

Potential transfer from road transport to short-sea-shipping in Denmark

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Jimmi Normann Kristiansen	PoA, VP

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Summary

This report examines the potential gross volume that can be shifted from road transport to short-sea-shipping in Denmark, categorized by different goods types. This encompasses analyses of the price structure for transportation of the goods by both road transport and short-sea-shipping; including an analysis of last mile / destination delivery (cf. AEGIS, WP10, D10.1 Case C description).

The report analyses all relevant goods in Denmark, including national and international goods. The report firstly identifies the type of goods that can be shifted (through time-value analysis), and subsequently includes discrete analyses of national and international goods that can be shifted. Analyses are on a regional level.

From the time-value analyses, as well as interviews with companies, the core findings related to the relevant goods and also conversion potential were:

- The overall price for the transport solution is important when deciding on a transport solution. A more expensive solution would hinder shifting from road to short-sea-shipping.
- For low-time-value goods, longer transport times are acceptable, and can be planned. Many customers are merely accustomed to very fast and flexible shipments.
- For high-time-value goods (e.g. machinery, machine equipment), longer transport times are not acceptable. Similarly, the transport cost is low compared to both the risk of any damages with SSS solutions as well as lost-opportunity costs due to delays.
- Companies were skeptical that short-sea-solutions could become cheaper, or be on par, with the price of road transports.
- Most production companies said that their freight forwarders were in charge of a solution, and that this was not in the interest of the company to change, as long as the previous solution worked.
- Companies were not keen on extending the dialogue with freight forwarders.
- Companies mentioned that ports and partners should develop the solutions, then freight forwarders and companies would choose accordingly (a hen-and-the-egg discussion).

Based on the findings, additional analyses were made in order to understand the price structures of both road and short-sea-shipping solutions. The prices were based both on different road freight-, as well as short-sea-shipping statistics. Additionally, the work group stress tested different pricings on trucking, short-sea-shipping and other, to recalibrate the price structures.

In conclusion, and in order to have a comparable price structure baseline, it was found that any road transport would need to be more than 150 km in order for a shift to a short-sea-shipping would be economically viable. This included a last-mile analysis.

This can be seen in the table below.



(From Table 2 - Overview of total price for a 24-hour cycle with a short-sea-shipping solution)

24h cost cycle - example			
50-trailer Ro/Ro ship (80% utilization), 10 knots, 3.600 dwt, 5.000 GT. 80 trucks per day.			
In €	Baseline	Scenario 1	Scenario 2
Price / day	11,000	8,250	5,500
Price (THC) per move x 2	120	120	120
Number of moves in a full cycle (40x2)	80	80	80
Price total (SSS+THC)	20.600	17.850	9.600
Price for last mile (25 km x 2 per truck at 2,6 EUR per move)	10.400	10.400	10.400
Total price for moving 80 trucks in 24 hrs	31.000	28.250	15.900
Minimum price per truck for SSS solution (/80)	387,5	353	199
Km driven for break-even cost (min price/2,6)	149	136	76
Break-even km, current scenario	149		
25% reduction (no crew)		136	
50% reduction (no fuel, no crew)			76

The scenarios consider last-mile delivery for the short-sea-shipping solutions of 25 km at each end. Applying a conservative estimation (also to account for additional costs), a minimum limit of 150 km for a direct road transport to be converted to short-sea-shipping is applied throughout the report.

The assessment of the gross-volume of goods have been divided into two distinct sections in the report.

Firstly, the national gross-volume of goods was analyzed. For the national goods, emphasis is put on the region of Northern Jutland as well as the Capital Region and Zealand. This is both due to the case focus of the ports of Aalborg and Vordingborg, as well as the distance between these regions. A summary of the total goods being transported between the regions can be seen in the table below.

(From Table 5 - National trucking data to/from Northern Jutland from/to the Capital Region and Zealand.
The data is from 2019. Source: Statistics Denmark (NVG23))

National freight to/from Northern Jutland from Zealand and Copenhagen				
	Tonnes (1000)	Tonne km (1000)	Vehicle km (1000)	Movements (1000)
Total	1.003	236.651	19.900	57
%	100,00%	100,00%	100,00%	100,00%
From Northern Jutland to all	555	134.085	11.913	34
%	55,33%	56,66%	59,86%	59,65%
To Northern Jutland from all	448	102.566	7.987	23
%	44,67%	43,34%	40,14%	40,35%



As can be seen in the table above, approximately 1 million tonnes of goods are transported to/from Northern Jutland (mostly of relevance to Port of Aalborg) and Zealand (mostly of relevance to Port of Vordingborg).

The analysis searched comprehensively for goods possible for conversion (taking into account time-value of goods) and found that the goods groups of:

- “Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials”
- “Food products, beverages, tobacco and animal fodder”
- “Only mixed goods; assumed palletized”

were the primary ones which could be converted. Applying a scenario-based analysis, it was estimated that 177.540 tonnes of national goods, covered by 9.899 truck movements, could be shifted yearly in Denmark.

The next step was to analyze the international road freight to/from Denmark and European countries. This was done through initially identifying the total volume of goods and distilling these goods between the five Danish regions. This is shown in the table below.

(From Table 18 – Consolidated international trucking data to/from the five Danish regions. 2019. Source: Statistics Denmark based on Eurostat Data (2021))

	Tonnes	Tonne kilometer ¹	Vehicle kilometer	Number of movements
Total	26.481.732	18.257.569	1.226.135.544	1.576.052
%	100,00%	100,0%	100,0%	100,0%
To Northern Jutland	1.212.423	963.171	62.487.171	72.297
%	4,6%	5,3%	5,1%	4,6%
From Northern Jutland	1.276.434	1.078.368	75.988.478	71.532
%	4,8%	5,9%	6,2%	4,5%
To Central Denmark	2.860.942	2.408.465	163.290.196	166.802
%	10,8%	13,2%	13,3%	10,6%
From Central Denmark	2.589.399	2.113.083	143.864.536	156.554
%	9,8%	11,6%	11,7%	9,9%
To Southern Denmark	5.918.195	3.548.431	240.671.139	360.818
%	22,3%	19,4%	19,6%	22,9%
From Southern Denmark	6.406.546	3.998.658	256.192.995	366.586
%	24,2%	21,9%	20,9%	23,3%
To Zealand	1.367.639	865.408	59.894.960	86.035
%	5,2%	4,7%	4,9%	5,5%
From Zealand	1.370.356	687.435	45.957.624	78.868

¹ Unfortunately, the EUROSTAT data only includes tonne-km statistics on the distance on the national territory of the reporting country for international and transit transport. This number will therefore be much higher if all countries were involved in the statistics. [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Tonne-kilometre_\(tkm\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Tonne-kilometre_(tkm))



%	5,2%	3,8%	3,7%	5,0%
To the Capital Region	1.538.319	1.284.612	90.909.354	98.791
%	5,8%	7,0%	7,4%	6,3%
From the Capital Region	1.697.020	1.074.257	72.100.416	103.614
%	6,4%	5,9%	5,9%	6,6%
To Denmark (unallocated region)	33.724	62.351	3.994.631	2.250
%	0,1%	0,3%	0,3%	0,1%
From Denmark (unallocated region)	210.735	173.330	10.784.044	11.905

Continuing to use the time-value, as well as price structure methodology, the ensuing analysis analyzed all goods to/from the five Danish Regions to Countries in Europe. All data was cleansed for all high time-value goods, and additionally applied scenarios for conversion potential.

The primary countries of international truck-traffic to/from the Danish Regions were Germany, Sweden, Poland, Norway, The Netherlands, Belgium, France, Belgium and Spain. These countries accounted for 90% of all in- and outgoing truck traffic to/from Denmark.

Based on the registry analyses conducted for each of the Danish regions to/from all countries, the following table was constructed based on a synthesis of all the analyses of in- and outgoing goods by trucks. It needs to be noted that the scenarios build on a short-sea-shipping being on par, or less expensive than the alternative road freight solution.

(From Table 36 – Total gross volume of goods that can be shifted from road to short-sea-shipping in Denmark. Yearly basis, based on 2019 data.)

2019		
International/Denmark (yearly)	Tonnes	Movements
Total - International/Denmark (yearly)	26.471.732	1.576.052
Median Scenario of relevant goods	4.864.392	274.755
Jutland-Zealand National (yearly)	Tonnes	Movements
Total - International/Denmark (yearly)	1.003.000	57.000
Median Scenario of relevant goods	177.540	9.899
GRAND TOTAL	<u>5.041.932</u>	<u>284.654</u>
/day	13.814	780
% of relevant regions	18,4%	
% of all trucking goods (162,5+26,471732 mill.)	2,7%	



Based on all the analyses (scenarios with reduced conversion probabilities), it was estimated that a median scenario included a conversion of 4.864.392 tonnes in Denmark for international truck transport.

Collectively, it was thus estimated that the potential gross volume of goods that can be shifted from road transport to Short-sea-shipping in Denmark is approximately 5 million tonnes yearly, or about 18% of the relevant goods by truck. It is again important to note that this is provided that any short-sea-shipping solution would be on par or cheaper than a competing direct road solution.



Definitions and abbreviations

CAPEX: Refers to the capital expenditure of companies. Encompasses the capital used by companies to acquire, and maintain physical assets, e.g. buildings, plants, equipment etc. CAPEX is often applied when making business cases for understanding investment decisions.

OPEX: Refers to operating expenses of companies. These relate to the costs companies incur to be operational. These would be any running costs related to conducting day-to-day business.

DWT: Deadweight tonnes (DWT) measures how much weight a vessel can carry. Includes cargo, fuel, crew, passengers, provisions etc.

Trailer: Refers to a standard-size 40-foot trailer, often used by trucks in Europe. A full load of a trailer for statistics purposes is 22.000 kg. Average loads in Europe vary from 15-17 tonnes for national- international trucking transport.

GT: The volume of the closed spaces in a ship (Gross Tonnage). Shows the capacity of ship. It is often used to determine manning regulation, safety, port dues and other.



1 Introduction

A large proportion of both national- and international goods in Denmark is transported by truck. In 2018, approximately 28% of total international goods transport (in tonnage) were transported by truck, and approximately 91% of domestic goods were transported by truck (Vejdirektoratet, 2020). Numbers for 2019 account for approximately 162,5 million tonnes nationally and 26,5 million tonnes internationally by truck (Statistikbanken, Statistics Denmark, 2021). The AEGIS project is aimed to directly impact the transport mode of goods on shorter distances, looking to potentially shift transportation of goods from road to short-sea-shipping solutions.

This report examines the potential gross volume of goods that can be shifted from road transport to short-sea-shipping in Denmark, categorized by different goods types. It also includes analyses of the price structure for transportation of the goods by both road transport and short-sea-shipping; including an analysis of last mile / final destination delivery (cf. AEGIS, WP10, D10.1 Case C description).

The report pertains to all relevant goods that can be shifted in Denmark; with emphasis on Port of Aalborg and Port of Vordingborg. It is presupposed that most goods of relevance to Port of Aalborg would be in the Danish region of Northern Jutland. Similarly, relevant goods to the Port of Vordingborg is estimated to be primarily in the Zealand-, possibly the Capital Region. The deliverable description for WP10 D.10.1 encompasses all goods in Denmark, hence all goods relevant to all regions will be considered.

The report begins with an understanding of time-value of goods, in order to understand the price mechanism for any potential conversion from road to short-sea-shipping. It is a core assumption (see e.g., Gnap et al., 2019 and interview findings) that any conversion from road to short-sea shipping has to be “on-par” with alternative road transportation total costs. Time is relevant, yet several studies suggest that certain goods type transportations can be “slot-planned” with producers.

The following sections include:

- An analysis of time-value of goods, as well as interview input, to estimate the types of goods that can be shifted from road to short-sea-shipping.
- An analysis of the price structure of transportation of the goods, including last-mile-delivery.
- An analysis of the national road freight (with relevance to Case C) in Denmark.
- An analysis of the total international road freight to/from Denmark.
- An estimation of the gross volume of goods that can potentially be shifted from road to short-sea-shipping.²

² For the above points, relevant information to build gross volume estimates are included in the report. Whenever data is confidential (or due to policy restrictions of registry data of what may be published), aggregation of said data is made.



2 Goods value and time-value of goods

The choice of transport mode for goods is impacted by the value of the goods and the time-value of those goods (Trafikverket, 2016). Consequently, this report applies a notion of time-value of goods to assess which types can be shifted from road transport to short-sea-shipping.

The Swedish Traffic Authorities have been analyzing the time-value indications for international goods (import and export). To calculate the time-value of goods, the Swedish model for valuation multiplies the capital value of goods by a factor 0,00011.

This is computed in the following way:

$$0,00011 = 20\% * \frac{2}{3600}$$

- Rate of 20% is assumed to be cost of binding capital in stock.
- Logistics factor of "2" indicates size of logistics gains that can be done in handling due to time savings. Longer transportation increases demand of buffer stock.
- Logistics system is assumed to use 3.600 out of the year's 8.760 hours.

These time values are based on goods types, i.e., the value of goods will be the same regardless of the way it is transported. The authorities have made distinct time-value calculations for goods on trucks. Here, it is assumed that the value is twice as high as the average (as can be seen in the table calculations done by ASEK (Trafikverket, 2016). The logic of time-value is applied in the report to determine which are goods with "high time value" vs. "low time value".

While these indicators are often used for macro-economical considerations for infrastructure developments (e.g., whether we should build a Femern connection), it still provides an understanding of the relative switching costs between different goods types from road to short-sea-shipping, as additional time would be incurred.

When the time-value of goods is known, it is possible to determine goods that are not suitable (or worthwhile) to pursue for short-sea-shipping conversion. Figure 1 shows an excerpt from a 2016 report from ASEK 6.0 (Trafikverket, 2016), showing different goods product types and their time values for 2014, as well as a prognosis for 2040.



	2014	2014	2014	Prognosis 2040	Prognosis 2040
SAMGODS-commodity group (NSTR-group)	Million ton/year	Time value excl. VAT	Time value incl. VAT	Time value excl. VAT	Time value incl. VAT
1 Grain (10)	3.9	0.24	0.29	0.21	0.25
2 Potatoes, fresh and frozen vegetables, fresh fruit (20)	11.8	0.22	0.27	0.28	0.34
3 Live animals (31)	0.70	0.97	1.17	0.97	1.17
4 Sugar beet (32)	0.30	0.41	0.50	0.41	0.50
5 Round wood, paper industry (41)	53.2	0.03	0.04	0.04	0.05
6 Sawn wood products (42)	10.6	0.44	0.53	0.44	0.53
7 Wood chips, waste wood, sawing waste (43)	10.8	0.07	0.08	0.10	0.12
8 Bark, cork, other timber and wood (44)	-	-	-	-	-
9 Fabrics (50)	0.3	3.18	3.85	3.83	4.63
10 Food and animal feed (60)	23.0	1.90	2.30	1.95	2.36
11 Oilseeds, oily nuts and grains (70)	2.5	0.54	0.65	0.57	0.69
12 Coal, lignite and peat, coke and briquettes (80)	7.1	0.14	0.17	0.18	0.22
13 Crude oil (90)	20.2	0.58	0.70	0.59	0.71
14 Petroleum products (100)	45.0	0.64	0.77	0.87	1.05
15 Iron ore and waste (110)	32.7	0.11	0.13	0.17	0.21
16 Non-ferrous metals (120)	2.50	1.13	1.37	1.41	1.71
17 Raw material, semi- manufactures of iron/metal (130)	14.0	1.35	1.63	1.04	1.26
18 Cement, lime and building materials (140)	9.3	0.27	0.33	0.26	0.31
19 Soil, stone, gravel and sand (151)	41.9	0.01	0.01	0.01	0.01
20 Other raw minerals (152)	8.5	0.14	0.17	0.15	0.18
21 Manure, natural and manufactured (160)	1.6	0.32	0.39	0.44	0.53
22 Carbon chemicals and tar (170)	0.8	0.65	0.79	1.30	1.57
23 Other chemicals except carbon chemicals and tar (180)	19.9	1.29	1.56	1.56	1.89
24 Pulp, paper and paper waste (190)	5.5	0.59	0.71	0.63	0.76
25 Machinery, appliances, transport equipment (200)	3.0	10.89	13.18	10.95	13.25
26 Metal products (210)	4.0	2.95	3.57	3.09	3.74
27 Glass and ceramics (220)	0.6	2.31	2.80	3.51	4.25
28 Paper, paperboard and products thereof (231)	8.8	0.67	0.81	0.71	0.86
29 Various other finished goods (232)	13.0	3.32	4.02	3.88	4.69
30 Mixed (240, not in use)	-	-	-	-	-
31 Round wood sawmill (45)	13.0	0.06	0.07	0.06	0.07
32 Machines (201)	7.6	15.86	19.19	16.62	20.11
33 Paper products (233)	7.5	0.98	1.19	0.93	1.13
34 Packaging (250)	-	-	-	-	-
35 Air freight (-)	-	-	-	-	-
Sum	384	1.00	1.21	1.69	2.04

Figure 1 - Overview of time-value of different goods types, 2014 and 2040 prognosis. Source: Trafikverket, 2016: (20), pp. 19.



The above shows different groups (35) covering goods types following the NSTR legacy grouping. As there is no official EU conversion table³ made for translating the goods types, a conversion is made in Table 1 based on the groups which are similar in wording to the NST2007 goods types used by Eurostat and Statistics Denmark. These will be the goods types that are used for value-estimation throughout the report. Note that some data statistics are further aggregated into five groups. Whenever this occurs, translation between the goods groups and Statistics Denmark's official nomenclature designation is used (Statistics Denmark, 2021).⁴

Table 1 - Conversion from SAMGODS to NST2007 classification.⁵

Code	Description	SAMGODS-commodity group
1	Products of agriculture, hunting, and forestry; fish and other fishing products	1,2,3,4
2	Coal and lignite; crude petroleum and natural gas	13,14, 21
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	15,16, 18, 19,
4	Food products, beverages and tobacco	10, 11
5	Textiles and textile products; leather and leather products	9
6	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media	5, 6, 7, 8, 24, 28, 31, 33
7	Coke and refined petroleum products	12
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel	22, 23
9	Other non-metallic mineral products	27,
10	Basic metals; fabricated metal products, except machinery and equipment	17, 26
11	Machinery and equipment not elsewhere classified; office machinery and computers; electrical machinery and apparatus not elsewhere classified; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	25, 32
12	Transport equipment	No
13	Furniture; other manufactured goods not elsewhere classified	Yes
14	Secondary raw materials; municipal wastes and other wastes	20,
15	Mail, parcels	No
16	Equipment and material utilized in the transport of goods	25
17	Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods not elsewhere classified	N/A
18	Grouped goods: a mixture of types of goods which are transported together	29
19	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16.	No
20	Other goods not elsewhere classified	30

³ <https://unece.org/DAM/trans/doc/2015/wp6/ Peter Smeets Report TF Prague on Classifications.pdf>

⁴ <https://www.dst.dk/en/Statistik/dokumentation/nomenklaturer/standardgodsnomenklatur-til-transportstatistik--nst-2007->

⁵ This is done through interpreting the lines/codes, as there is no official nomenclature for translation in existence. <https://unece.org/DAM/trans/doc/2015/wp6/ Peter Smeets Report TF Prague on Classifications.pdf>



2.2 Interview findings

As part of the project process, interviews were conducted with companies in the Northern Jutland as well as the Zealand region. The aim of these interviews was to get a better understanding of transportation needs across sectors (of which these sectors had goods transportation needs; either production companies or wholesalers). In essence, the motivation for conducting interviews was to get a qualitative understanding of which type of goods could potentially be shifted from road to short-sea-shipping in a new logistics constellation. Most emphasis was put on exporting, as initial interviews proved that materials for production often were sourced locally.

Interviewed companies were promised anonymity. In all, 14 interviews were initiated/conducted in the period of January 1 – May 15, 2021. The interviews were conducted over phone with a brief introduction to the AEGIS project, as well as an explanation of the aim of the project of conversion to short-sea-shipping solutions.

In general, the findings from the interviews harmonized with the assumptions in the research group, and the core messages are portrayed in bullets below:

- The overall price for the transport solution is important when deciding on a transport solution. A more expensive solution would hinder shifting from road to short-sea-shipping.
- For low-time-value goods, longer transport times are acceptable, and can be planned. Many customers are merely accustomed to very fast and flexible shipments.
- For high-time-value goods (e.g. machinery, machine equipment), longer transport times are not acceptable. Similarly, the transport cost is low compared to both the risk of any damages with SSS solutions as well as lost-opportunity costs due to delays.
- Companies were skeptical that short-sea-solutions could become cheaper, or be on par with the price of road transport.
- Most production companies said that their freight forwarders were in charge of a solution, and that this was not in the interest of the company to change, as long as the previous solution worked.
- Companies were not keen on extending the dialogue with freight forwarders.
- Companies mentioned that ports and partners should develop the solutions, then freight forwarders and companies would choose accordingly (a hen-and-the-egg discussion).

In all, interviews strengthened the understanding of the importance of time-value of goods, and moreover accentuated that any solution should/could be built, and it would then be up to freight-forwarders to take advantage of that.



2.3 Price Structure of Transportation Alternatives

The work package focuses on the conversion of goods from road to short-sea-shipping alternatives. For this reason, emphasis is put mainly on European countries in relation to the use cases of Port of Vordingborg and Port of Aalborg. Looking at transported goods from a country-aggregated level, and as well into transit goods going through Denmark, it is estimated that no more than 5-10% of the goods on trucks are containerized (Statistics Denmark, 2021: IVG23; Vejdirektoratet, 2020). This could be due to different reasons, an apparent one that either the goods had originated from other countries (e.g., Ocean Freight), got reloaded, and then registered as containerized goods from the originating country to Denmark. Alternatively, it could be shipments from Denmark that will be unloaded in other countries, to reach an ocean freight liner there (e.g. if feeder connection was inappropriate). The price analysis will pertain to mainly Ro/Ro price examples. For bulk, it is assumed that any reasonable quantity would already be converted to ship (as a lot of bulk goods are today, also domestically) and that any additional bulk goods would be transported by truck. This implies that bulk goods now registered as “road transport” will not be converted back to bulk shipments (i.e., the goods would still need to be on trucks/in containers).

The scenarios and analysis of last-mile transportation costs will be built on estimates of potential “market pricing” of competing solutions. This is done as the conversion to short-sea-shipping is expected to rely heavily on market forces, and hence the price of competing solutions will be instrumental to conversion dialogues.⁶

2.3.1 Road transportation costs

The pricings used for road freight rates for calculating scenarios have been derived from Ti-Upply's European Road Freight Rate Benchmark (2020-2021). This is based on statistical modelling of over 200 million quotes, giving estimations of full truck loads (22 000 kg) pricing from core hauls in Europe. The statistics are updated every quarter (Ti Insight, 2021). Based on data from Q1, Q2, and Q4, 2020, prices for linehauls (full truck loads) will be derived to estimate road transportation pricing. Pricings from these statistics will also be applied in the calculation of last-mile transportation costs with any short-sea-shipping solution.

2.3.2 CAPEX and OPEX of baseline short-sea-shipping solution

In order to discuss the Capital Expenditures (CAPEX) and Operating Expenditures (OPEX) of ships, a point of departure have been taken in existing costs structures of Ro/Ro vessels. Analyses have been performed by the Swedish “Trafikverket” (Trafikverket, 2016), covering aggregate costs on both time and distance for 1.300 different Ro/Ro vessels. This is computed and updated regularly with very detailed costings on the entire transportation system in Sweden (ASEK, 2016). Distance related costs are primarily related to fuel (pure OPEX), and time-related costs will cover costs such as personnel, nautical gear, maintenance, spare parts, inspections as well as capital costs (OPEX and CAPEX). Additionally, other costs related to loading-unloading in ports (tonnage based on amount of goods) as well as port duties related to gross tonnage of ships are included (Trafikverket, 2016).

The smallest Ro/Ro type vessel type in the analysis of Trafikverket (2016) have the following characteristics:

⁶ Any costing calculated for involved companies (e.g. block hour costs, OPEX, CAPEX) will be added with a 10% margin. In some cases, market prices will be used in which case these will be used as baseline. European transportation companies have approximately 8% in operating margins (Damodaran, 2020 – cleansed for Covid-19 influence). This is rounded up to 10% to reflect a more cautious scenario on estimating short-sea-shipping solutions to compete with road freight transportation.



- 3.600 dwt
- Knots (actual): 10
- Cost: per hour: 242 EUR
- Cost: distance: 6 EUR per km

It is assumed that this pricing would cover small vessels with capacity of >50 trailers (this work was also discussed internally in other work packages). In addition to these costs, there would be additional costs related to:

- Price: Port dues/fairway charges, often based on GT of ships. Blended sample^{7,8,9} (Trafikverket, 2016) set to: 5.000 EUR per GT per month per port (repeated calls).
- Port cargo dues: Blended Sample^{10,11} set to 800 EUR per loading/unloading (e.g., 40 trailers (80% utilization of Ro/Ro ship) ~ 20 EUR per trailer).

In Table 22, an example of a 24-hour operation with two port callings is given. This includes: Loading in port A, sailing to port B, unloading in Port B, Loading in Port B, sailing to Port A, unloading in port A.

Table 2 - Overview of total price for a 24-hour cycle with a short-sea-shipping solution¹²

24h cost cycle - example					
50-trailer Ro/Ro ship (80% utilization), 10 knots, 3.600 dwt, 5.000 GT					
	In €				
Cost /hr	242				
Cost /km	5,93				
Fairway 5.000 GT / month/port**	5.000				
Port cargo dues (per loading/unloading) (bunkering, waste mgt. not included)	1.000				
	Cost (HR)	Cost (KM)	Fairway*	Cargo due	Total
Port A loading (2 hrs)	484	0		800	1.284
Sail to port B (8 hrs - 148,16 km)	1.936	879			2.815
Port B unloading (2 hrs)	484	0	167	800	1.451
Port B loading (2 hrs)	484	0		800	1.284
Sail to port A (8 hrs)	1.936	879			2.815
Port A unloading (2 hrs)	484	0	167	800	1.451
(+ margin)	581	176			757
Sum	6.389	1.933	333	3.200	
Operator price		8.322			
Port(s) price				3.533	
Total price/day in €					11.855
*(assumed continuous fairway cycles (single calls) between two destinations only incur one fairway price per port per cycle.					
**See terms of business Port of Esbjerg, Port of Frederikshavn ^{13,14}					

⁷ https://portofaalborg.dk/media/8d8921c0776eb2f/terms-of-business_2021_port-of-aalborg.pdf

⁸ <https://www.vordingborg.dk/media/cllmkzhw/terms-of-business-list-of-rates-2021.pdf>

⁹ <https://www.portofrotterdam.com/sites/default/files/general-terms-and-conditions-including-port-tariffs-2021.pdf?token=3xBWI9f>

¹⁰ https://portofaalborg.dk/media/8d8921c0776eb2f/terms-of-business_2021_port-of-aalborg.pdf

¹¹ <https://www.portofrotterdam.com/sites/default/files/general-terms-and-conditions-including-port-tariffs-2021.pdf?token=3xBWI9f>

¹² Does not include terminal handling costs or parking at terminal.

¹³ <https://portesbjerg.dk/en/port%20services/prices-regulations>

¹⁴ [https://pof.dk/UserFiles/Image/Filer/Terms_of_business_2021\(1\).pdf](https://pof.dk/UserFiles/Image/Filer/Terms_of_business_2021(1).pdf)



2.3.3 Pricing structures for road and short-sea-shipping with last-mile delivery

The above calculation in section 2.3.2 is based on historic registry data from Trafikverket (2016), with legacy logistics solutions and Ro/Ro costing dating back to 2012-2013. It is assumed that costs of operation will be lower for modern ships (fuel-based, with crew) in an appropriate vessel size that would incorporate up to 50 trailers (noPax).

As a result, and due to internal discussion in AEGIS, the scenario building for this deliverable will use a blended rate for price comparison between competing options at 11.000 EUR/day (note that this is not cost, but market price estimations). It is this price, excluding Terminal Handling Charges, that needs to be compared to road freight rate pricing when looking at conversion potential. For calculating different scenarios, the prices in Table 3 will be applied.

Table 3 - Prices used to calculate the price structure of different transport alternatives (used in scenarios for both Port of Aalborg as well as Port of Vordingborg)¹⁵

Range	Price €
Road 0-250 km	2,6 (per km)
Road 251-500 km	2,25 (per km)
Road 501-750 km	1,75 (per km)
Road 751-1000 km	1,25 (per km)
Road 1000+ km	1 (per km)
THC blended average per trailer per terminal shunt.	60
RO/RO 50-trailer vessel	11,000 (€/day) 458 (€/hour)

The above linehaul prices, Terminal Handling Costs as well as block-hour prices will be applied as baseline prices for transportation of goods. As both the road transport statistics as well as RO/RO block hour costing take point of departure in trailer transportation, the time-value cost of different goods types will not be included in this calculation. Rather, time-value calculations have been applied in qualifying the type and proportion of goods that can potentially be shifted from road transport to short-sea-shipping solutions. Wherever applicable, scenarios will be used to do conservative estimations for conversion.

2.3.4 Further price reductions – unmanned vessels

There are a number of different cost types included in vessel total operating costs (including financing). Based on a study performed by Colling and Heckingberg (2020), an analysis of different vessel types and their cost breakdowns was performed. The following vessels were analyzed:

¹⁵ Sources: Ti Insight, 2021, AEGIS Work group, Trafikverket, 2016, Port of Aalborg, Port of Vordingborg, Port of Gothenburg, Port of Rotterdam, Port of Copenhagen/Malmö.



Table 1
Input data for four sample vessel types.

Reference Market segment	I Fast and large	II Fast and small	III Slow and large	IV Small and slow
Vessel type	Feeder	General cargo	General cargo	General cargo
Length (m)	153	100	137	89
Beam (m)	21.5	20	21	13.6
Gross tonnage (t)*	9100	6500	8950	2850
Installed power (kW)*	8000	7800	4350	1800
Capacity (TEU)*	900	650	1000	150
Operating speed (kn)	18	16.5	13	11.5

* Rounded to the nearest 50.

Figure 2- Comparison of different vessel types. The figure is from Colling and Heckingberg (2020: 5)

The study made an in-depth analysis of the cost structures of the different vessel types. In general, wage costs seems to be proportionately bigger, the slower the ship was sailing. This is illustrated in Figure 3 below.

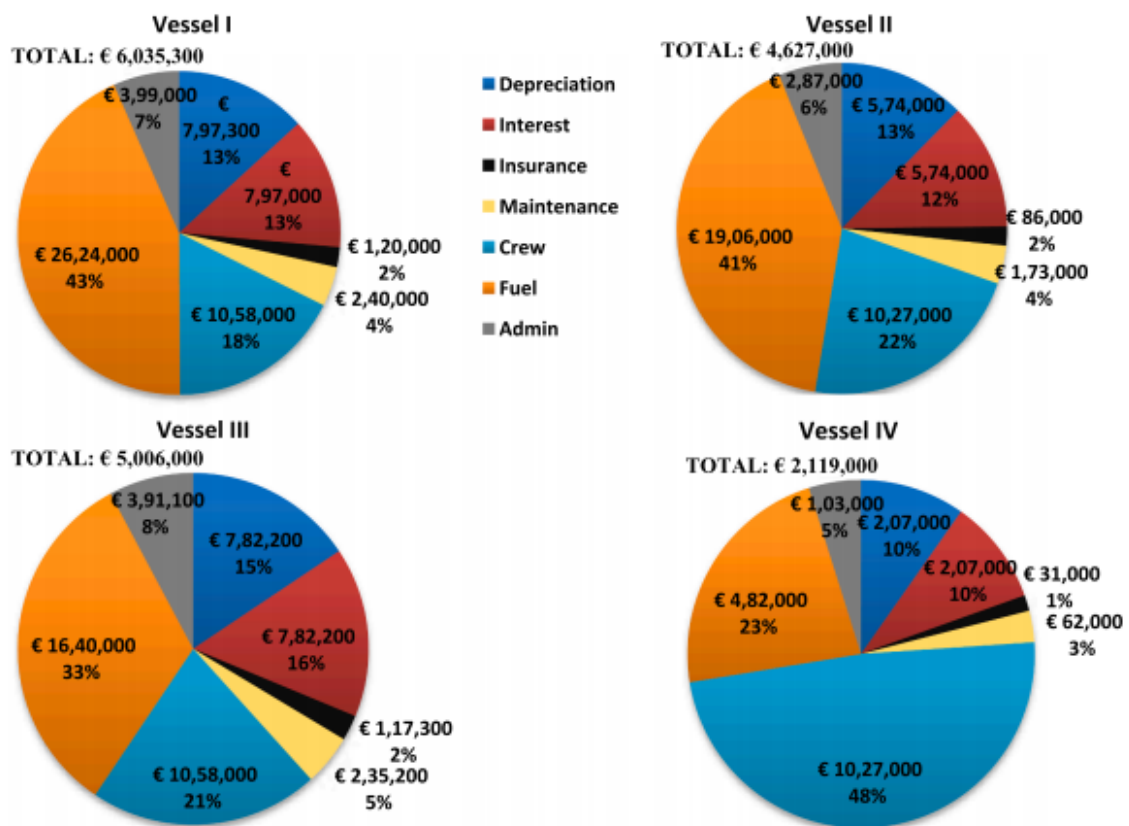


Fig. 4. Cost breakdown for all vessel types.

Figure 3 - Cost comparison of different vessel types. The figure is from Colling and Heckingberg (2020: 8).

As can be seen in the pie-charts in Figure 3, based on in-depth analyses of cost structures of OPEX and CAPEX of the different vessels, faster boats have a proportionately higher cost of fuel, whereas slower boats have a proportionately higher accumulated cost of crew (see vessel II and vessel IV). For vessel IV, the vessel used for comparison in this study, was for general cargo with a capacity of 150 TEU. It is assumed that even smaller vessels with smaller capacity would have less demands for crew (for vessel IV, in all 10 crew members at a



time). For smaller vessels, this would be lower. To work on the scenarios (and take into account a blend of different small, ship types, not one ship type), the core assumption applied would be that crew would constitute roughly 25% of the cost, 25% of the cost for fuel and the remaining 50% cost for depreciation, interest, insurance, maintenance and admin. These will be discussed in the following section.

2.3.5 A principal methodology for assessing convertible goods types

The previous section explained the general pricing structure, including capital expenditures and operating expenditures, applied in the current document. Even though no winning concept in AEGIS has yet been defined, neither exactly how cost savings can be done at ports in the future, an overall revenue model must be applied in terms of assessing the likelihood of converting goods from road to short-sea-shipping.

To get a general understanding of shifting of goods, a 24-hour ship cycle is used. It is assumed that 24-hour short-sea-shipping calls would on average, have a max 2 port calls. Including the block-price per day for short-sea-shipping solutions, as well as costs for THC, compared to prices on road, Table 4 below can be developed.

Table 4 - Example of a 24-hour comparable cost-cycle looking into short-sea-shipping solutions. Conceptual lowest break-even distances between SSS and road.

24h cost cycle - example			
50-trailer Ro/Ro ship (80% utilization), 10 knots, 3.600 dwt, 5.000 GT. 80 trucks per day.			
In €	Baseline	Scenario 1	Scenario 2
Price / day	11,000	8,250	5,500
Price (THC) per move x 2	120	120	120
Number of moves in a full cycle (40x2)	80	80	80
Price total (SSS+THC)	20.600	17.850	9.600
Price for last mile (25 km x 2 per truck at 2,6 EUR per move)	10.400	10.400	10.400
Total price for moving 80 trucks in 24 hrs	31.000	28.250	15.900
Minimum price per truck for SSS solution (/80)	387,5	353	199
Km driven for break-even cost (min price/2,6)	149	136	76
Break-even km, current scenario	149		
25% reduction (no crew)		136	
50% reduction (no fuel, no crew)			76

Table 44 above shows the thresholds of minimum distances of when short-sea-shipping solutions are no longer viable compared to road freight. The scenarios consider last-mile delivery for the short-sea-shipping solutions of 25 km at each end. This scenario is a “bare-minimum” and does not include any potential charges for parking at ports, lost time etc. As a result, and to account for improved technology in the future, a minimum limit of 150 km for a direct road transport to be converted to short-sea-shipping is applied. It would be too complex to account for distance to sea for each subregion in each country in Europe. For instance, going beyond 150 km in a straight-line inland would not improve the access to short-sea-shipping. However, this is applied as rule-of-thumb to determine, on a gross-volume level, which goods are considered in the analysis.



3 Road Freight - Denmark

The following section analyses both the national- and international goods by truck that is transported in/out of Denmark yearly. It is based on 2019 data to ensure that the dataset is complete.

3.1 National Road Freight

Table 5 includes an overview of the national road freight in Denmark, focusing on Northern Jutland, Zealand and the Capital Region. This emphasis is made as the distances covered between other regions are considered too short to be relevant for short sea-shipping (cf. the previous price analysis), and that the case ports Port of Aalborg as well as the Port of Vordingborg are of primary relevance to these regions.

Table 5 - National trucking data to/from Northern Jutland from/to the Capital Region and Zealand. The data is from 2019. Source: Statistics Denmark (NVG23).

National freight to/from Northern Jutland from Zealand and Copenhagen				
	Tonnes (1000)	Tonne km (1000)	Vehicle km (1000)	Movements (1000)
Total	1.003	236.651	19.900	57
%	100,00%	100,00%	100,00%	100,00%
From Northern Jutland to all	555	134.085	11.913	34
%	55,33%	56,66%	59,86%	59,65%
To Northern Jutland from all	448	102.566	7.987	23
%	44,67%	43,34%	40,14%	40,35%

As can be seen in the table above, approximately 1 million tonnes of goods are transported to/from Northern Jutland (mostly of relevance to Port of Aalborg) and the Capital Region and Zealand (mostly of relevance to Port of Vordingborg) every year. This is distributed between approximately 57.000 movements (i.e., 17,6 tonnes per movement). There is a slight skewness in tonnage balance, i.e., 55% outbound and 45% inbound from Northern Jutland, where truck movements account for approx. 60% and 40% respectively. These figures are not surprising, as central Copenhagen, due to population density, would have a higher degree of consumption and lesser degree of production, where the opposite is true for Northern Jutland in relative terms.

3.1.1 From Northern Jutland to The Capital Region and Zealand

Table 6 gives a breakdown of the different goods types between the provinces. The emphasis is still put on the geographical centers of Northern Jutland as well as provinces in Zealand, due to distances and water passages in between.



Table 6 - National trucking data to/from Northern Jutland from/to the Capital Region and Zealand. The data is from 2019. Source: Statistics Denmark (NVG23)

From Northern Jutland to:				
	Tonnes (1000)	Tonne km (1000)	Vehicle km (1000)	Movements (1000)
The Capital Region	284	67.464	7.191	21
%				
In containers/swap bodies	0	-	-	-
In other type of cargo unit, Agricultural products, forestry products, fishing products	36	6.288	640	1
In other type of cargo unit, Food products, beverages, tobacco and animal fodder	40	8.464	915	3
In other type of cargo unit, coal, oil and chemical products	3	1.285	54	0
In other type of cargo unit, Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials	152	40.649	3.487	10
In other type of cargo unit, Other manufactured goods and other goods	53	10.778	2.095	7
Zealand	271	66.621	4.722	13
%				
In containers/swap bodies, Agricultural products, forestry products, fishing products	1	282	125	0
In containers/swap bodies, Other manufactured goods and other goods	36	4.800	351	1
In other type of cargo unit, Agricultural products, forestry products, fishing products	15	3.538	455	1
In other type of cargo unit, Food products, beverages, tobacco and animal fodder	91	22.213	1.303	4
In other type of cargo unit, coal, oil and chemical products	6	2.624	80	0
In other type of cargo unit, Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials	91	27.638	1.383	4
In other type of cargo unit, Other manufactured goods and other goods	31	5.526	1.025	3
Total	555	134.085	11.913	34

A dominant goods type being transported out of Northern Jutland pertain to “Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials”. Northern Jutland has a relatively large extraction of Stone, Gravel and Sand (different municipalities), as well as Chalk and Limestone (primarily Aalborg). An overview of extraction of raw material in Northern Jutland can be seen in Table 7.



Table 7 - Extraction of raw material (falling into category of metal ores, stones, sand gravel clay, etc). Based on 2019 data. Source: Statistics Denmark, 2021 (RST01)

Extraction of raw materials in Denmark. by type of raw material, region and time		
		2019
Units: 1,000 m ³		
Stone, gravel and sand	Brønderslev	81
	Frederikshavn	547
	Hjørring	77
	Jammerbugt	497
	Læsø	5
	Mariagerfjord	777
	Morsø	30
	Rebild	1.187
	Thisted	414
	Vesthimmerlands	476
	Aalborg	298
	Sum	4.389
Quartz sand	Thisted	21
	Sum	21
Clay	Hjørring	18
	Mariagerfjord	16
	Thisted	26
	Aalborg	53
	Sum	113
Moler	Morsø	74
	Sum	74
Chalk and Limestone	Thisted	26
	Vesthimmerlands	153
	Aalborg	2.203
	Sum	2.382
Peat and sphagnum	Jammerbugt	38
	Aalborg	16
	Sum	54
Other raw materials	Thisted	18
	Frederikshavn	4
	Mariagerfjord	2
	Sum	24



As can be seen in Table 7, the region of Northern Jutland has a relatively large extraction of raw materials. Evidently, these goods have relatively high weight, high volumes, are uniform, and also have a relatively low value per tonne (Anderstig & Berglund, 2016). These are typically transported in lorries with tippers or other types of modified loading systems (although characteristics of trucks from a Ro/Ro perspective should not be severely impacted). Looking at the average tonnage for all transports from Northern Jutland with metal ores, stones, sand, gravel, clay, salt, cement and manufactured construction materials, these amount to roughly 17,4 tonnes per movement from Northern Jutland to The Capital Region and Zealand. This is in all 243.000 tonnes per year, covered by 14.000 trips, that can potentially be converted. This is supported by the fact that these goods types are already being transported domestically by sea (Statistics Denmark, 2021: SKIB451).

Another interesting goods type that is being transported from Northern Jutland to The Capital Region and Zealand falls under the category of “Food products, beverages, tobacco and animal fodder”. These amount for a total of roughly 131.000 tonnes per year (Statistics Denmark, 2021: NVG23). This category comprises several product types, including meat, raw hides, fish, fruit, beverages and other. Lastly, it includes grain mill products and animal feeds. While the former categories will be time-contingent (including fresh foods, live animals and other), categories such as grain mill products and animal feeds have traditionally been transported by ship due to large bulk quantities – also domestically (e.g., Statistics Denmark, 2021; SKIB451). It is assumed that a proportion on land transport would be in big-bags or other (and to a lesser degree bulk, as a big part of this is already done by ship). Due to the aggregation of the statistics, there is no detail as to seeing the proportion of the 131.000 tonnes per year that are attributed to grain mill products and animal feeds. However, Cereal production for fodder in Northern Jutland amount to 113.000 tonnes per year in 2019 (Statistics Denmark, 2021; HALM1). It is also known that companies such as Hedegaard A/S as well as Danish Agro A/S have operations in this region of Denmark (cvr.dk, 2021). In addition, to add possible conversions of “processed foods”, “processed vegetables” as well as “beverages” – which are not isolated and not identifiable in the statistics database, a conservative estimation in the scenarios entail a 10%, 20% and 30% conversion of all goods within the type to be applied, distributed to a transportation from Northern Jutland to The Capital Region and Zealand. This is shown in Table 8 below.

Table 8 - Proportion of goods “grain mill products and animal feeds; “processed foods”; “processed vegetables”; and “beverages” estimated to be convertible (from the category of Food products, beverages, tobacco and animal fodder). Scenarios based on Statistics Denmark, 2021 (2019 numbers; NVG23; SKIB451, HALM1).

From Northern Jutland to:				
	Tonnes (1000)			
(In other type of cargo unit, Food products, beverages, tobacco and animal fodder)		Scenario 1	Scenario 2	Scenario 3
The Capital Region	40,00	4,00	8,00	12,00
%		10%	20%	30%
Zealand	91,00	9,10	18,20	27,30
%		28%	55%	83%
Total	131,00	13,10	26,20	39,30



In the scenario, respectively 13.100, 26.200 and 39.300 tonnes of product can be estimated to be potentially converted from truck each year. This equals roughly 803, 1.605, 2.408 movements per year.

The final category “In other type of cargo unit, other manufactured goods and other goods” represents approximately 120.000 tonnes per year. Between regions in Denmark, this is not further detailed into different goods types. However, the total national distribution of goods by truck can be cleansed from the other categories and would indicate the proportions (note that this excludes food products, vegetables etc.). In all of Denmark, approximately 29.877.000 tonnes per year (all directions) fall within the category. Isolating to “Grouped goods, mixture of goods”, it is assumed that many of these goods are palletized within the category (in Danish Statistics also indicated as “Stykgods”). These amount for roughly 48% of the goods being transported within the category, i.e., 14.403.000 tonnes in all of Denmark. If this logic is applied to isolate the goods types within the category of “other manufactured goods and other goods” between Northern Jutland and The Capital Region and Zealand, Table 9 can be created.

Table 9 - Proportion of mixture of goods in grouped goods (often times palletized) excluding food products, vegetables etc. – assumed to be “dry goods”. Therefore, the total is less than Statistics Denmark (2021; NVG41) based on 2019 data.

National transport of goods by road by type of cargo, unit, type of goods and time		
<i>(excluding food products, vegetables etc.)</i>		
Weight of goods loaded (1000 tonnes)		2019
Textiles and textile products	468	2%
Products of wood, paper and paper products	2.416	8%
Metal products	2.731	9%
Machinery and equipment	2.193	7%
Transport equipment	1.396	5%
Furniture and other manufactured goods	1.187	4%
Mail, parcels	1.295	4%
Empty containers and swap bodies	1.213	4%
Removal goods	251	1%
Grouped goods, mixture of goods	14.403	48%
Unidentifiable goods, e.g. in containers	2.324	8%
Total	29.877	100%

Based on the above, it can be indicated that the "grouped goods/mixture of goods", assumed to be palletized, accounts for roughly 48% of the “In other type of cargo unit, other manufactured goods and other goods” from the province data. This does not include food products, vegetables etc. Looking only at the transportation from North Jutland to The Capital Region and Zealand, this logic is applied to identify the proportion of the 120.000 tonnes of goods that falls within the category of “Grouped goods, mixture of goods” (In Danish: Stykgods), that are not fresh foods, vegetables etc.

As a result, it can be deduced that these palletized goods would constitute roughly ($,48 \cdot 120.000$) 57.600 tonnes of goods each year. As this data will have a high degree of variance, and also value, scenarios of



converting respectively 10%, 25% and 50% of those goods to short-sea-shipping solutions are given in Table 10.¹⁶

Table 10 - Proportion of goods in mixed goods (often times palletized) excluding food products, vegetables etc. – assumed to be “dry goods” that can be estimated as convertible (based on scenarios). Statistics Denmark (2021; NVG41) based on 2019 data.

From Northern Jutland to:				
	Tonnes (1000)			
(In other type of cargo unit, only mixed goods; assumed palletized)		Scenario 1	Scenario 2	Scenario 3
The Capital Region	23,52	2,35	5,88	11,76
%		10%	25%	50%
Zealand	34,08	3,41	8,52	17,04
%		10%	26%	52%
Total	57,60	5,76	14,40	28,80

The scenario above shows an even conversion of the residual mixed goods (estimated to be 48% of the category “In other type of cargo unit, other manufactured goods and other goods”) of a 10%, 25% and 50% conversion rate respectively. A 10% conversion rate would be equivalent to approximately 0,88% of the total goods, a 25% conversion rate would be equivalent to approximately 2,2% of the total goods, and a 50% conversion rate would be equivalent to approximately 4,4% of the total goods. In this perspective, mixed cargo today accounts for approximately 1,3% of all domestic goods transported by ship (Statistics Denmark, 2021; based on 2019 data; SKIB451). In the scenario, respectively 5.760, 14.400 and 28.800 tonnes of goods are estimated to have a potential for conversion. This equals 352, 882, or 1.764 movements per year.

Based on the analyses, the vast majority of conversion potential is estimated to rest in the category of “Metal ores, stones, sand, gravel, clay, salt etc.”, followed by conservative scenarios within grain and animal fodder, as well as mixed goods (non-food, non-vegetable, non-perishable).

This total sum is broken down as shown in Table 11, giving a total gross volume of goods that can potentially be shifted from road to short-sea-shipping in the above at 283.600 tonnes (year), distributed between 16.487 movements (17,26 tonnes per movement).

¹⁶ Currently, mixed cargo account for approximately 1,3% of all domestic goods transportation by ship (Statistics Denmark, 2021; based on 2019 data; SKIB451). Mixed cargo account for approximately 8,8% of domestic transportation by truck (Statistics Denmark, 2021; based on 2019 data; NVG41).



Table 11 - Estimated total gross volume of goods that can be shifted from road to short sea shipping (From Northern Jutland to The Capital Region and Zealand) Sources: Statistics Denmark, 2021: NVG41, SKIB451, NVG23, HALM1, RST01, cvr.dk

From Northern Jutland to:							
(in 1000 Tonnes)	Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials	(In other type of cargo unit, Food products, beverages, tobacco and animal fodder)			(In other type of cargo unit, only mixed goods; assumed palletized)		
		Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
The Capital Region	152	4,00	8,00	12,00	2,54	6,36	12,72
Zealand	91	9,10	18,20	27,30	3,22	8,04	16,08
Total (in 1000 tonnes)	243	13,10	26,20	39,30	5,76	14,40	28,80
Movements (actual #)	14.000	803	1.605	2.408	353	882	1.764
Grand total in Tonnes (Scen. 2)							283.600,00
Grand total in Movements (Scen. 2)							16.487



3.1.2 From the Capital Region and Zealand to Northern Jutland

Table 12 gives a breakdown of the different goods types between the provinces. In this case, the movement is any truck activity from The Capital Region and Zealand to Northern Jutland.

Table 12 - National trucking data to Northern Jutland from The Capital Region and Zealand. The data is from 2019. Source: Statistics Denmark, 2021 (NVG23).

To Northern Jutland from:				
	Tonnes (1000)	Tonne km (1000)	Vehicle km (1000)	Movements (1000)
The Capital Region	102	30.780	2.083	5
%				
In containers/swap bodies	0	-	-	-
In other type of cargo unit, Agricultural products, forestry products, fishing products	11	2.029	220	1
In other type of cargo unit, food products, beverages, tobacco and animal fodder	5	2.119	96	0
In other type of cargo unit, coal, oil and chemical products	22	5.140	258	0
In other type of cargo unit, Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials	24	10.126	399	1
In other type of cargo unit, Other manufactured goods and other goods	40	11.366	1.110	3
Zealand	346	71.786	5.904	18
%				
In containers/swap bodies	0	-	-	-
In other type of cargo unit, Agricultural products, forestry products, fishing products	9	1.881	113	0
In other type of cargo unit, food products, beverages, tobacco and animal fodder	46	15.621	862	2
In other type of cargo unit, coal, oil and chemical products	0	0	0	0
In other type of cargo unit, Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials	167	34.898	2.281	7
In other type of cargo unit, Other manufactured goods and other goods	124	19.386	2.648	9
Total	448	102.566	7.987	23

As can be seen from Table 12, the three main categories of goods being transported by truck from the Zealand regions to North Jutland are “Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials”, “other manufactured goods and other goods”, and “Food products, beverages, tobacco and animal fodder” amount to 191, 164 and 51 thousand tonnes yearly, respectively. This corresponds to 9.801,



8.420 and 2.618 movements per year from Zealand to Northern Jutland in these categories by truck. None of the goods are containerized.

For “Metal ores, stones, sand, gravel, clay, salt, cement, and manufactured construction materials”, and in line with Northern Jutland, the Zealand regions have a relatively large extraction of Stone, Gravel and Sand. The extraction of raw material on land are shown in Table 13.

*Table 13 - Extraction of raw material (falling into category of metal ores, stones, sand gravel clay, etc).
Based on 2019 data. Source: Statistics Denmark, 2021 (RST01).*

Extraction of raw materials in Denmark. By type of raw material, region and time		
<i>Units: 1,000 m³</i>		
		2019
Stone, gravel and sand	Roskilde	3.300
	Kalundborg	1.102
	Sorø	739
	Høje-Taastrup	304
	Holbæk	245
	Frederikssund	202
	Vordingborg	121
	Helsingør	110
	Gribskov	95
	Guldborgsund	92
	Næstved	90
	Odsherred	77
	Lejre	25
	Allerød	22
	Lolland	20
	Halsnæs	10
	Sum	6.554
Clay	Fredensborg	11
	Vordingborg	1
	Sum	12
Plastic clay and bentonite	Odsherred	12
	Sum	12
Chalk and Limestone	Faxe	295
	Stevns	170
	Høje-Taastrup	2
	Sum	467
Other raw materials	Guldborgsund	55
	Roskilde	31
	Odsherred	15
	Kalundborg	4
	Sorø	4



	Gribskov	2
	Vordingborg	2
	Høje-Taastrup	1
	Allerød	1
	Næstved	1
	Sum	116

Applying the same logic as for Northern Jutland, these goods have relatively high weight, high volumes, are uniform, and also have a relatively low value per tonne (Anderstig & Berglund, 2016). For truck transportation nationally, these goods account for 191.000 tonnes per year, covered by 9.806 trips, that can potentially be converted. This is supported by the fact that these goods types are already being transported domestically by sea (Statistics Denmark, 2021: SKIB451).

For the goods type “other manufactured goods and other goods”, the further breakdown for finding the appropriate goods type “Grouped goods, mixture of goods” is applied in the same way as for the transportation from Northern Jutland to the five provinces (see section 3.1.1). This constitutes in all approximately ($,48 \cdot 164.000$) 78.720 tonnes yearly. As this data will have a high degree of variance, and also value, scenarios of converting respectively 10%, 25% and 50% of those goods to short-sea-shipping solutions are given in Table 14 (except for “Byen København”, which is expected to be lower in terms of production).

Table 14 - Proportion of goods in mixed goods (often times palletized) excluding food products, vegetables etc. – assumed to be “dry goods” that can be convertible (based on scenarios). Source: Statistics Denmark (2021; NVG41) based on 2019 data.

To Northern Jutland from:				
	Tonnes (1000)			
(In other type of cargo unit, only mixed goods; assumed palletized)		Scenario 1	Scenario 2	Scenario 3
The Capital Region	19,20	1,44	3,36	6,24
%		8%	18%	33%
Zealand	59,52	5,95	14,88	29,76
%		18%	45%	90%
Total	78,72	7,39	18,24	36,00

In the scenario, respectively 7.390, 18.240 and 36.000 tonnes of goods are estimated to have potential for conversion. This equals 380, 936, or 1.848 movements per year.

The last goods type “Food products, beverages, tobacco and animal fodder” applies the same principle as the estimated flow from Northern Jutland the Zealand Regions. It builds scenarios by isolating “Grain mill products and animal feeds”, “processed foods”, “processed vegetables” as well as “beverages”. A 10%, 20% and 30% conversion of all goods within the type is considered to be a conservative estimate.

This is shown in the scenarios in Table 15.



Table 15 - Proportion of goods “grain mill products and animal feeds; “processed foods”; “processed vegetables”; and “beverages” estimated to be convertible (from the category of food products, beverages, tobacco and animal fodder). Scenarios based on Statistics Denmark, 2021 (2019 numbers; NVG23; SKIB451, HALM1).

Northern Jutland from:				
	Tonnes (1000)			
(In other type of cargo unit, Food products, bevarages, tobacco and animal fodder)		Scenario 1	Scenario 2	Scenario 3
The Capital Region	5,00	0,50	1,00	1,50
%		10%	20%	30%
Zealand	46,00	4,60	9,20	13,80
%		14%	28%	42%
Total	51,00	5,10	10,20	15,30

In the above scenarios, respectively 5.100, 10.200 and 16.300 tonnes of goods are estimated to have a potential for conversion. This equals 262, 524, or 785 movements per year.

Based on the analyses, the vast majority of conversion potential is estimated to rest in the category of “Metal ores, stones, sand, gravel, clay, salt etc.”, followed by conservative scenarios within grain and animal fodder, as well as mixed goods (non-food, non-vegetable, non-perishable).

This total sum is shown in Table 16, giving a total gross volume of goods that can potentially be shifted from road to short-sea-shipping in the above at 219.440 tonnes (year), distributed on 11.266 movements (19,48 tonnes per movement).



Table 16 – Estimated total gross volume of goods that can be shifted from road to short sea shipping (From the Zealand Regions to Northern Jutland).

To Northern Jutland from:							
(in 1000 Tonnes)	Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials	(In other type of cargo unit, Food products, beverages, tobacco and animal fodder)			(In other type of cargo unit, only mixed goods; assumed palletized)		
		Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
The Capital Region	24	1	1	2	1	3	6
Zealand	167	5	9	14	6	15	30
Total (in 1000 tonnes)	191	5,10	10,20	15,30	7,39	18,24	36,00
Movements (actual #)	9.806	262	524	785	380	936	1.848
Grand total in Tonnes (Scen. 2)							219.440,00
Grand total in Movements (Scen. 2)							11.266

Source: Statistics Denmark, 2021: NVG41, SKIB451, NVG23, HALM1, RST01, cvr.dk.



3.2 National Road Freight – Total Gross Potential

The analyses above show a total of approximately 1 million tonnes of goods being transported between the Zealand regions and Northern Jutland yearly. This equals approximately 57.000 truck movements.

In the analyses, it was identified that the goods types of “Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials” as well as the specific types of “Food products, beverages, tobacco, and animal fodder”, and “Grouped goods, mixture of goods” (in Danish stykgods) hold the biggest potential for national conversion from road to sea. The argument for this is threefold:

- The time-value of goods is relatively low for those identified (including scenario building), which means that wait-times should be acceptable in the supply chain (Trafikverket, 2016).
- These goods types to some extent already are represented by national transportation by sea, i.e. those goods types have already shown a potential for a shift.
- These goods types represent the three biggest categories of national truck transport (in tonnage) between the identified provinces.

Fresh products within the “Food products” category actually have a lower time-value than some other types of goods (e.g. machines) (Trafikverket, 2016 (7): pp. 16). However, for fresh products, it would require an understanding of how long time the engine / coolant system could be switched off before having a potential impact on the cooling of the products (if trailer were to be transported by sea). These goods could be assumed to be palletized, and thus have potential for a Ro/Ro solution, if the above would be converted. Similarly, the category of food products also includes conserved and processed food. Therefore, conservative scenarios were applied in the estimation of gross volume of goods in order to omit fresh fruit, meat and other.

For “Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials” the potential seems very high. This could be related to construction- or roadwork; that would e.g., require quick transportation for large construction projects. This could e.g. be asphalt, cement or other, that require a certain operating temperature, humidity or fluidity. This argument reduces the total potential for conversion. It is not possible to statistically identify what is “raw” material and what is semi processed in the statistical registry database, yet it is something to have in mind when looking at the overall potential within this goods type category. As it both is a goods group that holds potential (which can be seen from national transportation by ship), we choose to apply a 10%, 25% and 50% scenario on the total volume. This is a conservative measure, to sort out/reduce goods that are related to construction- or road-work. This is shown in Table 17.

Having these possibilities and restrictions in mind, the potential gross volume that can be shifted from road-transport to short-sea-shipping in Denmark (national road freight) equals 177.540 tonnes each year, covered by 9.899 movements.



Table 17 – Estimated total gross volume of goods that can potentially be shifted from road to short sea shipping (Between the Zealand regions and Northern Jutland). Source: Statistics Denmark, 2021: NVG41, SKIB451, NVG23, HALM1, RST01, cvr.dk

To/from Northern Jutland:											
(in 1000 Tonnes)			Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials			(In other type of cargo unit, Food products, beverages, tobacco and animal fodder)			(In other type of cargo unit, only mixed goods; assumed palletized)		
			Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Province Byen København			17,6	44	88	4,5	9	13,5	3,984	9,72	18,96
Province Københavns omegn			25,8	64,5	129	13,7	27,4	41,1	9,168	22,92	45,84
Total (in 1000 tonnes)			43,4	108,5	152	18,20	36,40	54,60	13,15	32,64	64,80
Movements (actual #)			2381	5951	11903	1.064	2.129	3.193	732	1.819	3.613
Grand total in Tonnes (Scen. 2)											177.540,00
Grand total in Movements (Scen. 2)											9.899



3.3 International Road Freight

The following section includes an analysis of international road freight in and out of Denmark. It is based on database Eurostat- and Statistics Denmark Data. In the data (which is aggregated in this report for confidentiality- and data-treatment policy reasons), we can see:

- A description of the type of goods transported
- NUTS2 specification of the goods by load region and unload region
- Tonnes, tonne kilometer as well as vehicle kilometer based on the above
- The number of movements (trips) for each goods type to/from each region (with emphasis on Denmark)

Note that the data is not rounded to thousands. To keep the integrity of the datasets, and omit rounding in Excel between national- and international road freight data, the numbers in the tables are kept intact.

In Table 18, a summary and consolidation of the core data is given.¹⁷

Table 18 – Consolidated international trucking data to/from the five Danish regions. 2019. Source: Statistics Denmark based on Eurostat Data (2021)

	Tonnes	Tonne kilometer ¹⁸	Vehicle kilometer	Number of movements
Total	26.481.732	18.257.569	1.226.135.544	1.576.052
%	100,00%	100,0%	100,0%	100,0%
To Northern Jutland	1.212.423	963.171	62.487.171	72.297
%	4,6%	5,3%	5,1%	4,6%
From Northern Jutland	1.276.434	1.078.368	75.988.478	71.532
%	4,8%	5,9%	6,2%	4,5%
To Central Denmark	2.860.942	2.408.465	163.290.196	166.802
%	10,8%	13,2%	13,3%	10,6%
From Central Denmark	2.589.399	2.113.083	143.864.536	156.554
%	9,8%	11,6%	11,7%	9,9%
To Southern Denmark	5.918.195	3.548.431	240.671.139	360.818
%	22,3%	19,4%	19,6%	22,9%

¹⁷ Data takes into account "load region" and "unload region" per trip. Therefore, central distribution centres located in other regions of Denmark could be an intermediary location that can give variations to the picture (e.g., trucks from Italy may access a distribution center in Southern Denmark (unloading) before continuing the journey to Northern Denmark). Transit trucks not included. As several Danish logistics points are located in Southern Denmark, it is expected that this is an intermediary point that would skew the direct logistics data as given in the illustrations. Data represents only directly identifiable data as per extract from Eurostat.

¹⁸ Unfortunately, the EUROSTAT data only includes tonne-km statistics on the distance on the national territory of the reporting country for international and transit transport. This number will therefore be much higher if all countries were involved in the statistics. [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Tonne-kilometre_\(tkm\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Tonne-kilometre_(tkm))



From Southern Denmark	6.406.546	3.998.658	256.192.995	366.586
%	24,2%	21,9%	20,9%	23,3%
To Zealand	1.367.639	865.408	59.894.960	86.035
%	5,2%	4,7%	4,9%	5,5%
From Zealand	1.370.356	687.435	45.957.624	78.868
%	5,2%	3,8%	3,7%	5,0%
To the Capital Region	1.538.319	1.284.612	90.909.354	98.791
%	5,8%	7,0%	7,4%	6,3%
From the Capital Region	1.697.020	1.074.257	72.100.416	103.614
%	6,4%	5,9%	5,9%	6,6%
To Denmark (unallocated region)	33.724	62.351	3.994.631	2.250
%	0,1%	0,3%	0,3%	0,1%
From Denmark (unallocated region)	210.735	173.330	10.784.044	11.905

In order to identify the potential relevant goods types that can be transported to/from the Danish regions, it is firstly important to establish the type of goods that are included in the international dataset, based on Eurostat data. This is shown in Table 19, along with Yes/No marks of which goods types are included in the conversion discussion from road to short-sea-shipping. This is in line with the discussions of time-value of goods in Section 2 in this document. As the international goods already have longer trips, it is assumed that a potential conversion is higher than for domestic goods (i.e., waiting times, congestion, delays on e.g. German highways must be expected. Concurrently, only for the identified goods types, a median scenario of potentially converting 30% of the goods is applied.¹⁹)

¹⁹ For “Metal ores, stones, sand, gravel, clay, salt, cement, manufactured construction materials”, the domestic example was a 50% conversion. To take into account potential delays in construction, other, a conservative estimation of 30% conversion is applied for international goods.



Table 19 – Overview of NST2007 goods types. Estimation of potential conversion.²⁰

Code	Description	Potentially Convertible?	Why? And how to apply?
1	Products of agriculture, hunting, and forestry; fish and other fishing products	Yes	Low time-value (30% median scenario)
2	Coal and lignite; crude petroleum and natural gas	Yes	Low time-value (30% median scenario)
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	Yes	Low time-value (30% median scenario)
4	Food products, beverages and tobacco	Yes	Low time-value (but some fresh) (30% median scenario)
5	Textiles and textile products; leather and leather products	Yes	Medium time-value (30% median scenario)
6	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media	Yes	Undefined time-value (30% median scenario)
7	Coke and refined petroleum products	Yes	(30% median scenario)
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel	Yes	Medium time-value (30% median scenario)
9	Other non-metallic mineral products	Yes	Low time-value (30% median scenario)
10	Basic metals; fabricated metal products, except machinery and equipment	Yes	Medium time-value (30% median scenario)
11	Machinery and equipment not elsewhere classified; office machinery and computers; electrical machinery and apparatus not elsewhere classified; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	No	High time-value
12	Transport equipment	No	High time-value
13	Furniture; other manufactured goods not elsewhere classified.	Yes	Undefined time-value (30% median scenario)
14	Secondary raw materials; municipal wastes and other wastes	Yes	Low time-value (30% median scenario)
15	Mail, parcels	No	High time-value
16	Equipment and material utilized in the transport of goods	No	High time-value
17	Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods not elsewhere classified.	No	Undefined time-value
18	Grouped goods: a mixture of types of goods which are transported together	Yes	Medium time-value (10, 20, 30% scenario as a result)

²⁰ <https://www.dst.dk/en/Statistik/dokumentation/nomenklaturer/standardgodsnomenklatur-til-transportstatistik-nst-2007->



19	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16.	No	Unknown and undeterminable. Conservative estimation.
20	Other goods not elsewhere classified.	No	Unknown and undeterminable. Conservative estimation.
99	Grouped goods due to confidentiality and quality';	No	Unknown and undeterminable. Conservative estimation.

The above logic will be applied when considering the potential for a shift from road to short sea shipping. Scenarios are applied.²¹ In the following sections, comments toward the different regions in Denmark and their international road freight transport statistics are given. This is shown in Figure 4 below.



Figure 4 - An illustration of the different regions in Denmark (NUTS2) applied in this section to estimate goods flows in/out of Denmark²².

²¹ Furthermore, destinations with a short distance on land/bridge between the place of loading and unloading will also be taken into account when estimating the total goods potential. For instance, this could apply to transportation between the Northern Part of Germany (Schleswig-Holstein) to Region South Denmark. This last sorting will be applied as appropriate and described in the estimation of the total gross volume of goods than can potentially be shifted.

²² Source for map: <https://ec.europa.eu/eurostat/web/nuts/nuts-maps>



The subsequent subchapters covering the five regions in Denmark are written as discrete, independent chapters. Goods will be sorted by tonnage (descending).

3.3.1 Northern Jutland

In 2019, Northern Jutland had a total of 1.212.423 tonnes inbound and 1.276.434 tonnes outbound by road. This was transported by 72.297 trips inbound and 71.532 trips outbound. Figure 5 gives an illustration of the number of yearly movements of trucks to/from Northern Jutland in 2019 (not all countries are included, below are the main ones).

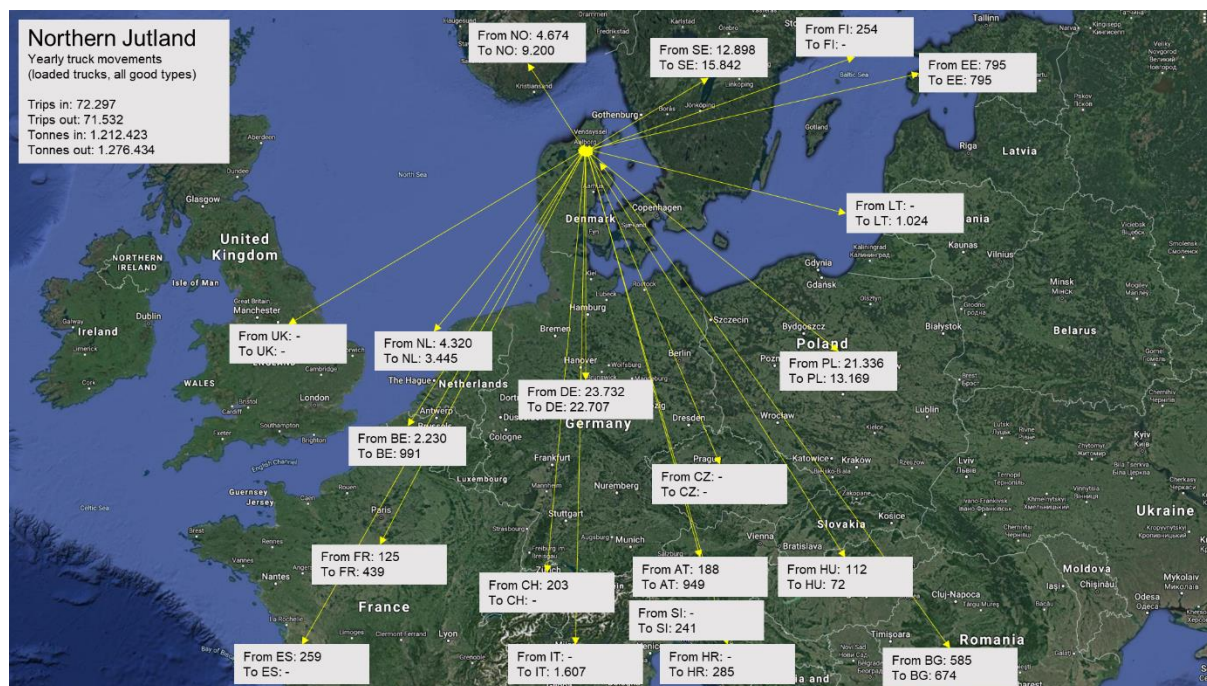


Figure 5 - Number of trips in/outbound of Northern Jutland to European countries (2019). Based on 2019 Eurostat Data.

The major countries with traffic (sorted by tonnage) inbound and outbound of Northern Jutland are shown in Table 20.

Table 20 – Inbound goods to Northern Jutland, sorted by yearly tonnage.²³

load_region	unload_region	tonnes	tkm	vehicle km	movements
DE	DK050	405.976	239.844	14.304.905	23.732
PL	DK050	320.854	385.903	28.088.731	21.336
SE	DK050	243.938	116.352	6.328.228	12.898
NL	DK050	68.804	62.601	4.342.195	4.320
NO	DK050	85.568	32.612	1.887.380	4.674
BE	DK050	33.110	32.290	1.911.994	2.230
EE	DK050	14.576	16.035	874.599	795
Other ²⁴	DK050	39.597	77.534	4.749.139	2.312
Total	DK050	1.212.423	963.171	62.487.171	72.297

²³Other countries, including AT, CH, ES, FI, FR, HU, RO each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



Table 21 – Outbound goods from Northern Jutland, sorted by yearly tonnage.²⁵

load_region	unload_region	tonnes	tkm	vehicle km	movements
DK050	DE	388.080	224.053	13.985.641	22.707
DK050	SE	363.413	233.363	11.064.012	15.842
DK050	NO	171.530	143.235	8.437.210	9.200
DK050	PL	170.273	205.553	15.917.337	13.169
DK050	NL	55.463	51.022	3.839.699	3.445
DK050	BE	20.264	26.500	10.673.052	991
DK050	AT	20.307	44.133	1.997.232	949
DK050	IT	18.126	33.292	3.089.446	1.607
DK050	EE	16.431	18.076	874.599	795
DK050	BG	14.830	40.010	1.818.652	674
DK050	FR	11.074	18.976	753.858	439
DK050	Other	26.643	40.155	3.537.740	1.714
DK050	Total	1.276.434	1.078.368	75.988.478	71.532

As can be seen in Table 20 and Table 21, the top 5 countries for inbound/outbound international road freight both in terms of tonnage and # of movements are the countries Germany, Norway, Sweden, Poland and The Netherlands. Of the total tonnage from the region of North Jutland to the European countries, these five countries constitute roughly 91% of the total international truck traffic in/out of the region of the region.

Based on our thorough analysis of the complete dataset, scenarios (30% baseline of selected types of goods) for both inbound- and outbound potential for conversion from road to short-sea-shipping are applied to estimate the overall potential gross volume of goods that can be shifted, see Table 22.

²⁵Other countries, including CZ, HR, HU, LU, SI each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



*Table 22 – Overall estimated gross volume of goods that can be shifted from road to short-sea-shipping
(Northern Jutland – all). Based on Eurostat data.*

From DK050 to ALL	tonnes	movements	(2019)
DE	284.849	13.929	
SE	256.712	11.036	
PL	145.373	9.619	
NO	140.949	7.414	
NL	33.596	1.630	
Other	82.697	3.871	
Total	944.176	47.499	
20%	188.835	9.500	
30%	283.253	14.250	
40%	377.670	19.000	
(Movements at 30% /day)		39	
From ALL to DK050	tonnes	movements	(2019)
DE	311.811	17.116	
SE	170.260	8.839	
PL	261.896	15.369	
NO	56.224	2.387	
NL	41.113	2.645	
Other	47.822	2.705	
Total	889.126	49.061	
20%	177.825	9.812	
30%	266.738	14.718	
40%	355.650	19.624	
(Movements at 30% /day)		40	
Grand Total (in-out)	1.833.302	96.560	
20%	366.660	19.312	
30%	549.991	28.968	
40%	927.661	38.624	
(Movements at 30% /day)		79	



3.3.2 Central Denmark

In 2019, Central Denmark had a total of 2.860.942 tonnes inbound and 2.589.399 tonnes outbound by road. This was transported by 166.802 trips inbound and 158.554 trips outbound. Figure 6 gives an illustration of the number of yearly movements of trucks to/from Central Denmark in 2019.

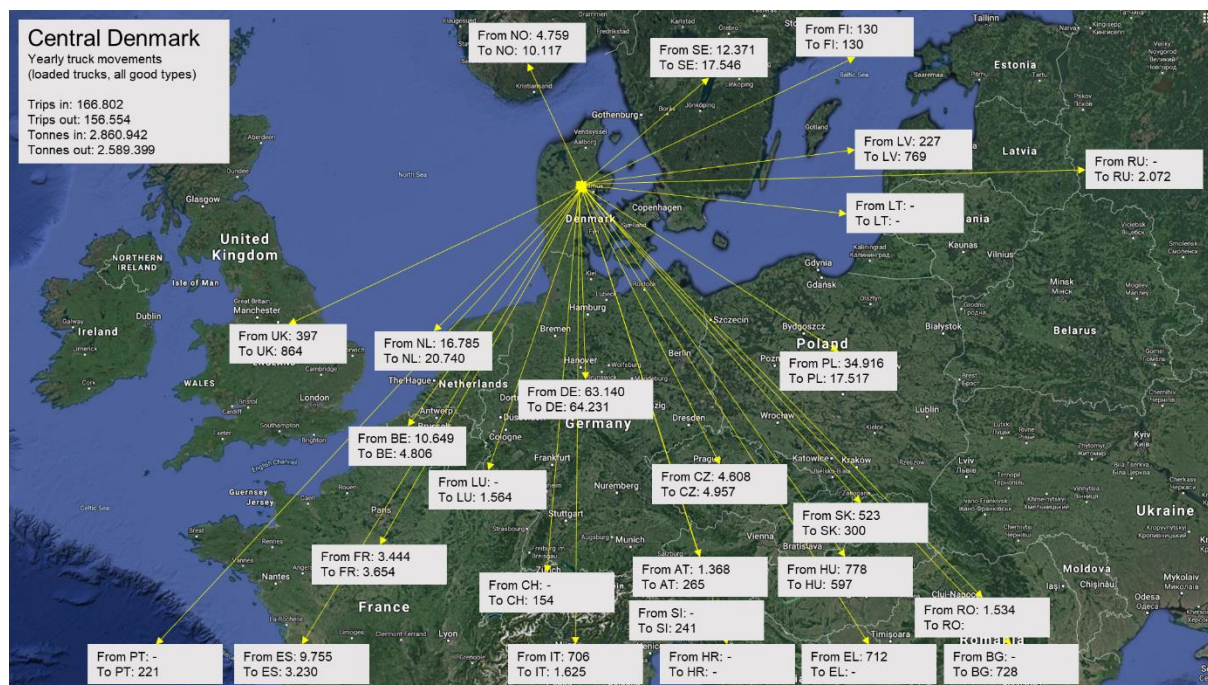


Figure 6 - Number of trips in/outbound of Central Denmark to European countries (2019). Based on 2019 Eurostat Data.

The major countries with traffic (sorted by tonnage) inbound and outbound of Central Denmark are shown in Table 23.

Table 23 – Inbound goods to Central Denmark, sorted by yearly tonnage.²⁶

load_region	unload_region	tonnes	tkm	vehicle km	movements
DE	DK040	1.061.565	586.857	37.443.218	63.140
PL	DK040	607.108	609.746	36.039.809	34.916
NL	DK040	301.622	218.511	17.356.962	16.785
SE	DK040	212.376	98.174	5.304.610	12.371
ES	DK040	181.777	468.773	37.001.974	9.755
BE	DK040	180.049	79.156	6.864.826	10.649
NO	DK040	105.984	59.659	2.630.203	4.759
FR	DK040	58.681	64.548	4.102.158	3.444
CZ	DK040	54.009	54.583	4.461.071	4.608
AT	DK040	24.138	31.534	2.757.436	1.368
EL	DK040	16.450	41.124	1.780.275	712

²⁶Other countries, including FI, LV, SK, UK each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



IT	DK040	15.916	33.172	1.472.032	706
HU	DK040	14.571	19.749	1.304.454	778
RO	DK040	14.110	27.746	3.001.794	1.534
Other	DK040	12.586	15.133	1.769.374	1.277
Total	DK040	2.860.942	2.408.465	163.290.196	166.802

Table 24 – Outbound goods from Central Denmark, sorted by yearly tonnage.²⁷

load_region	unload_region	tonnes	tkm	vehicle km	movements
DK040	DE	946.740	556.289	38.241.725	64.231
DK040	NL	328.544	256.701	16.276.125	20.740
DK040	SE	303.746	177.490	12.292.411	17.546
DK040	PL	281.520	281.439	17.477.030	17.517
DK040	BE	162.592	46.557	2.068.311	4.806
DK040	NO	160.322	95.814	7.077.662	10.117
DK040	CZ	71.662	87.556	9.041.107	4.957
DK040	ES	66.762	164.784	11.294.852	3.230
DK040	FR	66.541	93.649	5.211.632	3.654
DK040	LU	52.774	88.191	8.514.147	1.564
DK040	RU	44.726	56.590	2.621.650	2.072
DK040	IT	38.994	100.918	4.204.902	1.625
DK040	LV	17.281	18.698	817.220	769
DK040	UK	10.447	20.442	1.270.599	864
DK040	Other	318.268	349.404	24.932.193	20.379
DK040	Total	2.589.399	2.113.083	143.864.536	156.554

As can be seen in Table 23 and Table 24, the top 7 countries for inbound/outbound international road freight in terms of tonnage are Germany, Poland, The Netherlands, Sweden, Belgium, Norway and Spain. These countries constitute about 90% of the total international truck traffic in/out of the region.

Based on our thorough analysis of the complete dataset, scenarios (30% baseline of selected types of goods) for both inbound- and outbound potential for conversion from road to short-sea-shipping are applied to estimate the overall potential gross volume of goods that can be shifted, see Table 25.

²⁷Other countries, including AT, BA, BG, CH, FI, HU, PT, SI, SK each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



Table 25 – Overall estimated gross volume of goods that can be shifted from road to short-sea-shipping
(Central Denmark – all). Based on Eurostat data.

From DK040 to ALL	tonnes	movements	(2019)
DE	570.231	33.567	
PL	252.172	14.402	
NL	273.823	16.464	
SE	250.963	14.804	
BE	146.574	4.019	
NO	148.956	9.581	
ES	64.049	2.783	
Other	252.388	13.555	
Total	1.959.156	109.175	
20%	391.831	21.835	
30%	587.747	32.753	
40%	783.662	43.670	
(Movements at 30% /day)		90	
From ALL to DK040	tonnes	movements	(2019)
DE	602.991	32.054	
PL	484.787	26.518	
NL	262.101	14.089	
SE	147.617	8.167	
BE	157.565	9.052	
NO	93.816	3.855	
ES	163.239	8.806	
Other	145.575	8.291	
Total	2.057.691	110.832	
20%	411.538	22.166	
30%	617.307	33.250	
40%	823.076	44.333	
(Movements at 30% /day)		91	
Grand Total (in-out)	4.016.847	220.007	
20%	803.369	44.001	
30%	1.205.054	66.002	
40%	1.988.717	88.003	
(Movements at 30% /day)		181	



3.3.3 Southern Denmark

In 2019, Southern Denmark had a total of 5.918.195 tonnes inbound and 6.406.546 tonnes outbound by road. This was transported by 360.818 trips inbound and 366.586 trips outbound. Figure 7 gives an illustration of the number of yearly movements of trucks to/from Southern Denmark in 2019.

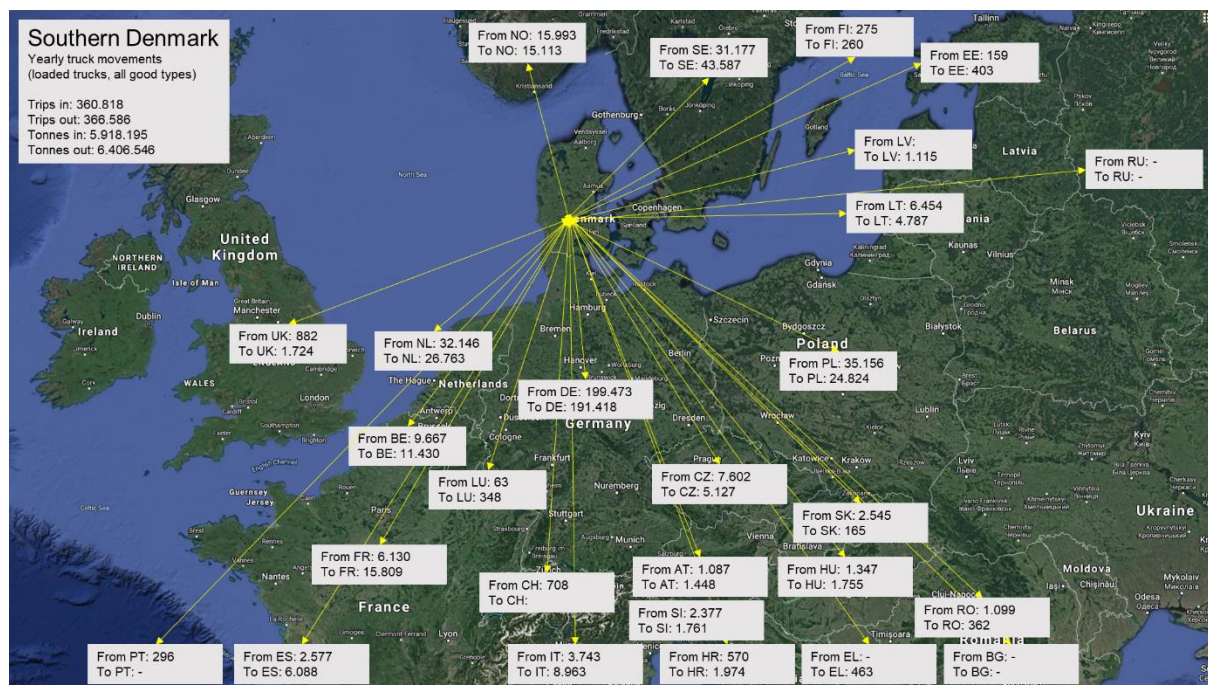


Figure 7 - Number of trips in/outbound of Southern Denmark to European countries (2019). Based on 2019 Eurostat Data.

The major countries with traffic (sorted by tonnage) inbound and outbound of Southern Denmark are shown in Table 26.

Table 26 – Inbound goods to Southern Denmark, sorted by yearly tonnage.²⁸

load_region	unload_region	tonnes	tkm	vehicle km	movements
DE	DK030	3.493.766	1.392.645	80.308.242	199.473
PL	DK030	570.520	498.575	30.797.147	35.156
NL	DK030	554.031	414.633	34.480.425	32.146
SE	DK030	409.024	183.554	12.891.866	31.177
NO	DK030	252.965	197.822	11.284.234	15.993
BE	DK030	160.714	135.430	8.324.703	9.667
FR	DK030	103.012	144.058	8.362.925	6.130
IT	DK030	78.447	115.436	6.744.592	3.743
LT	DK030	70.421	100.311	9.318.480	6.454
ES	DK030	38.653	89.287	5.970.020	2.577

²⁸ Other countries, including EE, FI, LU, PT each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



SK	DK030	30.681	40.424	4.582.755	2.545
CZ	DK030	27.538	30.584	12.313.615	7.602
SI	DK030	26.048	40.560	5.366.894	2.377
RO	DK030	23.494	50.715	2.386.960	1.099
HU	DK030	18.960	25.379	2.001.499	1.347
AT	DK030	18.186	22.115	1.749.068	1.087
UK	DK030	14.530	14.575	997.020	882
HR	DK030	13.572	21.795	913.879	570
Other	DK030	13.633	30.533	1.876.815	793
Total	DK030	5.918.195	3.548.431	240.671.139	360.818

Table 27 – Outbound goods to Southern Denmark, sorted by yearly tonnage.²⁹

load_region	unload_region	tonnes	tkm	vehicle km	movements
DK030	DE	3.429.635	1.096.057	73.303.554	191.418
DK030	SE	687.065	434.723	25.719.302	43.587
DK030	PL	472.404	459.044	24.802.807	24.824
DK030	NL	413.559	267.316	18.485.807	26.763
DK030	FR	322.736	355.784	23.226.438	15.809
DK030	NO	240.048	190.989	13.013.096	15.113
DK030	BE	178.020	166.570	10.960.174	11.430
DK030	IT	172.863	285.623	16.191.575	8.963
DK030	ES	114.108	252.862	13.351.301	6.088
DK030	LT	84.849	107.006	6.195.993	4.787
DK030	AT	54.752	77.083	2.121.892	1.448
DK030	SI	39.156	59.334	3.465.939	1.761
DK030	CZ	37.905	33.401	10.349.733	5.127
DK030	HU	34.939	44.012	2.428.029	1.755
DK030	HR	27.826	42.510	3.033.271	1.974
DK030	UK	27.519	32.651	2.300.644	1.724
DK030	LV	21.309	9.165	1.200.840	1.115
DK030	EL	12.341	33.248	2.290.441	463
DK030	CH	12.244	15.494	881.708	708
DK030	Other	23.268	35.786	2.870.451	1.729
DK030	Total	6.406.546	3.998.658	256.192.995	366.586

As can be seen in Table 26 and Table 27, the top 7 countries for inbound/outbound international road freight in terms of tonnage are Germany, Sweden, Poland, The Netherlands, France, Norway and Belgium. These countries constitute about 92% of the total international truck traffic in/out of the region.

²⁹ Other countries, including EE, FI, LU, PT each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



Based on our thorough analysis of the complete dataset, scenarios (30% baseline of selected types of goods) for both inbound- and outbound potential for conversion from road to short-sea-shipping are applied to estimate the overall potential gross volume of goods that can be shifted, see Table 28.

Table 28 – Overall estimated gross volume of goods that can be shifted from road to short-sea-shipping (Southern Denmark – all). Based on Eurostat data.

From DK030 to ALL	tonnes	movements	(2019)
DE	1.355.891	82.163	
SE	501.480	27.237	
PL	362.724	19.165	
NL	301.548	18.058	
FR	256.448	13.010	
NO	194.271	12.173	
BE	89.970	6.528	
Other	517.623	29.591	
Total	3.579.955	207.925	
20%	715.991	41.585	
30%	1.073.987	62.378	
40%	1.431.982	83.170	
(Movements at 30% /day)		171	
From ALL to DK030	tonnes	movements	(2019)
DE	1.769.327	94.669	
SE	320.362	16.369	
PL	472.683	26.872	
NL	499.364	27.513	
FR	80.494	4.643	
NO	211.894	13.460	
BE	142.509	8.629	
Other	276.870	22.491	
Total	3.773.503	214.646	
20%	754.701	42.929	
30%	1.132.051	64.394	
40%	1.509.401	85.858	
(Movements at 30% /day)		176	
Grand Total (in-out)	7.353.458	422.571	
20%	1.470.692	84.514	
30%	2.206.037	126.771	
40%	3.638.019	169.028	
(Movements at 30% /day)		347	



3.3.4 Zealand

In 2019, Zealand had a total of 1.367.639 tonnes inbound and 1.370.356 tonnes outbound by road. This was transported by 86.035 trips inbound and 78.868 trips outbound. Figure 8 gives an illustration of the number of yearly movements of trucks to/from Zealand in 2019.



Figure 8 - Number of trips in/outbound of Zealand to European countries (2019). Based on 2019 Eurostat Data.

The major countries with traffic (sorted by tonnage) inbound and outbound of Zealand are shown in Table 29.

Table 29 – Inbound goods to Zealand, sorted by yearly tonnage.³⁰

load_region	unload_region	tonnes	tkm	vehicle km	movements
DE	DK020	474.777	227.452	15.120.773	30.293
SE	DK020	298.106	110.882	7.354.861	19.348
PL	DK020	203.394	160.418	8.406.700	11.118
NL	DK020	141.517	105.350	10.093.906	9.645
NO	DK020	47.550	33.215	2.697.400	3.640
LT	DK020	40.864	43.453	1.386.719	1.123
CZ	DK020	39.089	27.461	2.243.758	3.037
BE	DK020	37.024	20.344	980.075	2.067
FR	DK020	26.538	35.042	2.359.840	1.799
ES	DK020	18.083	44.216	4.799.708	1.532
SI	DK020	14.946	21.700	786.715	581
HU	DK020	13.039	7.591	622.290	471
Other	DK030	12.712	28.284	3.042.215	1.381
Total	DK030	1.367.639	865.408	59.894.960	86.035

³⁰ Other countries, including IT, LU, PT, RO, UK each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



Table 30 – Outbound goods from Zealand, sorted by yearly tonnage.³¹

load_region	unload_region	tonnes	tkm	vehicle km	movements
DK020	SE	879.105	296.500	17.528.591	43.367
DK020	DE	286.276	162.206	11.412.479	20.028
DK020	PL	49.483	36.992	3.597.511	4.978
DK020	NO	36.126	37.097	2.070.002	1.918
DK020	NL	28.822	16.424	2.756.819	3.009
DK020	FR	24.577	36.719	2.040.179	1.332
DK020	IT	23.930	40.981	2.182.473	1.269
DK020	LT	11.626	13.998	723.100	613
DK020	Other	30.411	46.518	3.646.470	2.354
DK020	Total	1.370.356	687.435	45.957.624	78.868

As can be seen in Table 29 and Table 30, the top 5 countries for inbound/outbound international road freight in terms of tonnage are Sweden, Germany, Poland, The Netherlands, and Norway. These countries constitute about 89% of the total international truck traffic in/out of Zealand.

Based on our thorough analysis of the complete dataset, scenarios (30% baseline of selected types of goods) for both inbound- and outbound potential for conversion from road to short-sea-shipping are applied to estimate the overall potential gross volume of goods that can be shifted, see Table 31.

³¹ Other countries, including AT, BE, ES, FI, HU, SI each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



Table 31 – Overall estimated gross volume of goods that can be shifted from road to short-sea-shipping (Zealand – all). Based on Eurostat data.

From DK020 to ALL	tonnes	movements	(2019)
SE	166.115	8.952	
DE	237.059	13.743	
PL	49.483	4.978	
NL	14.968	841	
NO	27.061	1.568	
Other	72.994	4.147	
Total	567.680	34.229	
20%	113.536	6.846	
30%	170.304	10.269	
40%	227.072	13.692	
(Movements at 30% /day)		28	
From ALL to DK020	tonnes	movements	(2019)
SE	37.418	1.950	
DE	351.849	20.015	
PL	163.398	8.925	
NL	107.730	6.410	
NO	21.223	1.223	
Other	152.204	8.984	
Total	833.822	47.507	
20%	166.764	9.501	
30%	250.147	14.252	
40%	333.529	19.003	
(Movements at 30% /day)		39	
Grand Total (in-out)	1.401.502	81.736	
20%	280.300	16.347	
30%	420.451	24.521	
40%	647.523	32.694	
(Movements at 30% /day)		67	



3.3.5 The Capital Region

In 2019, the Capital Region had a total of 1.538.319 tonnes inbound and 1.697.020 tonnes outbound by road. This was transported by 98.791 trips inbound and 103.614 trips outbound. Figure 9 gives an illustration of the number of yearly movements of trucks to/from the Capital Region in 2019.



Figure 9 - Number of trips in/outbound of the Capital Region to European countries (2019). Based on 2019 Eurostat Data.

Table 32 – Inbound goods to Zealand, sorted by yearly tonnage.³²

load_region	unload_region	tonnes	tkm	vehicle km	movements
SE	DK010	429.936	133.407	8.940.614	27.027
DE	DK010	278.909	156.478	11.271.778	18.418
NL	DK010	209.508	155.815	15.881.062	14.780
PL	DK010	158.758	137.848	9.559.591	10.800
FR	DK010	87.605	152.737	7.272.941	4.252
BE	DK010	62.714	55.212	3.476.394	3.641
ES	DK010	51.677	143.606	11.337.391	2.792
EL	DK010	47.059	95.478	3.978.225	1.961
IT	DK010	39.374	58.135	5.283.160	3.201
CZ	DK010	39.326	39.312	1.815.556	1.668
HU	DK010	23.330	22.160	2.828.857	1.706
LV	DK010	19.865	24.678	1.750.218	1.338
NO	DK010	17.255	10.402	847.771	1.398

³² Other countries, including CH, LT, LU, PT, SI, TR, UK each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



SK	DK010	16.946	18.929	788.714	706
AT	DK010	15.858	14.669	938.318	1.175
FI	DK010	11.786	12.760	577.160	565
Other	DK010	28.413	52.986	4.361.604	3.363
Total	DK010	1.538.319	1.284.612	90.909.354	98.791

Table 33 – Outbound goods from the Capital Region, sorted by yearly tonnage.³³

load_region	unload_region	tonnes	tkm	vehicle km	movements
DK010	SE	696.668	209.221	17.410.741	44.192
DK010	DE	449.935	271.160	15.564.617	25.868
DK010	NO	133.084	132.602	6.525.051	6.848
DK010	NL	115.431	88.574	7.679.302	7.984
DK010	PL	102.416	78.875	4.534.222	5.828
DK010	FR	74.713	100.954	6.314.963	4.287
DK010	FI	36.110	52.133	2.890.722	2.101
DK010	SK	28.244	38.116	1.905.764	1.412
DK010	BE	25.729	23.927	1.048.526	1.132
DK010	UK	14.811	33.740	2.600.038	1.514
DK010	Other	19.879	44.955	5.626.470	2.448
DK010	Total	1.697.020	1.074.257	72.100.416	103.614

As can be seen in Table 32 and Table 33, the top 7 countries for inbound/outbound international road freight in terms of tonnage are Sweden, Germany, The Netherlands, Poland, France, Norway and Belgium. These countries constitute about 88% of the total international truck traffic in/out of the region.

Based on our thorough analysis of the complete dataset, scenarios (30% baseline of selected types of goods) for both inbound- and outbound potential for conversion from road to short-sea-shipping are applied to estimate the overall potential gross volume of goods that can be shifted, see Table 34.

³³ Other countries, including CZ, ES, HU, LU, PT, RO each have less than 10.000 tonnes per year in total movements (detailed dataset can be seen in Appendix 1). Source: Statistics Denmark (2021) based on Eurostat Data from 2019. Tonne-kilometer only traced in reporting country (outgoing), therefore the number is relatively low.



Table 34 – Overall estimated gross volume of goods that can be shifted from road to short-sea-shipping (the Capital Region – all). Based on Eurostat data.

From DK010 to ALL	tonnes	movements	(2019)
SE	181.481	12.197	
DE	326.951	16.671	
NL	45.897	2.916	
PL	55.226	2.668	
FR	53.424	2.450	
NO	83.032	4.342	
BE	25.030	1.074	
Other	70.704	4.688	
Total	841.745	47.006	
20%	168.349	9.401	
30%	252.524	14.102	
40%	336.698	18.802	
(Movements at 30% /day)		39	
From ALL to DK010	tonnes	movements	(2019)
SE	52.080	2.946	
DE	167.309	10.613	
NL	115.719	7.530	
PL	84.943	6.613	
FR	67.191	3.200	
NO	1.474	363	
BE	45.042	2.333	
Other	234.027	14.371	
Total	767.785	47.969	
20%	153.557	9.594	
30%	230.336	14.391	
40%	307.114	19.188	
(Movements at 30% /day)		39	
Grand Total (in-out)	1.609.530	94.975	
20%	321.906	18.995	
30%	482.859	28.493	
40%	819.557	37.990	
(Movements at 30% /day)		78	



3.4 International Road Freight – Total Gross Potential

Based on the analyses conducted for each of the Danish regions in the sections above, Table 35 can be composed based on a synthesis of all the analyses of in- and outgoing goods by trucks. It must be noted that the scenarios build on a prerequisite that short-sea-shipping is on par, or less expensive than the alternative road freight solution. This was explained in Section 2.3. based on both the analyses of price structures, and also detailed analyses of different goods types and goods categories. Provided that short-sea-shipping solutions that are developed can be on par- or less expensive than a competing road solution, it is estimated that the potential gross volume of goods that can be shifted from road transport to short-sea-shipping (international) in Denmark is approximately 5 million tonnes yearly, or about 18% of current relevant international goods on truck to/from Denmark (Median scenario).



Table 35 – Total estimated gross volume that can be shifted (international road transport)

	Tonnes	Movements	
The Capital Region			
Grand Total (in-out)	1.609.530	94.975	
20%	321.906	18.995	
30%	482.859	28.493	
40%	819.557	37.990	
(Movements at 30% /day)		78	
Zealand			
Grand Total (in-out)	1.401.502	81.736	
20%	280.300	16.347	
30%	420.451	24.521	
40%	647.523	32.694	
(Movements at 30% /day)		67	
Southern Denmark			
Grand Total (in-out)	7.353.458	422.571	
20%	1.470.692	84.514	
30%	2.206.037	126.771	
40%	3.638.019	169.028	
(Movements at 30% /day)		347	
Central Denmark			
Grand Total (in-out)	4.016.847	220.007	
20%	803.369	44.001	
30%	1.205.054	66.002	
40%	1.988.717	88.003	
(Movements at 30% /day)		181	
Northern Jutland			
Grand Total (in-out)	1.833.302	96.560	
20%	366.660	19.312	
30%	549.991	28.968	
40%	927.661	38.624	
(Movements at 30% /day)		79	
Total - International/Denmark (yearly)			
Grand Total (in-out)	16.214.639	915.849	Of all int. trucking goods
10%	1.621.464	91.585	6%
20%	3.242.928	183.170	12%
30%	4.864.392	274.755	18%
40%	8.021.477	366.340	30%
(Movements at 30% /day)		753	



4 Potential Gross Volume of Goods for shifting

The following section includes a summary of the estimation of gross volume of goods that can be shifted from road transport to short-sea-shipping in Denmark. This includes both national- and international goods.

This section builds on all previous sections, providing:

- Analyses of price structures of transportation of goods types by road and short-sea-shipping, including a last-mile-analysis.³⁴
- Any short-sea-shipping solution should break-even, or be less expensive than a direct road transport solution.
- Scenarios building on the above for shifting national road transport to short-sea-shipping.
- Scenarios building on the above for shifting international road transport to/from Denmark to short-sea-shipping.

The potential gross volume that can be shifted from road transport to short-sea-shipping in Denmark, based on median scenarios in previous sections are captured below in the condensed Table 36.

Table 36 – Total gross volume of goods that can be shifted from road to short-sea-shipping in Denmark. Yearly basis, based on 2019 data.

2019		
International/Denmark (yearly)	Tonnes	Movements
Total - International/Denmark (yearly)	26.471.732	1.576.052
Median Scenario of relevant goods	4.864.392	274.755
Jutland-Zealand National (yearly)	Tonnes	Movements
Total - International/Denmark (yearly)	1.003.000	57.000
Median Scenario of relevant goods	177.540	9.899
GRAND TOTAL	<u>5.041.932</u>	<u>284.654</u>
/day	13.814	780
% of relevant regions	18,4%	
% of all trucking goods (162,5+26,471732 mill.)	2,7%	

Collectively, it is estimated that the potential gross volume of goods that can be shifted from road transport to short-sea-shipping in Denmark is approximately 5 million tonnes yearly, or about 18% of the goods from the relevant regions which is today transported by truck³⁵. It is again important to note that this is provided that any short-sea-shipping solution should be on par or cheaper than a competing direct road solution.

³⁴ Case examples of last-mile price analysis can be found in Appendix 3.

³⁵ Kindly note that the 2,7% conversion calculation includes all trucking transport, including intra-regional transportation in Denmark, which accounts for the vast majority of trucking transport.



5 Perspective – Transit Goods

In addition to the goods identified in a national- and international context for Denmark, there is also transit goods that is neither loaded nor unloaded in Denmark, yet passing through by truck. The most recent deep study on this phenomenon was conducted in 2007 (Vejdirektoratet, 2020; cf. NUTRADA, 2007). The comprehensive study encompassed a manual count of in- and outgoing trucks of the Danish borders, adjusted for seasonal variation, in a 24-hour period. To understand the content and distribution between containerized and non-containerized goods in the trucks, the total in- and outgoing traffic to countries Norway, Sweden and EU were considered. This logic is applied as it is assumed that most transit traffic by truck through Denmark either originates in mainland Europe (for the data that is possible to count), Norway or Sweden.

Similarly, the following is assumed (also looking at the quantities in the statistics):

- Goods to Sweden from Mainland EU in transit through Denmark could come from any country except Norway, Finland and Denmark.
- Goods from Sweden to Mainland EU in transit through Denmark could go to any country, except Denmark, Finland and Norway.
- Goods to Norway from Mainland EU in transit through Denmark could come from any country, except Sweden, Finland and Denmark
- Goods from Norway to EU could go to any country, except Denmark, Finland and Sweden.

This logic is applied in combination with the statistics provided by NUTRADA 2007 (cf. Vejdirektoratet, 2020) to estimate the proportion split between containerized- and non-containerized goods going through Denmark by truck, see Table 37.

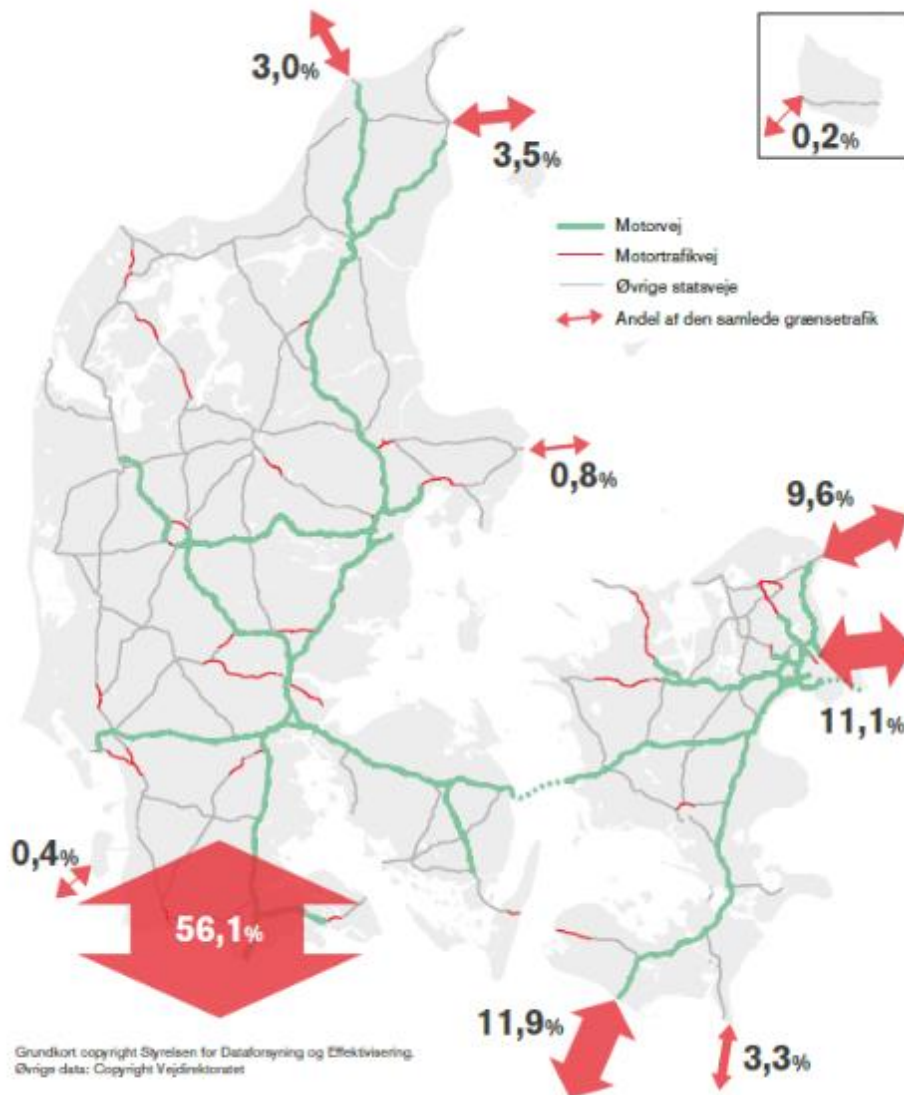


Table 37 – Calculation of the split between containerized- and non-containerized truck transport (transit) through Denmark.³⁶

TRANSIT			
To Sweden From EU (excl. DK, FIN, NO)		Approx. of total load in containers (2016-2019)	
		$=\frac{732-631-13-4}{(5907-4405-153-6)+(732-631-13-4)}$	5,89%
		Approx. of total load in non-containers	
		$=\frac{5907-4405-153-6}{(5907-4405-153-6)+(732-631-13-4)}$	94,11%
		100,00%	
From Sweden to EU (excl. DK, FIN, NO)		Approx. of total load in containers (2016-2019)	
		$=\frac{241-141-14-3}{(4102-2499-258-21)+(241-141-14-3)}$	5,90%
		Approx. of total load in non-containers	
		$=\frac{241-141-14-3}{(4102-2499-258-21)+(241-141-14-3)}$	94%
		100,00%	
To Norway from EU (EXCL DK, FIN, SWE)		Approx. of total load in containers (2016-2019)	
		$=\frac{186-135-14}{(2345-1467-258)+(186-135-14)}$	5,63%
		Approx. of total load in non-containers	
		$=\frac{2345-1467-258}{(2345-1467-258)+(186-135-14)}$	94,37%
		100,00%	
From Norway to EU (EXCL DK, FIN, SWE)		Approx. of total load in containers (2016-2019)	
		$=\frac{75-26-13}{(1419-621-153)+(75-26-13)}$	5,29%
		Approx. of total load in non-containers	
		$=\frac{1419-621-153}{(1419-621-153)+(75-26-13)}$	94,71%
		100,00%	
		Total avg.	
		Containerized	5,68%
		Non-containerized	94,32%
			100,00%

An illustration of the total traffic in/out of Denmark, including transit movements, are illustrated in Figure 10.

³⁶ This logic on the weight between the above can be used to calculate the approximate percentage and tonnage distribution in containerized- and non-containerized goods by truck through- and to/from Denmark. Source: Statistics Denmark, 2021; 2016-2019 data (IVG 23).



Figur 5.1 Procentvis andel af den samlede lastbiltrafik over grænserne fordelt på grænseovergange, 2018. Kilde: Danmarks Statistik og Vejdirektoratet

Figure 10 - In- and outgoing truck traffic across the Danish borders in 2018. Source illus: Vejdirektoratet, 2020: 14.

It can be seen in illustration in Figure 10 that the majority of the truck traffic goes through the border of Denmark/Germany, as well as the passage between the Eastern part of Denmark (Copenhagen/Helsingør) and the South-Eastern Part of Denmark (Rødby/Gedser). It is not surprising that the traffic follows these directions. The most important countries for trade are Germany and Sweden, constituting over 60% of the goods transported (Vejdirektoratet, 2020). To also understand how transit goods are represented by the above figure, the general growth in truck traffic since the NUTRADA manual border study was conducted in 2007 is extrapolated to 2018. Similarly, an additional layer distinguishing between containerized- and non-containerized truck traffic is applied. This is demonstrated in the table below. Based on our analyses, roughly 13,7% of all ingoing trucks on a daily basis to Denmark is transit traffic, either through the Southern part of Denmark, the Eastern part of Denmark, or the Northern part of Denmark. The calculations on this activity (2018 normalized numbers) can be seen in Table 38.



Table 38 – Transit traffic through Denmark in 2018 – estimation. Shows a distribution between containerized- and non-containerized goods on truck. ³⁷

2018 TRANSIT GOODS - TRUCKS - PER DAY				In containers	Rest	Est. # Trucks w/containers	Est. # Trucks rest	TOTAL
FROM ³⁸	TO	# of trucks	Tonnes					
FRH/GRE	FRØ/PAD	15	244	13,8	230,2	0,87	14,38	15
FRH/GRE	HEL/ØRS	26	413	23,4	389,5	1,46	24,34	26
FRH/GRE	HAN/HIR	4	56	3,2	53,1	0,20	3,32	4
FRH/GRE	RØD/GED	0	0	0,0	0,0	0,00	0,00	0
FRØ/PAD	FRE/GRE	21	338	19,2	318,7	1,20	19,92	21
FRØ/PAD	HAN/HIR	20	319	18,1	301,0	1,13	18,81	20
FRØ/PAD	HEL/ØRS	27	432	24,5	407,2	1,53	25,45	27
FRØ/PAD	RØD/GED	15	244	13,8	230,2	0,87	14,38	15
HAN/HIR	FRØ/PAD	62	995	56,5	938,3	3,53	58,65	62
HAN/HIR	FRE/GRE	19	300	17,0	283,3	1,07	17,70	19
HAN/HIR	HEL/ØRS	0	0	0,0	0,0	0,00	0,00	0
HAN/HIR	RØD/GED	0	0	0,0	0,0	0,00	0,00	0
HEL/ØRS	FRH/GRE	38	601	34,1	566,5	2,13	35,41	38
HEL/ØRS	FRØ/PAD	33	526	29,8	495,7	1,86	30,98	33
HEL/ØRS	HAN/HIR	0	0	0,0	0,0	0,00	0,00	0
HEL/ØRS	RØD/GED	265	4.242	240,8	4001,1	15,05	250,07	265
RØD/GED	FRE/GRE	0	0	0,0	0,0	0,00	0,00	0
RØD/GED	FRØ/PAD	25	394	22,4	371,8	1,40	23,24	25
RØD/GED	HAN/HIR	0	0	0,0	0,0	0,00	0,00	0
RØD/GED	HEL/ØRS	326	5.218	296,2	4921,8	18,51	307,61	326
Total		895	14.321	812,9	13508,3	50,80	844,27	895
				5,68%	94,32%			
TONNES	Avg. Load international EU		16					

³⁷Sources: NUTRADA 2007; Vejdirektoratet 2020; Statistics Denmark, 2021 (2016-2019 data) (IVG23).

³⁸FRH/GRE = Frederikshavn/Grenå; FRØ/PAD = Frøslev/Padborg; HEL/ØRS = Helsingør/Øresund; HAN/HIR = Hanstholm/Hirtshals; RØD/GED = Rødby/Gedser



As can be seen highlighted in bold in Table 38, most of the transit goods in Denmark are through the passages across the northern and southern part of Zealand. The daily truck activity in this region represents roughly 66% of daily transit goods through Denmark. In the southbound direction, it is assumed that these goods originate mostly from Sweden (perhaps also a smaller part from NO, FIN). In the northbound direction, it is assumed that most of these goods are going to Sweden (perhaps also a smaller part to Norway and Finland).³⁹ Lastly, the Northern part of Denmark, with ferry lines with most goods to/from Norway, accounts for roughly 7% of the daily transit goods through Denmark.

The above information provides additional insight into the goods flow of trucks in the region around Denmark. Although it is not directly applicable in terms of estimating the gross volume of goods in the areas around Vordingborg and Aalborg, it could be useful when understanding route planning for potential short-sea-shipping solutions (cf. other deliverables in AEGIS WP10).

³⁹ Note that the logic applied for identifying proportion of containerized and non-containerized goods was though gathering what proportion potentially could be transit goods. It was to cleanse for goods type that would go e.g. directly from Norway to Sweden as part of the statistics. I.e, it was to eliminate the cross-border traffic (mainland) between Norway and Sweden, and also any traffic between Norway, Finland and Sweden, potentially by road or Ro/RO. This does not leave out the possibility that transit traffic from e.g., Germany, would go through Denmark, to Sweden, and have an end destination in Norway.



References

- [1] Anderstig & Berglund (2016). "Nya varuvärden 2014 – data, metod och resultat." WSP Sverige AB.
- [2] Colling, A. & Hekkenberg, R. (2020). "Waterborne platooning in the short sea shipping sector." *Transportation Research Part C*, (120), pp. 1-14
- [3] Compass (2009). *The COMPetitiveness of EuropeAn Short-sea freight Shipping compared with road and rail transport.*
- [4] Damodaran (2020).
http://people.stern.nyu.edu/adamodar/New_Home_Page/dataarchived.html , retrieved on May 23, 2021.
- [5] Eurostat (2021). "Database" <https://ec.europa.eu/eurostat/data/database> , retrieved on May 23, 2021.
- [6] Eurostat (2013). "Glossary: Tonne-kilometre (tkm)". [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Tonne-kilometre_\(tkm\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Tonne-kilometre_(tkm)), retrieved on May 7, 2021.
- [7] Gnap, J., Poliak, M. & Semanova, S. (2019). "The Issue of a Transport Mode Choice from the Perspective of Enterprise Logistics". *Open Engineering*, Vol. 9(1), 2019: pp. 374-383.
- [8] Nutrada (2007). "Transittrafik med lastbil 2007: Resultater fra tælling af lastbilstrafikken ved grænserne maj 2007".
http://www.ntn.dk/download/rapporter_2007_dk/transittaelling2007_rapport.pdf , retrieved on March 21, 2021.
- [9] Port of Aalborg (2021). "Terms of business 2021".
https://portofaalborg.dk/media/8d8921c0776eb2f/terms-of-business_2021_port-of-aalborg.pdf, retrieved on May 3, 2021
- [10] Port of Esbjerg (2021). "Prices and Conditions 2021".
http://portesbjerg.dk/sites/default/files/files/documents/prices_april_2021_en.pdf, retrieved on May 3, 2021.
- [11] Port of Frederikshavn (2021). "Terms of Business".
[https://pof.dk/UserFiles/Image/Fler/Terms_of_business_2021\(1\).pdf](https://pof.dk/UserFiles/Image/Fler/Terms_of_business_2021(1).pdf), retrieved on May 3, 2021.
- [12] Port of Rotterdam (2021). "General Terms and Conditions including port tariffs".
<https://www.portofrotterdam.com/sites/default/files/general-terms-and-conditions-including-port-tariffs-2021.pdf?token=3xBWl9f> , retrieved on May 3, 2021
- [13] Port of Vordingborg (2021). "Terms of Business and List of Rates".
<https://www.vordingborg.dk/media/cllmkzhw/terms-of-business-list-of-rates-2021.pdf> ,
retrieved on May 3, 2021.
- [14] Statistics Denmark (2021). "Standard goods classification for transport statistics (NST 2007), v1:2007":
<https://www.dst.dk/en/Statistik/dokumentation/nomenklaturer/standardgodsnomenklatur-til-transportstatistik--nst-2007-> , retrieved on May 23, 2021.



- [15] Statistics Denmark (2021). "Statistikbanken: Business Sectors"
<https://www.statistikbanken.dk/statbank5a/default.asp?w=1920> , retrieved between January 2 – May 23, 2021.
- [16] The Central Business Register (2021). "cvr.dk",
<https://datacvr.virk.dk/data/index.php?q=forside&language=en-gb>, retrieved on May 3, 2021.
- [17] Ti Insight (2021). "European road freight rate benchmark report". <https://www.ti-insight.com/european-road-freight-rate-benchmark-report/>, retrieved on February 23, 2021.
- [18] Trafikverket (2016). "Analysmetod och samhällsekonomiska kalkylvärden för transportsektorn: ASEK 6.0". https://horvendile.files.wordpress.com/2017/01/asek_6_0.pdf , retrieved on January 2, 2021)
- [19] Smeets, P. (2015). "Report of the TF Classification system for transport statistics", UNECE WP 6, 6-7 Nov. 2014, Prague.
<https://unece.org/DAM/trans/doc/2015/wp6/ Peter Smeets Report TF Prague on Classifications.pdf>, retrieved on May 2, 2021.
- [20] Vejdirektoratet (2020). "Udvikling i national og international lastbiltrafik i Danmark - En statistisk belysning". Report no.: 601.
https://www.vejdirektoratet.dk/api/drupal/sites/default/files/2020-02/National%20og%20international%20lastbiltrafik%20i%20DK_WEB.pdf , retrieved on March 24, 2021.



Annex A. Goods type codes (NST2007)

Code	Description
1	Products of agriculture, hunting, and forestry; fish and other fishing products
2	Coal and lignite; crude petroleum and natural gas
3	Metal ores and other mining and quarrying products; peat; uranium and thorium
4	Food products, beverages and tobacco
5	Textiles and textile products; leather and leather products
6	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media
7	Coke and refined petroleum products
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
9	Other non-metallic mineral products
10	Basic metals; fabricated metal products, except machinery and equipment
11	Machinery and equipment not elsewhere classified; office machinery and computers; electrical machinery and apparatus not elsewhere classified; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
12	Transport equipment
13	Furniture; other manufactured goods not elsewhere classified
14	Secondary raw materials; municipal wastes and other wastes
15	Mail, parcels
16	Equipment and material utilized in the transport of goods
17	Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods not elsewhere classified
18	Grouped goods: a mixture of types of goods which are transported together
19	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16.
20	Other goods not elsewhere classified
99	Grouped goods due to confidentiality and quality';

Overview of different goods types. Source: Statistics Denmark, 2021.



SEQ.	CODE	LEVEL	TITLE
1	1	1	Products of agriculture, hunting, and forestry; fish and other fishing products
2	01.1	2	Cereals
3	01.2	2	Potatoes
4	01.3	2	Sugar beet
5	01.4	2	Other fresh fruit and vegetables
6	01.5	2	Products of forestry and logging
7	01.6	2	Live plants and flowers
8	01.7	2	Other substances of vegetable origin
9	01.8	2	Live animals
10	01.9	2	Raw milk from bovine cattle, sheep and goats
11	01.A	2	Other raw materials of animal origin
12	01.B	2	Fish and other fishing products
13	2	1	Coal and lignite; crude petroleum and natural gas
14	02.1	2	Coal and lignite
15	02.2	2	Crude petroleum
16	02.3	2	Natural gas
17	3	1	Metal ores and other mining and quarrying products; peat; uranium and thorium
18	03.1	2	Iron ores
19	03.2	2	Non-ferrous metal ores (except uranium and thorium ores)
20	03.3	2	Chemical and (natural) fertilizer minerals
21	03.4	2	Salt
22	03.5	2	Stone, sand, gravel, clay, peat and other mining and quarrying products n.e.c.
23	03.6	2	Uranium and thorium ores
24	4	1	Food products, beverages and tobacco
25	04.1	2	Meat, raw hides and skins and meat products
26	04.2	2	Fish and fish products, processed and preserved
27	04.3	2	Fruit and vegetables, processed and preserved
28	04.4	2	Animal and vegetable oils and fats
29	04.5	2	Dairy products and ice cream
30	04.6	2	Grain mill products, starches, starch products and prepared animal feeds
31	04.7	2	Beverages
32	04.8	2	Other food products not elsewhere classified and tobacco products (except in parcel service or grouped)
33	04.9	2	Various food products and tobacco products in parcel service or grouped
34	5	1	Textiles and textile products; leather and leather products
35	05.1	2	Textiles
36	05.2	2	Wearing apparel and articles of fur
37	05.3	2	Leather and leather products
38	6	1	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media
39	06.1	2	Products of wood and cork (except furniture)
40	06.2	2	Pulp, paper and paper products



41	06.3	2	Printed matter and recorded media
42	7	1	Coke and refined petroleum products
43	07.1	2	Coke oven products; briquettes, ovoids and similar solid fuels
44	07.2	2	Liquid refined petroleum products
45	07.3	2	Gaseous, liquefied, or compressed petroleum products
46	07.4	2	Solid or waxy refined petroleum products
47	8	1	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel
48	08.1	2	Basic mineral chemical products
49	08.2	2	Basic organic chemical products
50	08.3	2	Nitrogen compounds and fertilizers (except natural fertilizers)
51	08.4	2	Basic plastics and synthetic rubber in primary forms
52	08.5	2	Pharmaceuticals and para-chemicals including pesticides and other agro-chemical products
53	08.6	2	Rubber or plastic products
54	08.7	2	Nuclear fuel
55	9	1	Other non-metallic mineral products
56	09.1	2	Glass and glass products, ceramic and porcelain products
57	09.2	2	Cement, lime and plaster
58	09.3	2	Other construction materials, manufactures
59	10	1	Basic metals; fabricated metal products, except machinery and equipment
60	10.1	2	Basic iron and steel and ferro-alloys and products of the first processing of iron and steel (except tubes)
61	10.2	2	Non-ferrous metals and products thereof
62	10.3	2	Tubes, pipes, hollow profiles and related fittings
63	10.4	2	Structural metal products
64	10.5	2	Boilers, hardware, weapons and other fabricated metal products
65	11	1	Machinery and equipment not elsewhere classified; office machinery and computers; electrical machinery and apparatus not elsewhere classified; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks
66	11.1	2	Agricultural and forestry machinery
67	11.2	2	Domestic appliances not elsewhere classified (White goods)
68	11.3	2	Office machinery and computers
69	11.4	2	Electric machinery and apparatus not elsewhere classified
70	11.5	2	Electronic components and emission and transmission appliances
71	11.6	2	Television and radio receivers; sound or video recording or reproducing apparatus and associated goods (Brown goods)
72	11.7	2	Medical, precision and optical instruments, watches and clocks
73	11.8	2	Other machines, machine tools and parts
74	12	1	Transport equipment
75	12.1	2	Automobile industry products
76	12.2	2	Other transport equipment
77	13	1	Furniture; other manufactured goods not elsewhere classified
78	13.1	2	Furniture



79	13.2	2	Other manufactured goods
80	14	1	Secondary raw materials; municipal wastes and other wastes
81	14.1	2	Household and municipal waste
82	14.2	2	Other waste and secondary raw materials
83	15	1	Mail, parcels
84	15.1	2	Mail
85	15.2	2	Parcels, small packages
86	16	1	Equipment and material utilized in the transport of goods
87	16.1	2	Containers and swap bodies in service, empty
88	16.2	2	Pallets and other packaging in service, empty
89	17	1	Goods moved in the course of household and office removals; baggage and articles accompanying travelers; motor vehicles being moved for repair; other non-market goods not elsewhere classified
90	17.1	2	Household removal
91	17.2	2	Baggage and articles accompanying travelers
92	17.3	2	Vehicles for repair
93	17.4	2	Plant equipment, scaffolding
94	17.5	2	Other non-market goods not elsewhere classified
95	18	1	Grouped goods: a mixture of types of goods which are transported together
96	18.0	2	Grouped goods
97	19	1	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16.
98	19.1	2	Unidentifiable goods in containers or swap bodies
99	19.2	2	Other unidentifiable goods
100	20	1	Other goods not elsewhere classified
101	20.0	2	Other goods not elsewhere classified

NST2007 classification. Source, Statistics Denmark, 2021