough time on developing processes
- The increasing demands for "just in time" deliveries make it difficult to use the most energy efficient driving style.

3.4.3 Conditions for the transferral from road to rail

Both WT and NSB have made preparations to initiate fish transport on rail. Here we focus on conditions necessary to realise the introduction of intermodal transport between road and rail on the line Åndalsnes - Oslo.

Waagan Transport (WT)

This presentation is based on information from Per Waagan. WT's motivation for transferral of goods from road to rail is reduction in costs. Driver wages represent 40 percent of total costs in the company, and it is impossible to compete with other companies on the European continent with "eastern European (low) wages". Transferral of goods to rail is one solution for reducing costs for wages. Another motivation is to develop a more flexible transport system with road, rail and sea. Rail transport may also improve the transport company's public image. Positive environmental image might bring new customers to the company.

Investments in 49 new trailers with the huckepack system is the most important action made by WT to realise the transferral to rail transport. These kinds of trailers are adaptable for different transport modes. WT has also changed its organisation. In both ends of the rail transport segment they are now hiring services from other transport companies.

To obtain experiences, WT has started transporting furniture and some fish products through this new intermodal transport chain. In autumn 2000 fresh salmon was difficult to include in this system due to non-optimised logistic chain. When the punctuality is improved WT is going to include fresh fish in these intermodal transport chains.

This transferral of goods from road to rail has given a substantial reduction in the volume of goods transported by WT on road. In the coming years, with also fresh fish being transported on rail, the mode change will have been carried even further. The important factor for these operations is a streamlining of the logistic chain to improve the stability of the deliveries.

Norwegian railways (NSB)

Here we present preparations done both by NSB Cargo and The Norwegian National Rail Administration. The presentation is based on information from Knut Brunstad and Kjell Owrehagen in NSB Cargo.

Enlarging tunnels

The transport of semitrailers on train demands larger space than traditional goods trains. This implies that some tunnels need to be enlarged to facilitate this type of combined transport. In August 2000 Raumabanen (Dombås – Åndalsnes) was ready for such transport after preparation work of The Norwegian National Rail Administration. The administration is responsible of the rail infrastructure.

Intermodal rail equipment
NSB Cargo has procured wagons for semi-trailer transport. They also obtained new trucks especially adapted for handling semitrailers. The first third of the rail distance from Åndalsnes to Oslo is not electrified. Hence NSB uses diesel trains at this distance. At Otta the diesel locomotive is changed with electricity locomotive, and opposite on return. The change to electricity train at Otta means lower utilisation of the trains compared with using the diesel train the whole distance to Oslo.

Streamlining the timetable
In summer 2000 NSB Cargo changed the timetable on the CombiXpress on Rauma Railway in order to facilitate WT fish transport. This new timetable might cause problems in the future due to potential conflicts between goods trains and passenger trains. The plan is to develop the passenger train services with faster trains, but this will increase the need for passing lines for trains going the same direction. The policy in NSB is to give the passenger trains priority before goods trains.

Waagan makes cumulative effects
In year 2000 WT was the only transport company using the Åndalsnes-Oslo line for fish transport. When the intermodal transport co-operation between WT and NSB Cargo was published in august 2000, NSB received many inquiries from other transport companies. In 2001 therefore, two new large transport companies are going to transfer goods from road to rail using this line. Our case company has apparently started a process among the transport companies resulting in a substantial reduction in energy use in transport of goods. In NSB Cargo this process is mentioned as “the Waagan effect”.

4. Routes for fish on rail from Norway to the continent

Norwegian Railways has in co-operation with Swedish Railways (SJ) established transport possibilities for fish on rail with connection to rail transportsystems on the European continent. This gives the unique opportunity to transport fish from e.g. Narvik in northern Norway all the way to Verona in Italy, a distance of about 2700 km.

The transport product is called “CombiXpress” and comprises the option of bringing semi-trailers, ordinary containers and Swap bodies with the same train. The customers can order reservation or buy transport services daily. The transport of fish by semitrailers on train has increased during 2000. In Norway these lines are adapted for intermodal transport (www.nsb.no):

- Oslo- Åndalsnes
- Oslo-Trondheim
- Oslo-Narvik
- Oslo-Kristiansand-Stavanger

Further plans include the opening of parts of the line Trondheim-Bodø before the end of 2002 for this type of transport. More long-term plans exist for Oslo-Bergen, but this requires much work due to the many tunnels on this route. Below we give a short presentation of the rail transport routes from Scandinavia to the continent. So far, by year 2001, the main fish transport route consisting of rail from Norway to the European continent is performed with Arctic Rail Express (ARE) and Padborg-Oslo Rail Express. Scandinavian Rail Express also transports some fish cargo to Italy (Owrehagen, 2001).

4.1. Arctic Rail Express (ARE)

This rail serves fish transport from northern Norway (Finnmark, Troms and northern part of Nordland county). The trip takes 36 hours with departure from Narvik (Norway) or Gällivare (Sweden) through Sweden to Hälsingborg and across Denmark to Padborg. The connection to Padborg was established in year 2000 with direct connection to Malmö and Padborg without any reloading. See the map.

In January year 2001 there were six departures from Narvik to Oslo, and one to Padborg each day. NSB is making efforts to increase the volume to Padborg. The volume of fish carried by ARE was about 2700 containers, or about 30000 tonnes in 1999 and 2000 each year. This is one half with fresh fish and the other half with frozen fish (Bertnes, 2001).

The utilisation is 60 percent on the trip from Narvik to the continent, and 100 percent on the return trip. Total cargo weight for one train is 700 tonnes, and a normal fish transport contains about 300 tonnes of fish.

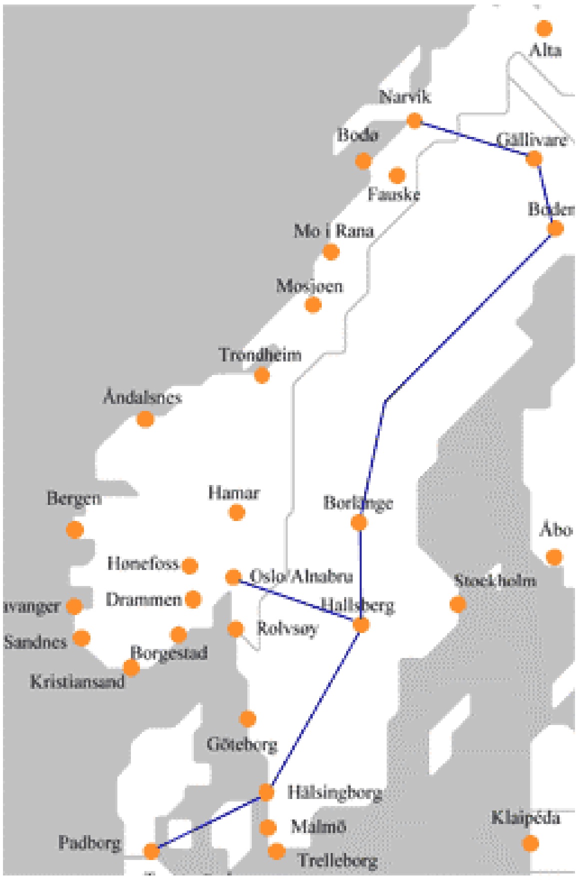


Figure 6: Artic Rail Express from Narvik/Gällivare to Padborg.

Source: www.nsb.no

4.2. Scandinavian Rail Express

The Scandinavian Rail Express has connected the "CombiXpress" in Scandinavia to different combitrains-systems on the continent since 1997. There are five weekly departures from Oslo to Travemünde, Duisburg, Cologne, Mannheim and Basel. Train-time from Oslo to Basel is 36 hours. There is also connection to Verona and Milano in Italy. This transport route is now often used for dried fish from Norway to Italy. See figure 7.

In 1999 the timetable was changed to get better connections with the ferry from Trelleborg to the continent, and the transport volume increased (Owrehagen, 2001). Scandinavian Rail Express is established in co-operation between NSB Cargo and Rail Combi AB in Sweden.

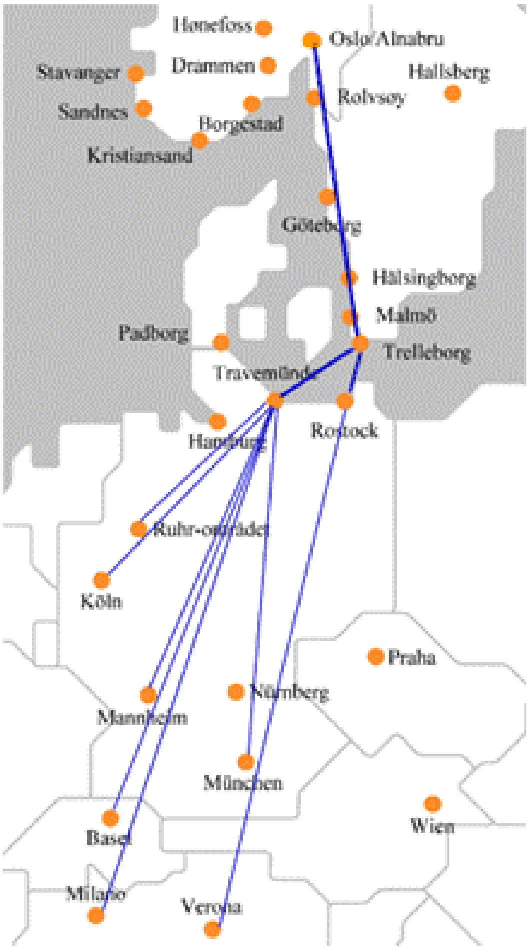


Figure 7: Scandinavian Rail Express (SRE), Oslo-Trelleborg-the European continent.

Source: www.nsb.no

4.3. Padborg - Oslo Rail Express

After the opening of the Öresund bridge a new combi-express train between Oslo and Padborg was started. This connection is adapted especially for fish transports to the continent, with departure from Oslo every Friday to serve the fish market on the continent over the weekend.

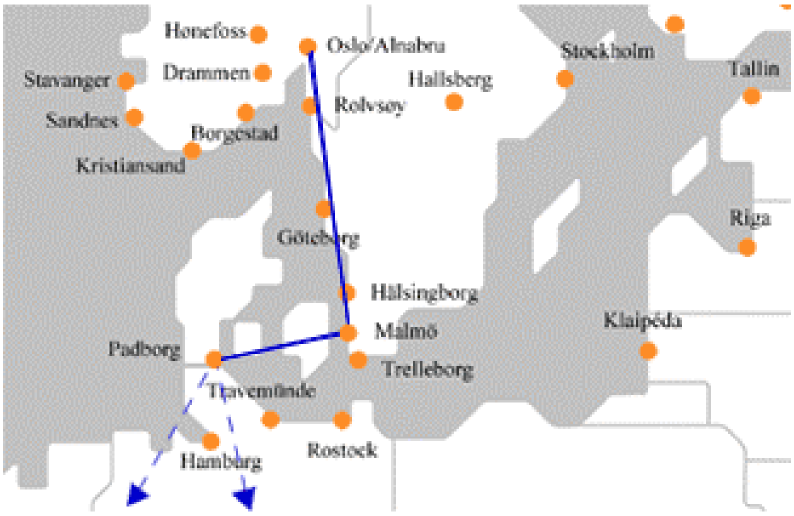


Figure 8: Padborg – Oslo Rail Express.

Source: www.nsb.no

5. Energy saving effects

In this chapter we present the energy saving effect of the performed pilot actions and the potential possible actions. The focus is on energy saving effects in the lorry transport, and the effect of transfer of transport mode from lorry to rail and sea. The effects are shown both for our four cases and for the Norwegian fish export as a whole.

5.1. Energy saving effects of actions in today's lorry transport

In the following we present an estimate of the energy saving potential in the lorry transport of fish exported from Norway. The calculations are based on the four cases. We assume that these four cases are representative for Norwegian fish export. This is a rough estimation, presumably good enough to illustrate the energy saving effects.

The energy saving potential in the present lorry transport is about 5 %, according to the energy saving results in the company Nistad Transport in western Norway. Total volume fish export by lorry from Norway was 3 222 557 tonnes in year 2000 (Dahle, 2001). Assuming 5 % decrease in fuel consumption in this transportation we obtain an energy saving potential at about 12 000 tonnes fuel or about 115 million kWh. The table below shows this effect.

Table 3: Energy saving potential in the present lorry transport of fish from Norway to the European continent (round trips).

Export by lorry, year 2000 (tonnes)	3 222 557
Export by lorry[1] (kWh/tonne)	317
5 % reduction, (kWh)	114 864 998
5 % reduction, (tonne fuel)	11 769

[1]Average of the four cases.

5.2. Energy saving effects of transfer to rail and boat

In this chapter we present the potential energy saving effects of a transfer of fish transport from road to rail and sea. The calculations are based on the four cases of fish transport from western Norway to the European continent (described in chapter 2). Today's lorry transport is the basic alternative.

The fuel consumption, distances, duration and average loads for the basic alternative are shown in Table 4. Data for this transport is based on the measurements made during the project for round trips (from Norway to the European continent and back to Norway). Data were collected in the period 1999-2000.

Table 4: Average[3] fuel consumption, distances, duration and loads for the basic alternatives for fish transport.

Case	Lorry fuel consumption (litre)	Road distance (km)	Ferry duration[4] (hrs)	Rail distance (km)	Total duration (hrs)	Payload (tonne)
A	1537	3161	16	-	96	18
B	1659	4622	28	436	158	22
C	904	2515	14	-	98	16
D	1232	3644	44 (14)	-	134	17

For all cases and alternatives the distance from the west coast of Norway near Ålesund to Åndalsnes (about 110 km) is done by lorry. During the project period a change in transport mode was implemented for case B and D. Dried cod (case B) is transported by train on the main distance from Åndalsnes to Verona (Italy). Lorry is used the last distance to Torino. This route is named B_R in the subsequent text of this chapter. In Case D lorry transport is replaced with rail and Cargo ferry (no passengers). Frozen herring and mackerel are transported with rail from Åndalsnes to Oslo, with boat from Oslo to Rotterdam, and lorry the last distance to Boulogne Sur-Mer. This route is named D_{FR}. These two intermodal transport routes were established during autumn year 2000, and have replaced lorry-based transport.

To achieve major improvements in energy efficiency a mode change from road to more rail and sea is however assumed to be necessary. The effects of such mode transfers on the energy-use are analysed by the Nordic Transportpolitical Network in the InterregIIc-programme in the report "Optimal transport corridors based on a sustainability- requirement". The data material from the report has been supplemented by updated data from the analyses in this SAVE-project. Here we use the scenarios from the InterregIIc-report for year 2015 to illustrate the potential energy saving effects for alternative routes to our cases. This include assumption with railway bridge across the Fehmarn Belt (Rødby-Puttgarden):

* *Case A* (fresh herring to Poland) with train to Poznan. This route is named A_R.
* The sea alternative in *Case B* (dried cod to Italy) is boat from Ålesund harbour to Genova, and lorry the last distance to Torino. This route is named B_B.
* *Case C* (fresh saith filet to Germany) with the two alternatives rail (C_R) or sea (C_B). The rail alternative includes rail from Åndalsnes to Bremerhaven. For the sea alternative, we assume boat the whole distance from Ålesund harbour to Bremerhaven.
* The boat alternative in *Case D* (fresh and frozen white fish to France) is by boat the whole distance from Ålesund harbour to Boulogne-Sur-Mer. This route is named D_B.

For calculation of energy and time expenditure, we assume the same average payloads on the alternative routes as on the actual transport by lorry. The energy factors shown in table 5 are

[3] The numbers are averages for each of the cases. Case A and D are each based on three round trips, B on one and C on five.
[4] The number in parenthesis is the route with ferry between Moss and Fredrikshavn.

applied. Note that two types of ferry are used: Traditional ferry carrying both passenger and goods, and Cargo ferry only carrying goods.

Table 5: Factors applied in the energy use calculations for rail and ferry

Means of transportation	Energy use (kWh/tonnekm)
Traditional ferry[5] (at 50% load factor)	0,50
Cargo-ferry[6] (at 80% load factor)	0,35
Lorry[7] (at 60% load factor)	0,26
Train[8], electric (at 70% load factor)	0,06
Boat[9] (at 70% load factor)	0,08

Source: Hansen, Høyer and Tengstrøm (2000), and own data collected in this SAVE project.

It is apparent from the table above that the energy efficiency of ferry is low compared with the other transport modes, especially train and boat. Contribution to the total energy use from traditional ferries is relatively large, even though the distances of the distances with transport of lorries on ferries are short compared with the total transported distances. From this one can conclude that the transport by lorry is more energy-efficient than when the lorries are transported by traditional ferry. This is the situation in the basic alternatives.

In the scenarios we have no traditional ferry use assuming railway bridge across the Fehmarn Belt. The distances with lorry, rail and boat, total duration and energy use for the scenarios are present in table 6. The calculation is based on round trips, from Norway to the European continent and back to Norway. Actions implemented during the project are in grey.

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[5] This is applied to all routes with ferry (for people, cars and cargo), except for the alternative route to BSM (D_{FR}). The energy data is based on Hansen, Høyer, Tengström (2000)

[6] The energy use factor is calculated from data received from DFDS Tor Line. They have a cargo-ferry route from Oslo to Rotterdam, carrying only cargo. This energy data is used on the route $D_{FR.}$

[7] Lorries are used for distances at 300 km and shorter. This explains the higher energy use factor than on long distance lorries.

[8] Trains are assumed to be powered by electricity only. The trains for goods transport are assumed to have maximum speed of 120 km/hr and with carriages for transport of containers/semitrailers on 2 storeys. Already at the end of the 1990's Swedish and Finnish rail transport averaged 0,03-0,04 kWh/tonnekm (load factor 60-70). A higher energy use factor than this is used to compensate for the weight of containers/semitrailers and the need for cooling of the fish during the transport.

[9] This is energy use for traditional long distance cargo ship using less energy than the ferries.

Table 6: Distances, duration and energy use in the scenarios of fish transport.

Case	Lorry distance	Rail distance	Boat/ferry distance	Total duration[10] (hrs)	Energy use (kWh)
A_R	226	3574	0	108	4918
B_R	826	4674	0	166	10894
B_B	814	0	10686	438	23463
C_R	226	3074	0	90	3891
C_B	0	0	2700	116	3456
D_B	0	0	3300	139	4488
D_{FR}	826	900	2056	128	16802

A comparison between the basic alternatives (with lorry transport in 1999) and the scenarios (rail transport, boat transport and ferry and rail based transport) is shown in table 7. The results are present in percentage change compared with lorry transport in parenthesis. Actions implemented during the project are in grey. The basic alternatives is based on are actual data from lorry transport. The scenarios are based on calculated data from implemented actions and potential transferable alternatives.

Table 7: The energy use (kWh) for the scenarios compared with the basic alternatives.

Main transport mode/case	**A**	**B**	**C**	**D**
Lorry based transport (1999)	20959	27341	12975	21145
Rail based transport	4918 (-77 %)	10894 (-60 %)	3891 (-70%)	
Boat based transport		23463 (-14%)	3456 (-73%)	4488 (-79%)
Ferry and rail transport				16802 (-21%)

Table 8: Time use for the scenarios compared with the basic alternatives.

Main transport mode/case	**A**	**B**	**C**	**D**
Lorry based transport (1999)	96	158	98	134
Rail based transport	108 (+13 %)	166 (+5 %)	90 (-8 %)	
Boat based transport		438 (+177 %)	116 (+18%)	139 (+ 4 %)
Ferry and rail transport				128 (- 4 %)

Rail based transport with dried cod to Italy (B_R) is *implemented* during the project in our case company. The reduction in energy use is large, with 60 % lower energy use than lorry based

[10] An average speed of 80 km/hr is assumed for trains. In addition 6 hours waiting time at each of the loading/recoupling locations. The average speed of boats is assumed to be 14 knots. In addition there are a loading and unloading time of 4 hours at each port. This is low due to the improved efficiency of the port operations. The average speed for lorries (including rest hours) is assumed to be 60 km/hour. This might appear to be low, but as pointed out earlier, the lorries are assumed to be used mainly for shorter distances in distribution- and supply transports.

transport. The effect comes from the more energy efficient train transport used on the whole distance from Western Norway to Verona in Italy. The transport is similar in time efficiency (5% difference) to the lorry-based transport in 1999.

The other *implemented action* D_{FR}, frozen fish to Boulogne Sur-Mer in France, is based on ferry and train transport. Here the reduction in energy use is "only" about 20 percent, caused by the train from Åndalsnes to Oslo. The energy saving effect is limited due to the long ferry distance Oslo-Rotterdam. Ferry is less energy efficient than lorry transport.

The other alternatives of transferral result in lager potential in energy use reduction. From the tables above it is clear that the train transport of fresh herring to Poland (Case A_R) is close to being as time efficient as the lorry based transport. The increase in time use is 13%, or 12 hours. The reduction in energy use is however immense, with 77% lower energy use than lorry based transport. This is due mainly to the use of the energy efficient train, but also from the reduced ferry distance. This calculation assumes bridge across the Fehmarn Belt (Rödby-Puttgarden).

One of the three boat alternatives, dried cod to Italy, gives only little reduction in energy use because of the long boat distance into the Mediterranean. The transport by boat (B_B) is more time consuming, but since the product is dried cod, this is of less importance due to the long durability of the fish product. The important question is not the time efficiency in itself, but rather if the delivery reaches the destination at the time agreed upon. Even if the sea transport, as is also the case for the ferry transport, may be affected by increased storm activity from climate changes, "loose couplings" and "simple interactions" enable it to deliver at the time agreed upon, though not as fast as the rail transport.

The sea transport, by ship (not ferry), is more energy efficient than the lorry based transport. In alternative C_B and D_B the boat caused a reduction in energy use at about 70-80 percent compared to lorry transport. These calculations are based on the important assumption using the same large ships as overseas transportation between Europe and America and Europe and Asia.

The transport of fresh saith filet to Germany by rail (C_R) does not differ much from the lorry transport in terms of time duration (8 % difference). The energy saving is in addition large with a reduction in energy use of 70%. The transport by sea to Bremerhaven (C_B) takes 18 % more time than the lorry based transport. Even though the time of transport (58 hours one way) does not seem prohibitive, the reduced time efficiency may reduce the likelihood of sea transport as the preferred choice. The energy saving of the sea transport compared to the lorry based transport for this case is quite large, with a reduction in energy use of 73%.

The transport of fresh whitefish by boat to France (D_B) is almost as time efficient as the lorry transport, taking 9 hours longer. The long ferry distance is part of the lorry-based transport can explain this. The reduction in energy use by the sea transport in this case is large, with 79% lower energy use than lorry based transport.

5.3. Potential effect for all fish transport

Here we present the potential energy saving effect of a transfer of fish transport from road to rail. As our figures in chapter 5.2 shows, the energy use in rail transport of fish is only 30 % compared with lorry transport. If all the fish export with lorry on road from Norway to the European continent were transported by train the total reduction in energy use could be about 70.000 tonnes fuel or nearly 700 mill kWh. The data is given in the table below.

Table 9: Energy saving potential of a transfer of fish transport from road to rail.

Export by lorry, year 2000 (tonnes)	3.222.557
Exported by lorry[1] (kWh/tonne)	317
70 % reduction with rail (kWh)	689.189.990
70 % reduction with rail (tonne fuel)	70.614

[1]Average of the four cases.

Table 9 includes round trips (Norway – European continent – Norway). This calculation is based on the assumption that our four cases are representative in terms of transport distance and transport mode in the present fish export. This is not necessarily right, but our calculation gives an estimate of the future energy saving potential.

6. Conclusions

Fish transport from western Norway to the continent shows an average energy use for down-trip and return trip of about 0,22 kWh per tonnekm. The return trips have lower energy efficiency due to low load factor. If the load capacity had been fully utilised on return trips, the energy efficiency could be improved to about 0,18 kWh per tonnekm.

Different driving style could have a large influence on fuel consumption and thereby energy efficiency. Hard driving could increase fuel consumption with 25 percent compared with traditional driving in areas with rugged topography in selected cases. While "eco-driving" could decrease fuel consumption with approx. 10 percent compared with traditional driving. This shows a very large range of possible fuel consumption due to the driving style.

Two pilot actions to increase energy efficiency have been carried out:

- Actions to reduce energy consumption and to increase the load factor in today's lorry transport
- Actions to achieve transferral of goods from lorries to more energy efficient rail and ship transport.

The result shows that it is possible to reach a 5 % reduction in the energy use in the lorry transport at company level actions containing information and motivation measures among the drivers. These actions comprise energy saving course for all drivers, examinations and motivation and competence developing processes. Participation has been mandatory for all drivers. An important element is to organise the drivers into groups and establish fuel reduction aims for the whole group and not individually. This gives a constructive competition between the groups to reduce fuel consumption, and focus on teamwork.

For the whole fish export from Norway transported on lorry, a 5 % reduction in fuel consumption would give an energy saving effect of about 12.000 tonnes fuel or about 115 mill kWh a year. This estimate is based on an assumption that our four fish cases are representative for Norwegian fish export as a whole.

In general, commercial companies need economic motivation to reduce the energy use more than to a level required by public laws and regulations. Such motivation could come from an increase in income or reduction in costs. Reduction in energy use could also be a strategy for developing other competitive advantages (e.g. positive image) to keep their position in the market without particular possibilities to increase income or to reduce costs.

More specifics conditions for reduction of fuel consumption in today's lorry transport:

- Actions and strategies have to be suitable with other main processes going on in the company
- The hard competition in the transport sector makes it difficult to spend much time on developing processes like information and motivation of drivers
- The increasing demands for "just in time" deliveries make it difficult to use the most energy efficient driving style.

During the project period transferral from road to rail and ferry took place for two of the four case routes. In rail-based transport with dried cod to Italy, reduction in energy use amounts to

60 % compared with lorry based transport. The effect comes from the more energy efficient train transport used on the whole distance from Western Norway to Verona in Italy. The train transport is nearly similar in time efficiency to the lorry-based transport.

The other *implemented action* concerns transport of frozen fish to Boulogne Sur-Mer (BSM) in France, which is based on ferry and train transport. In this case the reduction in energy use is “only” about 20 percent. The energy saving effect is limited due to the long ferry distance Oslo-Rotterdam as ferry is less energy efficient than lorry transport.

The other potential alternatives of modal shift give larger reduction in energy use. Transferrals of goods from road to rail transport in three cases (from western Norway to Poznan, Bremerhaven and Boulogne-sur-Mer) give an average reduction in energy use at about 70 %. This calculation assumes bridge across the Fehmarn Belt (Rödby- Puttgarden).

For the boat alternative the reduction is at the same level for the transport to Bremerhaven and BSM, whereas the boat transport to Italy uses nearly as much energy as the lorry transport due to the long sea distance. It is important to note that these calculations are based on the use of large vessels made for intercontinental sea transport.

A transfer from today’s road transport of fish from Norway to the European continent to rail transport could give a reduction in energy use at about 70.000 tonnes fuel or nearly 700 mill kWh. This calculation is based on the assumption that our four cases are representative in terms of transport distance and transport mode in the present fish export.

Specific necessary conditions for transferral of goods to rail in the case company Waagan Transport were the possibilities for reducing costs for wages. Another goal was to develop a more flexible transport system with road, rail and sea. Rail transport makes it also possible to improve the public acceptance. Positive environmental image might bring new customers to the company.

Another necessary condition is investment in new trailers with the huckepack system adaptable for different transport modes. In autumn 2000 fresh salmon was difficult to include in this system due to non-optimised logistic chain. When the punctuality is improved WT is going to include fresh fish in these intermodal transport chains.

Also Norwegian Railways (NSB) and The Norwegian National Rail Administration have done preparations to establish a transferral to train transport by enlarging tunnel profiles and investment in intermodal rail equipment. There is a potential conflict between cargo trains and public trains in the future. With increasingly faster public trains, there would be a need for passing lines also for trains in the same direction.

In year 2000 Waagan Transport was the only transport company using the Åndalsnes-Oslo railline for fish transport. When the intermodal transport co-operation between WT and NSB Cargo was published in august 2000, NSB got many similar inquiries from other transport companies. In 2001 two new large transport companies are therefore going to transfer goods from road to rail using this line. Our case company has apparently started a process among the transport companies resulting in a substantial reduction in energy use in transport of goods. In NSB Cargo this effect is mentioned as “the Waagan effect”.

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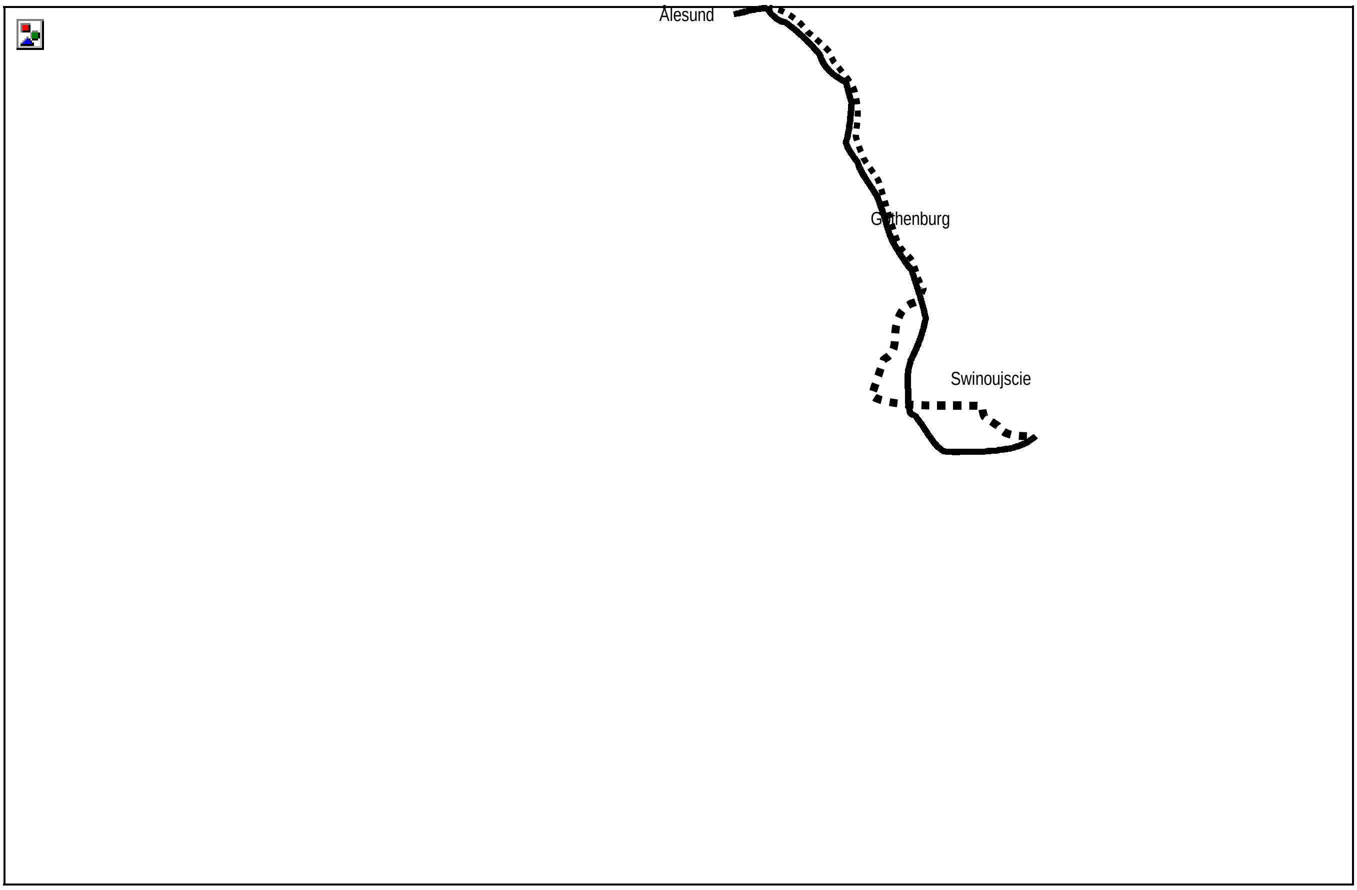
Attachment 1: Case routes described on map, including alternative routes by rail and boat

CASE A:

Fresh (and frozen) herring to Poland (Poznan) with lorry from Ålesund via Gothenburg to Trelleborg, ferry to Rostock and lorry on the last distance to Poznan. This route is marked with a whole line on the map.

The alternative route by train is marked with a dotted line: Lorry from Ålesund to Åndalsnes (110 km), train from Åndalsnes to Poznan. This assumes railway bridge across the Fehmarn Belt (Rødby-Puttgarden).

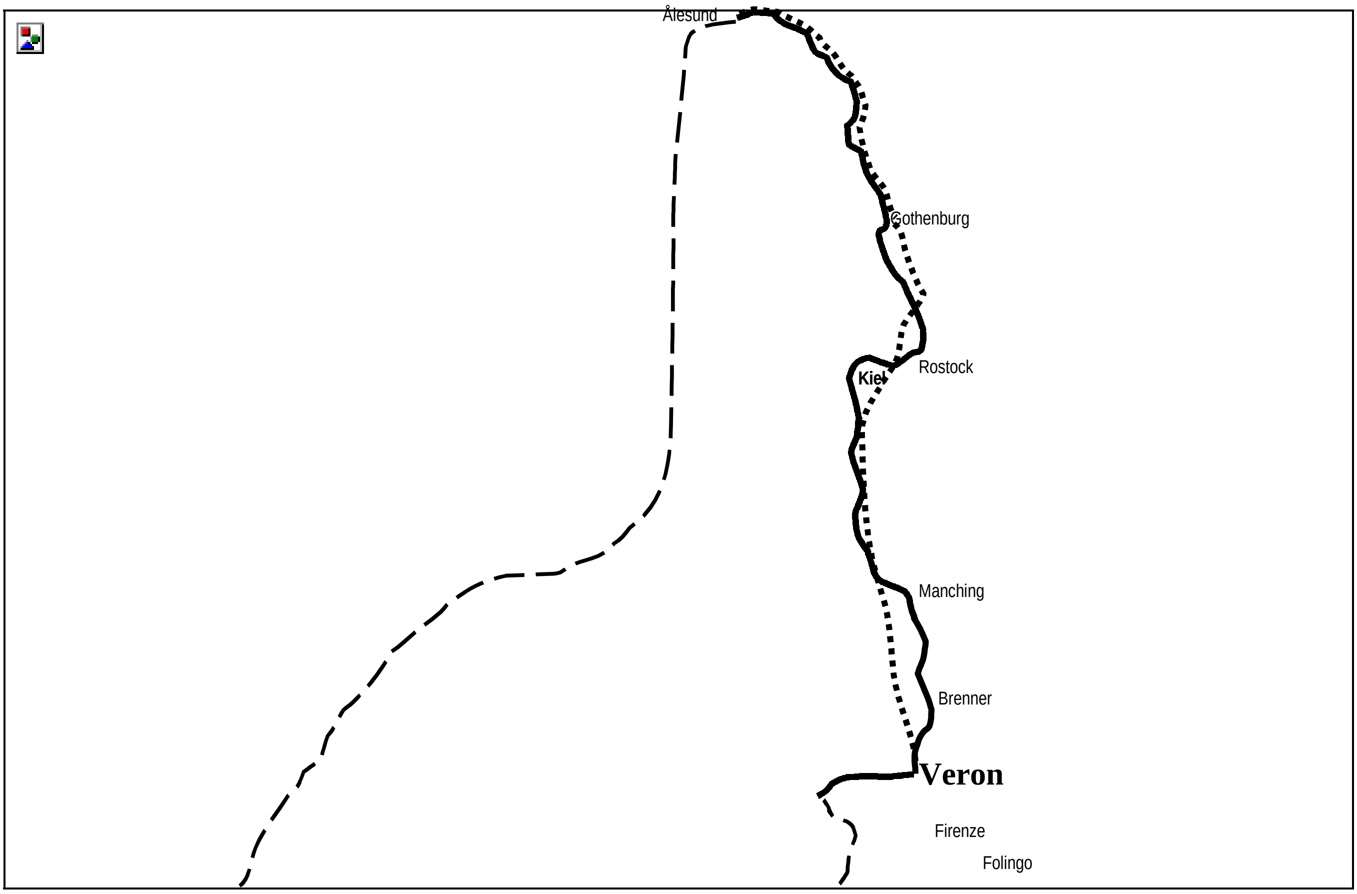


CASE B:

Dried cod from western Norway to Torino, Italy. The route with lorry is from Ålesund to Gothenburg, ferry from Gothenburg to Kiel, lorry transport from Kiel to Manching, rail transport (lorry on rail) from Manching to Brenner, and lorry transport on the last distance to Torino. On this map this a marked with a whole line.

The alternative route by rail is train transport the whole distance from Åndalsnes to Verona. Lorry is used in both ends, from Ålesund to Åndalsnes, and from Verona to Torino. This route is implemented during the project period, and is marked with a dotted line on the map.

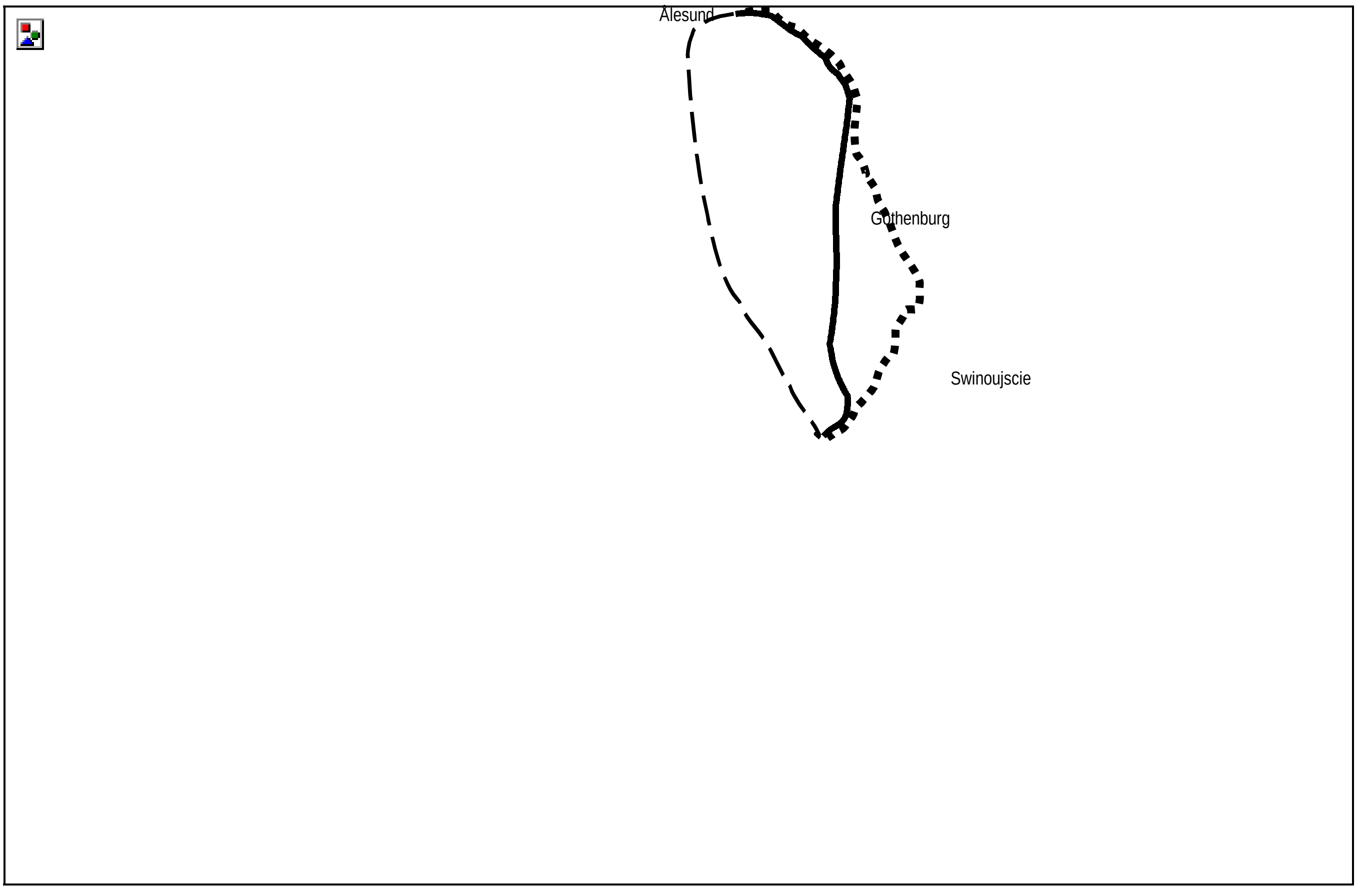
The sea alternative is boat from Ålesund harbour to Genova, and lorry the last distance to Torino.



CASE C:

Fresh saith fileet from western Norway to Bremerhaven. The route is lorry transport from Ålesund to Moss (south-eastern Norway), ferry from Moss to Hirtshals (Denmark), and lorry transport from Hirtshals to Bremerhaven. This route is marked with a whole line on the map.

The alternative route by rail goes from Ålesund to Bremerhaven with lorry transport in both ends. This is marked with a dotted line on the map. The sea alternative assumes boat the whole distance from Ålesund harbour to Bremerhaven.



CASE D:

Fresh (and frozen) white fish from western Norway to Boulogne-sur-Mer, France. The route is lorry transport from Ålesund to Oslo, ferry to Kiel, and lorry transport on the last distance. This route is marked with a whole line on the map.

The implemented alternative route is marked with a dotted line: Train from Ålesund to Oslo, cargo-ferry from Oslo to Rotterdam, and lorry on the last distance to Boulogne-sur-Mer.

The alternative sea route is by boat the whole distance from Ålesund harbour to Boulogne-sur-Mer.