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Reima Helminen, Riitta Pöntynen, Minna Alhosalo,

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FOREWORD

Since the early 1990's European Union has been promoting a multimodal transport corridor policy known as TEN-T policy. Corridor policy approaches have been adopted also on regional cross-border programmes to improve connectivity. This report has been made as a part of Reinforcing Eastern Finland-Estonia Transport Corridor (REFEC), which is an ERDF funded project under the Interreg Central Baltic Programme 2014–2020 in the priority Well-connected region. The REFEC project supports the transport corridor by mapping the cargo potential and impact of the activated corridor, and most importantly, conducting different concrete activities that aim to remove obstacles in the establishment of the Loviisa-Kunda roro connection.

The roro traffic between Finland has been growing ever since the 1990s when Estonia restored its independence. The growth trend in volumes has raised the issue of alternative routings for ferry traffic. The cooling of the economy in autumn 2019, boosted later by the COVID-19 pandemic lead to the economic downturn which has decreased transported cargo volumes everywhere. The change is supposedly temporary. This study is focusing on the impacts of the foreseen Loviisa-Kunda ferry connection from various perspectives. The impacts on transport distances, travel times, costs, and CO_2 emissions are covered. These impacts are benchmarked to currently existing roro connections over the Gulf of Finland. Furthermore, impacts on various aspects in regional development and congestion are discussed.

The report was made by research experts Reima Helminen, Riitta Pöntynen, and Minna Alhosalo in the Centre for Maritime Studies, part of Brahea Centre at the University of Turku. The Estonian part of the research was conducted by Aado Keskpaik and Rivo Noorkõiv from OÜ Geomedia. The authors want to express their gratitude to all parties that took part in the interviews or provided material for the study.

Turku 25th of September 2020

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SUMMARY

The launching of the ferry connection between the port of Loviisa in Finland and port of Kunda in Estonia would operationalize the transport corridor between Eastern Finland and Eastern Estonia (REFEC corridor). The aim of the study is to analyse the impacts generated by the foreseen ferry line. The impacts consist of comparisons of the Loviisa-Kunda route with the current existing port connections between Finland and Estonia. They encompass difference in the mileage, travel time, costs, CO_2 emissions and impact to regional development. The study results are based on measurements, statistical analysis, planning documents and interviews of stakeholders of different interest groups linked to regional development.

The comparison of mileages from REFEC area towns between Finland and Estonia expectedly shows that Loviisa-Kunda ferry would provide shorter mileage compared to the routes via the existing ferry services. The aggregate distance between REFEC area major towns in eastern Finland and Estonia via Loviisa-Kunda is 30%-85% shorter compared to the other connections. As for travel time, including ferry travel, the relative advantage of Loviisa-Kunda route narrows but it is faster than other alternatives. The very southeastern Finland cargoes would get the best advantage of the foreseen new ferry connection. As for the costs, the new ferry line would provide about ¼ lower costs for the estimated freight potential between eastern Finland and northeastern Estonia.

Majority of Finnish truck transports crossing the Gulf of Finland transit Estonia on their way to Central Europe. For Finnish REFEC area cargoes to/from Central Europe, the routing via Loviisa-Kunda would not in general be much more time consuming or costly compared to the alternative ports. For some origins/destinations like Kouvola, Lappeenranta and Joensuu the Loviisa-Kunda ferry would provide the lowest cost. Although Loviisa-Kunda ferry would seem a competitive alternative for the transports between eastern Finland and northeastern Estonia, as well as for Central Europe and beyond, there are many components which affect the eventual costs in real life, and which could not be incorporated into the study. These are e.g. the cost of ferry ticket, the cost structure of the transport company (age of fleet etc), the actual ferry schedules (calculations used averages), how driver's previous driving time and ferry schedule match with the driving and rest time regulation, thus affecting the aggregate travel time etc.

The CO_2 emissions are very much in line with the distance of origins and destinations. The emissions consist of road and sea components where the longer sea voyage between Loviisa-Kunda is compensated by shorter mileage to these two ports. Transports in eastern area of REFEC corridor via Loviisa-Kunda have less CO_2 emissions compared to the other port alternatives. Transports from Finnish REFEC area towns to Pärnu emit more CO_2 thanvia Vuosaari-Muuga or West Harbour-Old City but less than via Hanko-Paldiski.

One of the major benefits of Loviisa-Kunda ferry line would be relieving the congestion in the capital cities. The activation of the Loviisa-Kunda ferry service would re-route around 6-12% of the Helsinki-Tallinn ferry related truck traffic away from the centres of Helsinki and Tallinn. Negative impacts of the relocated traffic are not expected.

The Finnish transport strategies or maritime spatial plans include no indication of the foreseen new ferry connection while the Estonian strategy documents (spatial and maritime spatial plans) on national, regional and local level have been explicitly included port of Kunda having a ferry connection to Finland.

A new ferry line would stimulate regional development close to the ports in both countries. It is estimated to generate new jobs (Finland 25-37 jobs and Estonia 25-50 jobs), tax income to municipalities (FI 170-250 k€; EE 40-80 k€) and two million euros annual turnover to both ports. Major beneficiaries would be the manufacturing and logistics industries. Moreover, it would add the vitality of the ports and lead to cluster type development with growing mutual benefits. A ferry connection would bring new investments to both regions. The improved accessibility of eastern Uusimaa and western Virumaa would lead to improved Finnish-Estonian economic cooperation of the stakeholders and increased commuting and leisure time travelling.

CONTENTS

1 INTRODUCTION

1.1 Background and aim of the study

The heavy vehicle traffic (trucks and trailers) on ferries over the Gulf of Finland has been increasing since the beginning of the 1990s almost every year and the trend is estimated to continue. The expectations of cooling economy in autumn 2019, then resulting to economic downturn caused by Covid-19 pandemic is, however, creating a temporary break in the trend. At present there are two main ferry routes between Finland and Estonia (Helsinki-Tallinn and Hanko-Paldiski). In Helsinki, there are three options: West-Harbour and Katajanokka calling the Old City port in Tallinn, and Vuosaari-Muuga connection. Considerable part of this heavy vehicle traffic takes place between Eastern Finland and Eastern Estonia. Currently the trucks need to drive via Helsinki-Tallinn, or via Hanko-Paldiski, even longer route. One alternative to make the Eastern Finland-Eastern Estonia transport corridor more efficient is to establish a ferry connection between ports of Loviisa in Finland and Kunda in Estonia.

This report has been made as a part of the project Reinforcing Eastern Finland-Estonia Transport Corridor (REFEC). Objective in the project is to support the activation of REFEC corridor enabled by the Loviisa-Kunda ferry connection. The launching of the ferry line would provide a competitive alternative for existing ferry services. The project outputs are focused mainly on concrete measures to support Loviisa-Kunda ferry connection. The cargo potential of the corridor was analysed in the previous project report[1]. Furthermore, different other activities are made during the project. These include business model(s) with potential shipping companies, port operative and investment plans, roadmap to comply the needed licenses and regulatory requirements, best practices transferable from similar connections in the BSR, ferry scheduling and route option plans, marketing plan and events to promote the connection. The results of the cargo potential study are introduced in this report.

This study is focusing on the impacts of the foreseen Loviisa-Kunda ferry connection on mileage, travel time, costs and CO_2 emissions within REFEC corridor, and those transports which transit Estonia on their way to/from eastern Finland. The results are analysed and compared with the same calculations on existing ferry services between Finland and Estonia. Furthermore, the tentative impacts on regional development and congestion are discussed based on the official documents, statistics and interviews of the stakeholders.

[1] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight Potential of the Eastern Finland – Eastern Estonia Transport Corridor. Publications of the Centre for Maritime Studies. Brahea Centre at the University of Turku. A 74. 72 p.

2 DATA COLLECTION AND PROCESSING FOR MILEAGE AND TRANSPORT TIME

2.1 Origins and destinations in Finland and Estonia

The impact assessment focuses on the truck traffic of the eight counties (regions) in Finland**,** which was analysed in the REFEC "Freight Potential" report[2]. There is no relevant origin/destination (O/D) statistics on port-hinterland transports (see the freight potential report for details). Therefore, the results of the study on freight traffic in the Helsinki passenger ferry harbours[3] have been applied to estimate the share of freight transported to/from different regions. The truck volumes of these regions were pinpointed to respective capital town of each region to ease the measuring the distances from regions to different ports which have ferry connection to Estonia. These towns can be assumed to be in any case the main centres of production and consumption, thus being also the main origins and destinations of transports (table 2.1.)

Table 2.1. Division of Estonia-bound truck volume between Finnish REFEC regions.

Region	**Town**	**Share**
Kymenlaakso	Kouvola	30 %
Päijät-Häme	Lahti	28 %
Etelä-Karjala	Lappeenranta	7 %
Etelä-Savo	Mikkeli	4 %
Keski-Suomi	Jyväskylä	12 %
Pohjois-Savo	Kuopio	14 %
Pohjois-Karjala	Joensuu	5 %
Kainuu	Kajaani	1 %
		100 %

In Estonia similar studies as in Finland were not available concerning origin and destination of the trucks. Therefore, the allocation of truck volume to and from Estonian REFEC area regions, and respective major towns was made based on the value of exports in respective regions[4]. The value of oil shale was however, excluded from the data of the Ida-Virumaa region due to its large share of total exports, and since it is not a roro type of cargo. The remaining Ida-Virumaa volume was then divided between its two major towns Narva and Kohtla-Järve since concentrating all volume only to Narva had most probably biased the data compared to the solution where the

[2] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight Potential of the Eastern Finland – Eastern Estonia Transport Corridor. Publications of the Centre for Maritime Studies. Brahea Centre at the University of Turku. A 74. 72 p.

[3] Räty P., Planting, A., Määttälä, A. & Kantele, S. (2013). HJL 2015. Freight traffic in the Helsinki passenger ferry ports in autumn 2012. HSL Helsingin seudun liikenne, julkaisuja 26/2013. 38 p.

[4] Statistics Estonia (2019). Tööstustoodangu müük mitteresidentidele maakonna järgi.

volume is divided. Table 2.2. presents the derived division of truck volume in Estonian REFEC area.

Table 2.2. Division of Finland-bound truck volume based on the value of exports from northeastern Estonia in 2017.

Region	Town	Share
Ida-Virumaa	Narva	15 %
Ida-Virumaa	Kohtla-Järve	15 %
Jõgevamaa	Jõgeva	12 %
Järvamaa	Paide	11 %
Lääne-Virumaa	Rakvere	47 %
		100 %

2.2 Measuring mileages on land

Google Maps was used for measuring the driving distances from the capital of each region (table 2.3.) to the ports (table 2.4.) having existing roro traffic between Estonia and Finland and ports of Loviisa and Kunda (figure 2.1.). Some of the routes had to be modified manually since Google Maps provides optimal routes only for cars, not trucks which are often banned to enter city areas and directed to certain routes designated for port traffic. Katajanokka Harbour in Helsinki was not included in the assessment, since it is located between Vuosaari and West Harbour, and would thus not provide much added value in comparisons. Furthermore, the major part of traffic in the Helsinki centre area is operated via West Harbour.

For each trip the shares of highway and urban driving were estimated with Google Maps and complemented with available other information on highway and urban areas, e.g. on speed restrictions. This information was used also later in the emission calculations.

Table 2.3. Origin/destination cities in Finland and in Estonia.

Origin/destination city in Finland	Origin/destination city in Estonia
Kouvola	Rakvere
Lahti	Paide
Kuopio	Jõgeva
Jyväskylä	Narva
Lappeenranta	Kohtla-Järve
Joensuu	
Mikkeli	
Kajaani	

Table 2. 4. Ports in Finland and Estonia included in the impact assessment.

Ports in Finland	**Ports in Estonia**
Port of Loviisa	Port of Kunda
West Harbour, Port of Helsinki	Old City Harbour, Port of Tallinn
Vuosaari Harbour, Port of Helsinki	Muuga Harbour, Port of Tallinn
Port of Hanko	North Port of Paldiski

Figure 1.1. Origin and destination cities and ports in Finland and in Estonia.

Furthermore, the distances of different Estonian ports to Pärnu were measured to produce data for comparisons for those Finnish transports that are transiting Estonia. The junction just south of Pärnu unites the routes from different Estonian ports to Via Baltica[5] where the route southwards is naturally the same.

[5] From Kunda to road nr 5 Rakvere – Pärnu.

2.3 Measuring transportation time on land

Transportation times were measured on Tuesday and Thursday as in the study "Freight traffic in the Helsinki passenger ferry ports in autumn 2012". The two main methods were used: 1) calculating the time based to distances and average driving speed, and 2) with using Google Maps as a tool to measure the driving time.

1. Calculation based on driving speed and distance. The driving time on highway was counted by dividing the distance with average driving speed. On the highway leg of the voyage, the average driving speed in freight traffic was set to 81 km/h (winter time speed)[6]. In urban areas, the average speed of 30 km/h was used[7] for the Finnish urban areas. In Estonia, the average speed of 75 km/h on highway and 35 km/h in urban areas were used based to expert opinion[8].

2. Transportation routes and times using Google Maps. Google Maps was chosen since it enables to gain information about the impact of different weekdays and different arrival times in the ports[9].

In Google Maps, the most often used search option is "leave now". However, it is possible to select also "arrive by" and "depart at" and set travel date and time. This enables production of comparable data when the same date and time values are used for different connections. The search then produces a minimum and maximum travel times.

Two arrival dates were selected: Tuesday 25 February and Thursday 27 February 2020. To test the impact of timing, three different "arrival by" times to the destination ports were set: arrival by 9.00 in the morning, by 12.00 (midday) and by 16.00 in the afternoon[10].

The search results of Tuesday and Thursday proved to be rather similar. Therefore, only the search results for transportation times on Tuesday 25th February were selected to compare the towns - ports trips more closely. The maximum transportation time was taken into focus of comparing the transportation time to the ports. The truck companies need to consider having a safety margin when arriving to the port for not missing the ferry. As for the hour, a two-fold variation was observed. Firstly, there was variation between travel times on different hours (9/12/16), and secondly, variation between the provided minimum and maximum travel times. The maximum transportation time was also assumed to contain more possible variations in

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[6] Kiiskilä, K., Mäki, V., Saastamoinen, K., Rajamäki, R. (2019). Ajonopeudet maanteillä 2018. Väyläviraston julkaisuja 29/2019.
[7] Blomqvist P. (2018). Autoliikenteen sujuvuus Helsingissä 2010-2017. Kaupunkiympäristön julkaisuja 2018:7
[8] Interview of professor Dago Antov of Tallinn Technical University. 24 April 2020 conducted by Aado Keskpaik.
[9] Google maps Help https://support.google.com/maps/answer/144339
[10] Searches in Google maps done on 18, 20-21 February 2020 and 9-13 March 2020.

driving time. The arrival time by 9.00 was selected for the analysis since it provided most variation. Arrival by 12.00 had least variation as expected.

The results of the main measurements of mileage and travel times are presented in appendix 1.

2.4 Transport mileage and time at sea

Information concerning the transport mileages by sea were provided by the shipping companies who operate the existing routes. Loviisa-Kunda route was measured with help of Finnish Transport Agency fairway card and Estonian Maritime Administration web application Nutimeri[11]. The average travel times were elaborated by the research staff from the existing ferry timetables while for the Loviisa-Kunda connection 3,5 h travel time was considered appropriate in order to keep it competitive enough for clients. (Table 2.5.)

Table 2.5. The distances and travel times between ports in Finland and in Estonia.

Connection	km	Travel time
Loviisa - Kunda	110	3,5 h
West Harbour - Old City	81	2,25 h
Vuosaari - Muuga	83	3,5 h
Hanko - Paldiski	83	3,5 h

[11] Estonian Maritime Administration (2020). Nutimeri application. https://gis.vta.ee/nutimeri/, retrieved 15.5.2020.

3 COMPARISON OF MILEAGE, TIME AND COST WHEN USING DIFFERENT PORT CONNECTIONS

The preliminary assumption to support the activation of REFEC corridor enabled by Loviisa-Kunda ferry connection is that it provides a competitive alternative for current ferry services. In other words, Loviisa-Kunda ferry would provide better accessibility within the transport corridor. Accessibility can be measured in various ways. Schourer and Curtis (2007)[12] classify seven different types on accessibility measurements: spatial separation measures, contour measures, gravity measures, competition measures, time-space measures, utility measures and network measures. Spatial separation measures was selected as a starting point in this study since these measures are often easy to understand and the data for calculations is easy to obtain as well. The physical distance by road and sea, travel time and travel cost are all different dimensions, which describe the accessibility between two points or areas. The use of different ports for crossing the Gulf of Finland affect the mileage, time used and eventually the cost of the trip. This is elaborated in detail for the transports within the REFEC corridor (eastern Finland-northeast Estonia) and for those eastern Finland transports that use Estonia as a transit country.

3.1 Mileage and time used in transports within the REFEC corridor

The foreseen Loviisa-Kunda roro service would provide shorter distances for transport within the eastern Finland and eastern Estonia (called here REFEC corridor). The table 3.1. presents the mileage of different town-to-town trips within the eastern regions of the two countries via the three currently available ferry services and the foreseen Loviisa-Kunda service.

[12] Scheurer, J., Curtis, C. (2007). Accessibility Measures: Overview and Practical Applications.

Table 3.1. The mileage (km) between different towns in REFEC corridor (eastern Finland and Estonia) via different ports and aggregate mileage.

Via Loviisa	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	97	176	173	123	177	
Lahti	116	195	192	142	196	
Lappeenranta	178	257	254	204	258	
Mikkeli	205	284	281	231	285	
Jyväskylä	277	356	353	303	357	
Kuopio	366	445	442	392	446	
Joensuu	410	489	486	436	490	
Kajaani	533	612	609	559	613	Total
						12 995

Via Vuosaari	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	217	227	264	274	328	
Lahti	192	202	239	249	303	
Lappeenranta	311	321	358	368	422	
Mikkeli	315	325	362	372	426	
Jyväskylä	354	364	401	411	465	
Kuopio	468	478	515	525	579	
Joensuu	525	535	572	582	636	
Kajaani	636	646	683	693	747	Total
						16 893

Via West Harbour	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	251	246	298	307	361	
Lahti	229	224	276	285	339	
Lappeenranta	346	341	393	402	456	
Mikkeli	345	340	392	401	455	
Jyväskylä	385	380	432	441	495	
Kuopio	506	501	553	562	616	
Joensuu	556	551	603	612	666	
Kajaani	675	670	722	731	785	Total
						18 130

Via Hanko	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	417	397	457	474	528	
Lahti	373	353	413	430	484	
Lappeenranta	511	491	551	568	622	
Mikkeli	493	473	533	550	604	
Jyväskylä	532	512	572	589	643	
Kuopio	654	634	694	711	765	
Joensuu	703	683	743	760	814	
Kajaani	822	802	862	879	933	Total
						24 029

The mileages via different ports are summed up for providing a proximity indicator on how different port routes provide "nearness" between eastern Finland and north-eastern Estonia. The comparison of the sums of all distances via four different ports shows that the route via Loviisa-Kunda has, in general, least driving in kilometers as expected. The other port alternatives Vuosaari-Muuga has about ⅓, and West Harbour-Old City Harbour ⅖ more kilometers while Hanko-Paldiski has about ¾ more distance to drive (table 3.2.).

Table 3.2. The difference in mileage (%) compared to using Loviisa-Kunda route within REFEC corridor.

Connection	**Difference in mileage**
Loviisa - Kunda	100 %
Vuosaari - Muuga	130 %
West Harbour - Old City	140 %
Hanko - Paldiski	185 %

The driving times were calculated in the same way like mileage. The results are presented in the table 3.3.[13]

Table 3.3. The driving time (h, excluding ferry time) between different towns in REFEC corridor (eastern Finland and Estonia) via different ports and aggregate time.

Via Loviisa	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	1,7	2,7	2,7	1,9	2,7	
Lahti	2,2	3,2	3,2	2,4	3,2	
Lappeenranta	2,5	3,5	3,5	2,8	3,5	
Mikkeli	3,2	4,2	4,2	3,4	4,2	
Jyväskylä	4,0	5,0	5,0	4,3	5,0	
Kuopio	5,0	6,0	6,0	5,3	6,0	
Joensuu	5,3	6,3	6,3	5,6	6,3	
Kajaani	7,0	8,0	8,0	7,3	8,0	Total
						180,2

Via Vuosaari	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	3,1	3,2	3,7	3,8	4,5	
Lahti	2,6	2,7	3,2	3,3	4,0	
Lappeenranta	4,1	4,2	4,7	4,8	5,5	
Mikkeli	4,1	4,2	4,7	4,8	5,5	
Jyväskylä	4,6	4,7	5,2	5,3	6,0	
Kuopio	5,9	6,0	6,5	6,7	7,3	
Joensuu	6,6	6,7	7,2	7,3	8,0	
Kajaani	7,9	8,0	8,5	8,7	9,3	Total
						216,8

[13] Google Maps measurements. Tue 25 2020 arrival time by 9.00 to the port.

Via West Harbour	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	4,5	4,3	5,0	5,2	5,8	
Lahti	4,2	4,0	4,7	4,8	5,5	
Lappeenranta	5,5	5,3	6,0	6,2	6,8	
Mikkeli	5,5	5,3	6,0	6,2	6,8	
Jyväskylä	6,0	5,8	6,5	6,7	7,3	
Kuopio	7,3	7,2	7,8	8,0	8,7	
Joensuu	8,0	7,8	8,5	8,7	9,3	
Kajaani	9,3	9,2	9,8	10,0	10,7	Total
						270,3

Via Hanko	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	6,0	5,5	6,3	6,5	7,2	
Lahti	5,5	5,0	5,8	6,0	6,7	
Lappeenranta	7,0	6,5	7,3	7,5	8,2	
Mikkeli	6,8	6,3	7,2	7,3	8,0	
Jyväskylä	7,3	6,8	7,7	7,8	8,5	
Kuopio	8,8	8,3	9,2	9,3	10,0	
Joensuu	9,5	9,0	9,8	10,0	10,7	
Kajaani	10,8	10,3	11,2	11,3	12,0	Total
						321,2

The sums of *travel times* are in line with distance calculation with minor differences. Travel time via West Harbour shows slightly higher figure than distance if compared with travel time via Loviisa. Vuosaari and Hanko, on contrary, show a bit lower figures (table 3.4.).

Table 3.4. The difference in time (%) spent compared to using Loviisa-Kunda route within REFEC corridor (without ferry time).

Connection	**Difference in time**
Loviisa - Kunda	100 %
Vuosaari - Muuga	120 %
West Harbour – Old City	150 %
Hanko - Paldiski	178 %

Finally, the travel times are compared *including ferry travel* time which is 2,25 h for West Harbour-Old City and 3,5 h in other routes[14] (Table 3.5.).

[14] The travel times vary depending on departure time. These figures are approximate averages for enabling the calculations.

Table 3.5. The travel time (h) between different towns in REFEC corridor via different ports including ferry travel time, and aggregate time.

Via Loviisa	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	5,2	6,2	6,2	5,4	6,2	
Lahti	5,7	6,7	6,7	5,9	6,7	
Lappeenranta	6,0	7,0	7,0	6,3	7,0	
Mikkeli	6,7	7,7	7,7	6,9	7,7	
Jyväskylä	7,5	8,5	8,5	7,8	8,5	
Kuopio	8,5	9,5	9,5	8,8	9,5	
Joensuu	8,8	9,8	9,8	9,1	9,8	
Kajaani	10,5	11,5	11,5	10,8	11,5	Total
						320,2

Via Vuosaari	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	6,6	6,7	7,2	7,3	8,0	
Lahti	6,1	6,2	6,7	6,8	7,5	
Lappeenranta	7,6	7,7	8,2	8,3	9,0	
Mikkeli	7,6	7,7	8,2	8,3	9,0	
Jyväskylä	8,1	8,2	8,7	8,8	9,5	
Kuopio	9,4	9,5	10,0	10,2	10,8	
Joensuu	10,1	10,2	10,7	10,8	11,5	
Kajaani	11,4	11,5	12,0	12,2	12,8	Total
						356,8

Via West Harbour	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	6,8	6,6	7,3	7,4	8,1	
Lahti	6,4	6,3	6,9	7,1	7,8	
Lappeenranta	7,8	7,6	8,3	8,4	9,1	
Mikkeli	7,8	7,6	8,3	8,4	9,1	
Jyväskylä	8,3	8,1	8,8	8,9	9,6	
Kuopio	9,6	9,4	10,1	10,3	10,9	
Joensuu	10,3	10,1	10,8	10,9	11,6	
Kajaani	11,6	11,4	12,1	12,3	12,9	Total
						360,3

Via Hanko	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	9,5	9,0	9,8	10,0	10,7	
Lahti	9,0	8,5	9,3	9,5	10,2	
Lappeenranta	10,5	10,0	10,8	11,0	11,7	
Mikkeli	10,3	9,8	10,7	10,8	11,5	
Jyväskylä	10,8	10,3	11,2	11,3	12,0	
Kuopio	12,3	11,8	12,7	12,8	13,5	
Joensuu	13,0	12,5	13,3	13,5	14,2	
Kajaani	14,3	13,8	14,7	14,8	15,5	Total
						461,2

The impact of shorter ferry travel time in West Harbour-Old City Harbour improves its position compared to other port connections. The composite travel time via West Harbour is only 13 % longer than via Loviisa (table 3.6.). With ferry travel times the relative difference between Loviisa and Vuosaari (11%) and between Loviisa and Hanko (44%) in travel time is less than in previous comparison (see table 3.4.).

Table 3.6. The accumulated difference in travel times (%) compared to using Loviisa-Kunda route including ferry travel time.

Connection	Accumulated difference in travel times
Loviisa - Kunda	100 %
Vuosaari - Muuga	111 %
West Harbour - Old City	113 %
Hanko - Paldiski	144 %

The mileage and travel time, without and with time on ferry, are compared in the summary table 3.7.

Table 3.7. Loviisa-Kunda route (100%) compared by distance and travel time to available ferry routes.

	Driving distance (land)	Driving time (land)	Driving time + ferry time
Loviisa - Kunda	100 %	100 %	100 %
Vuosaari - Muuga	130 %	120 %	111 %
West Harbour - Old City	140 %	150 %	113 %
Hanko - Paldiski	185 %	178 %	144 %

The relative benefit of Loviisa-Kunda route is highest when mileages are compared. The benefit is decreasing when travel times are compared, especially when the ferry time (i.e. longer travel time) is included. The West Harbour driving time (land) difference is greater compared to mileage difference with Loviisa (140% vs. 150%). The 10 percentage point difference can be interpreted as a delay caused by the city traffic. The position of West Harbour is much improved if the ferry travel time is included in the comparison since the difference of 1h 15 min in ferry time forms a significant share of the overall travel time.

3.2 Mileage and time used in Finnish transports transiting Estonia

The major share of truck traffic from/to Finland across the Gulf of Finland is transiting the Baltic states[15]. For this traffic the mileage was measured from REFEC corridor towns via different ports to the crossroads just south of Pärnu where the Estonian main road T5 (Rakvere-Pärnu) unites to T4 (Via Baltica). Thereafter the route to Central Europe is the same (figure 3.1.).

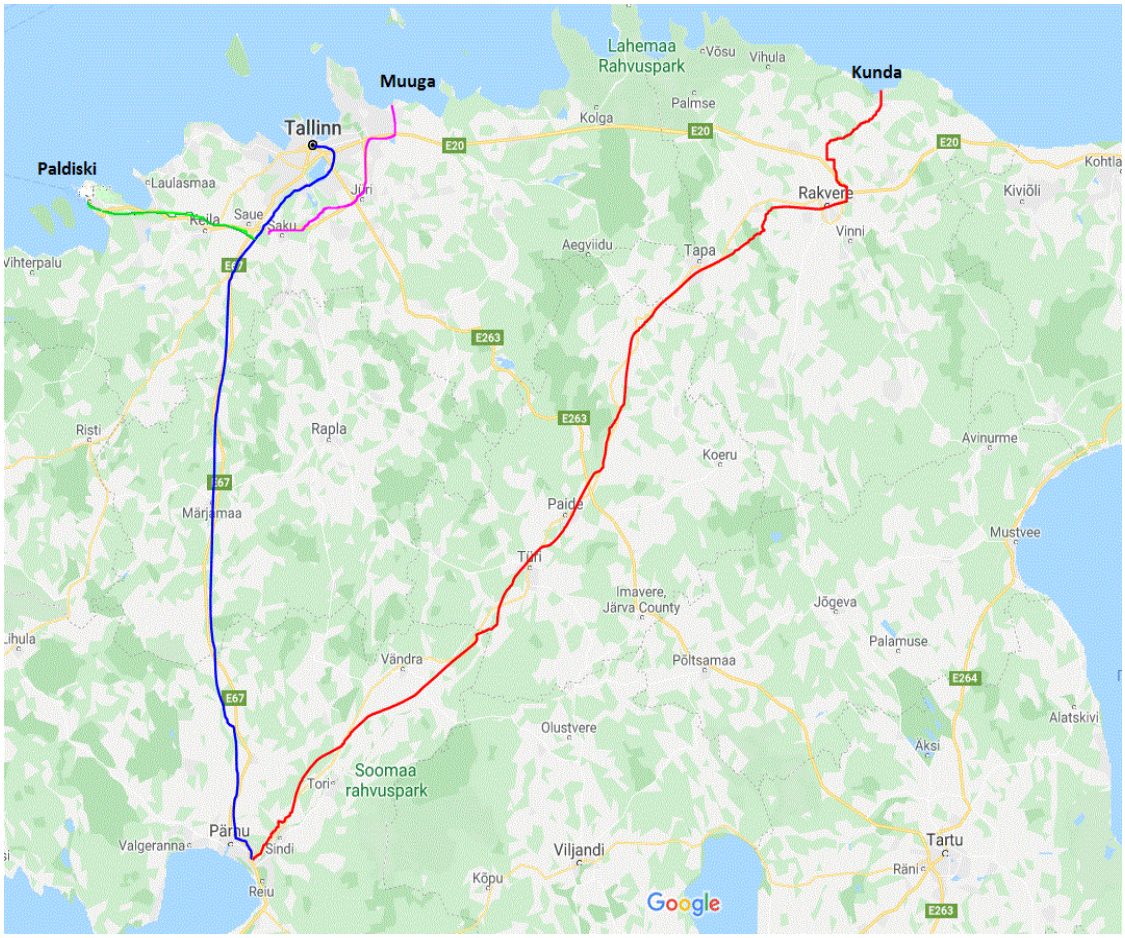

Figure 3.1. Routes from different Estonian ports to Pärnu.

For the measured (road) mileage from the Finnish REFEC corridor towns, it is about the same if the trucks move via West Harbour-Old City Harbour, Vuosaari-Muuga or Loviisa-Kunda while Hanko-Paldiski is on average around 100 km longer route (figure 3.2.). The shorter mileage from eastern Finland to Loviisa is counterbalanced by longer mileage from Kunda to Pärnu.

[15] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre For Maritime Studies of Brahea Centre at the University of Turku A 74.

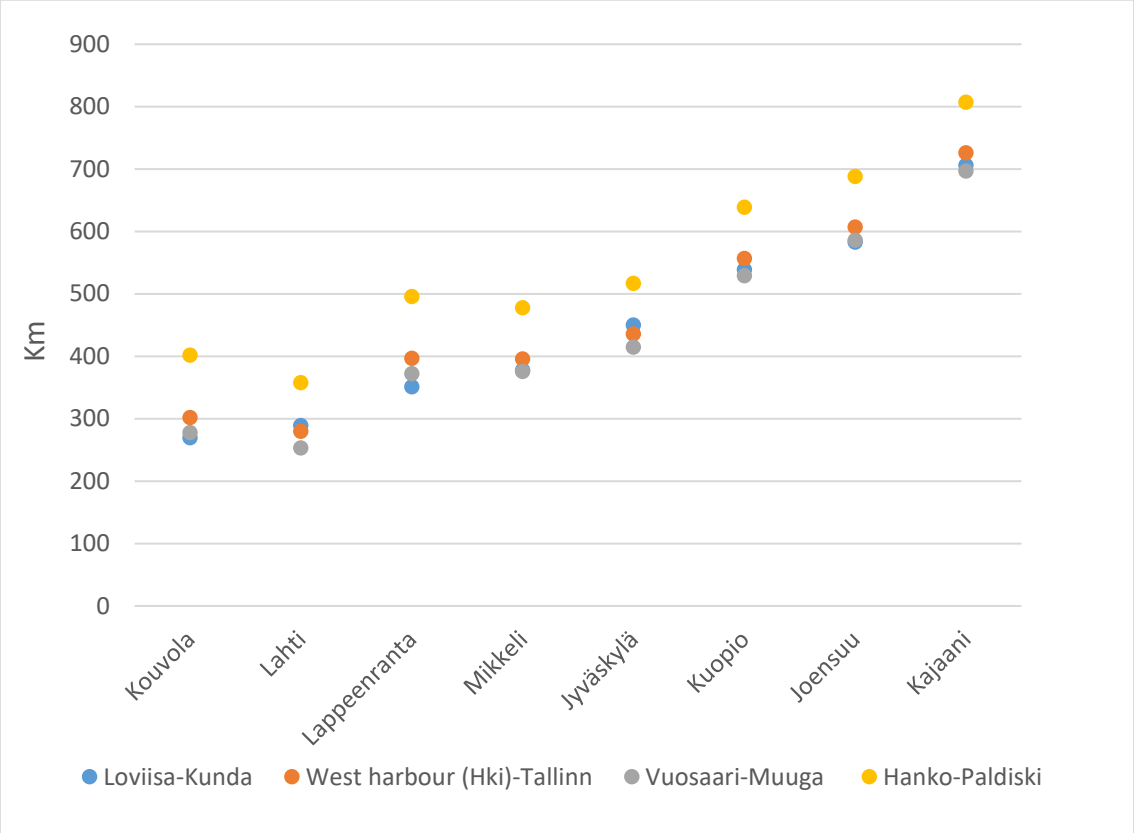

Figure 3.2. Mileage (road km) from REFEC towns via different ports to Pärnu.

A similar comparison was made for the driving time[16] from Finnish REFEC towns (figure 3.3.). Loviisa-Kunda and Vuosaari-Muuga have shorter driving times than West Harbour-Old City Harbour and especially Hanko-Paldiski. Vuosaari-Muuga is slightly faster than Loviisa-Kunda besides trips from Kouvola, Lappeenranta and Joensuu. Driving via West Harbour-Old City Harbour was about 1 h longer and via Hanko-Paldiski about 1,5 h longer. When mileage and driving time curves are compared the impact of city traffic slowing the driving time via West Harbour-Old City Harbour route is obvious.

[16] Arrivals by 9.00/maximum travel times given by Googlemaps.

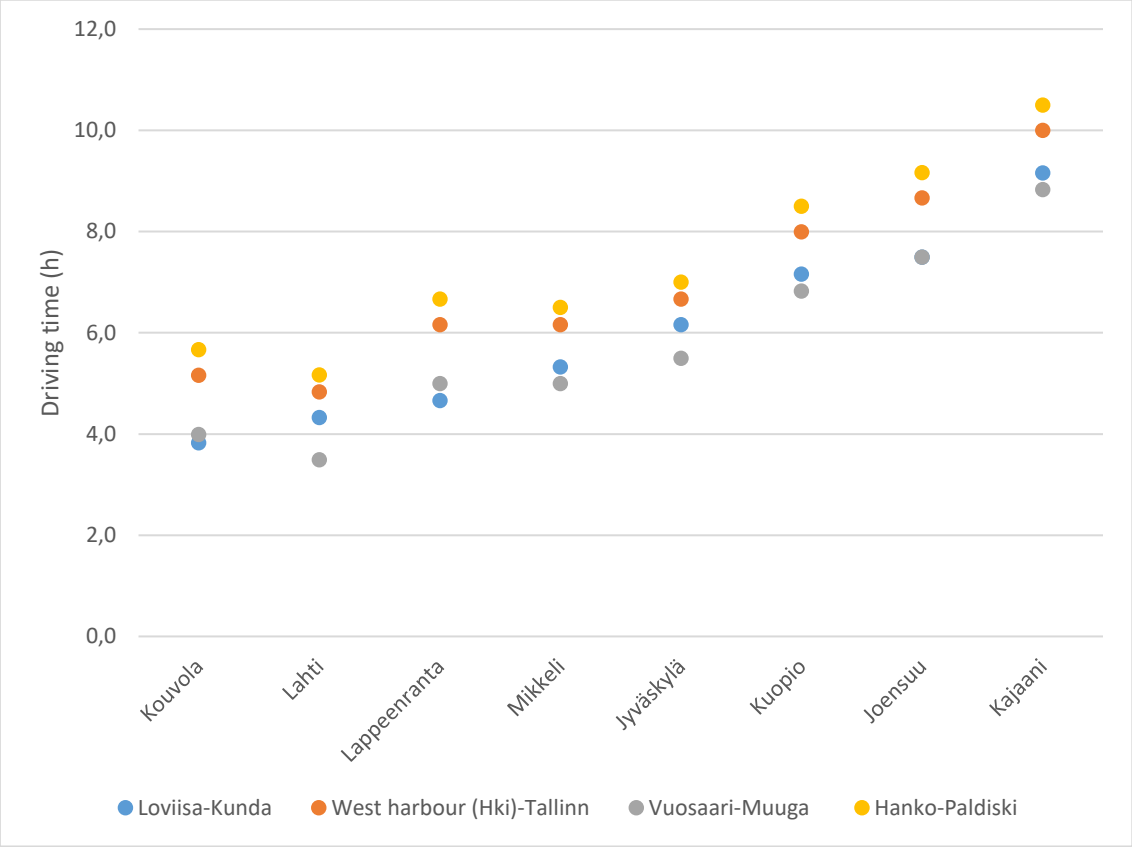

Figure 3.3. Driving time (h) from REFEC towns via different ports to Pärnu (excluding ferry time).

When duration of the ferry voyage[17] is included to driving time the total travel time can be summed (figure 3.4.). The travel time via Loviisa-Kunda is slightly longer besides from Kouvola and Lappeenranta. In practice all connections with exception of Hanko-Paldiski are within a small margin. Shorter ferry voyage time via West Harbour- Old City compensates longer driving times.

[17] The average time of 3,5 h was used besides in West Harbour-Tallinn (2 h 15 min).

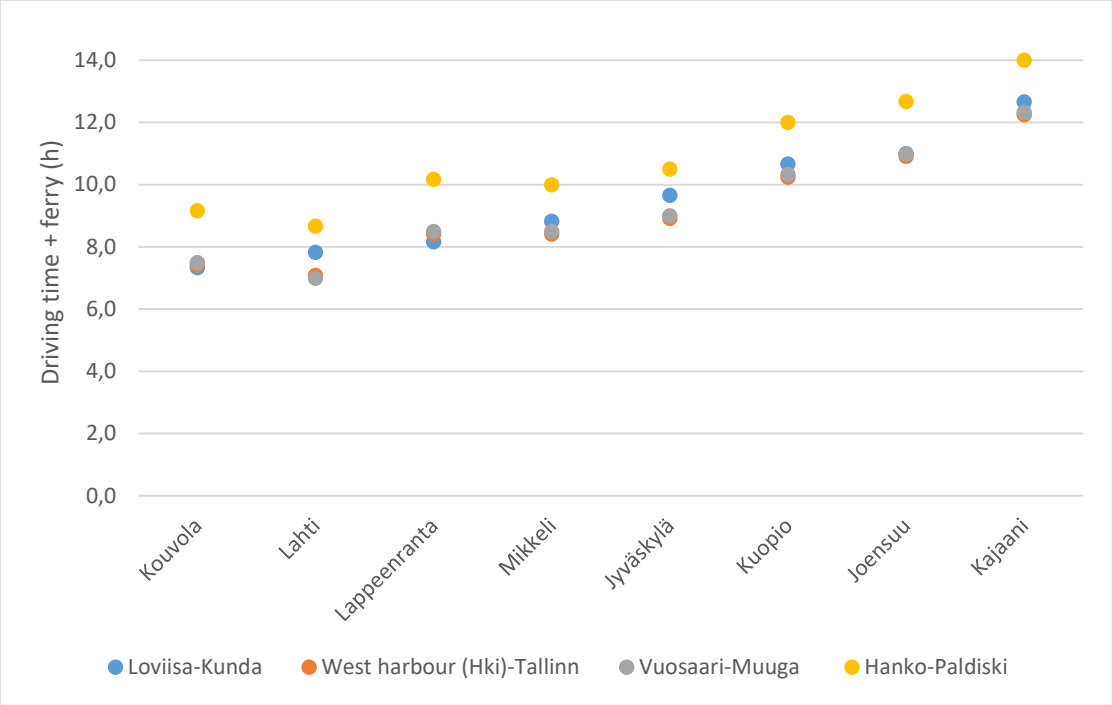

Figure 3.4. Total travel time (driving time and ferry voyage) in hours from REFEC towns via different ports to Pärnu.

3.3 Trips to Central Europe - difference in mileage of different routes

The most of the FI-EE truck traffic on ferries move between Finland and Eastern Central Europe[18]. The relative difference in mileage[19] on two cases via alternative routes are presented in table 3.8.

[18] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre For Maritime Studies of Brahea Centre at the University of Turku A 74.

[19] GoogleMaps was used only to measure mileage, not travel time since GoogleMaps do not have option for heavy traffic measuring. It does not include regulation based rest times or different routing (heavy traffic bans) in the cities. For shorter FI-EE journeys this aspect can be ignored.

Table 3.8. Difference of mileage in Loviisa-Kunda (100%) vs. other ferry routes from Warsaw and Vienna to Finnish REFEC towns.

	Warsaw				Vienna			
Distance km (%)	**Loviisa-Kunda**	**West Harbour - Old City**	**Vuosaari -Muuga**	**Hanko-Paldiski**	**Loviisa-Kunda**	**West Harbour -Old City**	**Vuosaari -Muuga**	**Hanko-Paldiski**
Kouvola	100,0 %	107,3 %	101,3 %	112,3 %	100,0 %	101,5 %	100,3 %	107,6 %
Lahti	100,0 %	103,6 %	97,4 %	106,6 %	100,0 %	99,2 %	97,9 %	104,1 %
Lappeenranta	100,0 %	108,0 %	102,2 %	112,5 %	100,0 %	102,1 %	101,0 %	108,0 %
Mikkeli	100,0 %	105,5 %	100,3 %	108,6 %	100,0 %	100,6 %	99,7 %	105,5 %
Jyväskylä	100,0 %	102,8 %	97,8 %	105,6 %	100,0 %	99,0 %	98,1 %	103,6 %
Kuopio	100,0 %	104,9 %	99,7 %	107,6 %	100,0 %	100,6 %	99,4 %	105,1 %
Joensuu	100,0 %	105,1 %	100,6 %	107,7 %	100,0 %	100,9 %	100,0 %	105,2 %
Kajaani	100,0 %	104,5 %	99,8 %	106,9 %	100,0 %	100,6 %	99,5 %	104,7 %

The differences between Loviisa-Kunda and other routes are small with exception of Hanko-Paldiski. Vuosaari-Muuga route has in practice the same mileages as Loviisa-Kunda. With longer distances the difference in relative shares naturally even out more.

3.4 Cost of transports

3.4.1 Cost components

Choosing different routes affect the mileage, driving times and overall duration of trips as described above. The differences have naturally implications to the costs as well. The basis of calculating the costs is drawn from Finnish Transport Agency guidance[20] on how to estimate the foreseen benefits of the planned transport infrastructure projects. The cost are composed of mileage-based *vehicle costs* (fuel and other costs), *capital costs* (depreciation, interest) and *travel time savings costs* (related to staff costs to the employer and cargo).

The cost estimation was adapted for an average Estonian transportation company since the Finnish companies have only a small market share of the total transported units[21] in ferry-bound transports between Finland and Estonia.

Vehicle costs (semi-trailer truck) include fuel costs and other costs. The fuel costs variation between Finland and Estonia is minimal since the tax rate is fairly similar (0,493 €/liter in

[20] Finnish Transport Agency (2020). Tie- ja rautatieliikenteen hankearvioinnin yksikköarvot 2018. Väyläviraston julkaisuja 48/2020.
[21] HSL Helsinki Region Transport (2013). HLJ 2015 Freight traffic in the Helsinki passenger ferry ports in autumn 2012. p.18

Estonia[22] vs. 0,5302 €/liter in Finland[23]). The different VAT rate (20% EE vs 24% FI) seems not affect much retail price[24] (1,36€/l EE vs. 1,38€/l FI). VAT cost was not included since it is reimbursable to enterprises.

The "other costs" are considered to be somewhat less in Estonia compared to Finland in maintenance and repair personnel costs due to the wage difference, while the tyres and e.g lubricant and other material costs are considered to be equal. Since the share of maintenance and repair is not very large[25] in transport company cost structure it was decided to use the Finnish value for the category other costs as such also for Estonia.

The capital costs consist of depreciation and interest costs. Interest rates seem to be slightly lower in Finland compared to Estonia[26]. However, the role of interest rate in calculation is marginal. Therefore interest rate and depreciation are considered to be the same in Estonia and Finland.

The travel time saving calculation is based on the personnel costs consisting of wage and employer's compulsory social security contributions. They are different in Estonia and Finland. The lorry driver's average wage in Finland is 3132 €/month[27] and 1171 €/month[28] in Estonia. The employer's social contribution costs are in Finland 21,4% and 33,8 % in Estonia[29] which slightly balances the wage difference. These values give the Estonian staff cost to be 41,1% of the Finnish costs (26,30€/h/truck). Thus, the travel time saving used in calculation is 10,81€/h/truck. The other travel time value component, cost of time for cargo, was not revised for Estonia since the cargo transported is based on Finnish foreign trade, and thus original values are justified.

The values used in cost impact calculations are in table 3.9. In summary, the Finnish values were used for an Estonian transport company as such besides for travel time savings which were adapted to Estonian cost (wage and employer's costs) level.

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[22] Eesti maksu ja tolliamet (2020). Aktsiisimäärad. https://www.emta.ee/et/ariklient/aktsiisid-vara-hasartmang/uldist/aktsiisimaarad#Kytus, retrieved 1.4.2020.

[23] Finnish tax administration (2020). Tax rates on liquid fuels. https://www.vero.fi/en/businesses-and-corporations/about-corporate-taxes/excise_taxes/nestemaiset_polttoaineet/nestem%C3%A4isten-polttoaineiden-verotaulukko/, retrieved 1.4.2020.

[24] Global Petrol Prices (2020). Diesel prices 30.3.2020. https://www.globalpetrolprices.com/diesel_prices/, retrieved 1.4.2020

[25] Tilastokeskus (2015). Kuorma-autoliikenteen kustannusindeksi. http://www.stat.fi/til/kalki/2014/12/kalki_2014_12_2015-01-19_tau_001_fi.html >, haettu 3.4.2120.

[26] Euro area statistics (2020). Bank interest rates – Loans. https://www.euro-area-statistics.org/bank-interest-rates-loans?cr=eur&lg=en, retrieved 14.8.2020.

[27] Statistics Finland (2020). Private sector monthly salaries 2018. http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__pal__yskp/, retrieved 1.4.2020.

[28] Salaryexpert.com (2020). https://www.salaryexpert.com/salary/job/truck-driver/estonia, retrieved 7.4.2020

[29] OECD (2020). Employer social security contribution rates 2018. https://stats.oecd.org/Index.aspx?DataSetCode=TABLE_III2, retrieved 1.4.2020.

Table 3.9. The values (€) used in cost calculation.

Vehicle costs	**€/km**	**Capital costs**	**€/h**	**Travel time savings**	**€/h/truck**
Fuel, (with tax)	0,4134	Depreciation	9,95	Driver staff cost	10,81
Other costs	0,1410	Interest	1,25	Cost of time for cargo	8,67
Total	**0,5544**	**Total**	**11,2**	**Total**	**19,48**

3.4.2

3.4.3 Cost of transports within REFEC corridor

The costs of different town-to-town routes were calculated based on the mileage and time cost. Loviisa-Kunda route is in practice always generating least costs compared to other options (table 3.10.).

Table 3.10. Cost of individual truck trip (€) between FI and EE towns within REFEC corridor via different ports.

LOVIISA-KUNDA	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
Kouvola	212	287	285	234	287
Lahti	238	313	311	260	313
Lappeenranta	283	357	356	305	358
Mikkeli	318	393	391	340	393
Jyväskylä	384	458	456	406	459
Kuopio	464	538	537	486	539
Joensuu	498	573	571	520	573
Kajaani	618	692	690	640	693

VUOSAARI-MUUGA	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
Kouvola	323	330	366	377	404
Lahti	293	301	337	348	374
Lappeenranta	405	413	449	460	486
Mikkeli	408	415	451	462	489
Jyväskylä	444	452	488	499	526
Kuopio	549	556	592	603	630
Joensuu	601	609	644	655	682
Kajaani	703	711	747	757	784

WEST HARBOUR-OLD CITY	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
Kouvola	346	344	388	398	448
Lahti	324	321	365	375	426
Lappeenranta	430	427	471	481	531
Mikkeli	429	426	470	481	531
Jyväskylä	467	464	508	518	568
Kuopio	575	572	616	626	676
Joensuu	623	620	664	674	725
Kajaani	730	727	771	781	831

HANKO-PALDISKI	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
Kouvola	523	496	555	570	620
Lahti	483	456	515	530	580
Lappeenranta	605	579	638	652	703
Mikkeli	590	564	623	637	688
Jyväskylä	627	601	660	674	725
Kuopio	741	715	773	788	838
Joensuu	789	762	821	836	886
Kajaani	895	869	928	942	993

The next step was to calculate the costs involved for the whole annual cargo potential in REFEC corridor. The annual EE-FI cargo potential within Estonian REFEC area (four counties in northeastern Estonia) to/from Finland was estimated to be 5 500 trucks[30]. About 20 % of all truck traffic in passenger ports in Helsinki arrive/leave from REFEC area in Finland[31]. This about 20% (1 095 trucks) volume was further allocated to main towns of each county in REFEC corridor to get town-to-town traffic volume between Finland and Estonia.

The division of the volume for different Finnish REFEC towns is based on the study on freight traffic in Helsinki passenger harbours[32]. Since the similar type of source was not available in Estonia the shares were calculated based on the value of exports of four Estonian counties[33] which were then allocated to the main towns in the regions (see details in chapter 2.1).

The shares of each town in both countries were multiplied to produce town-to-town cross-tabulation of shares of potential traffic (table 3.11.).

Table 3.11. Shares of town-to-town transports (%) in REFEC corridor.

	Narva	Kohtla-Järve	Jõgeva	Paide	Rakvere
Kymenlaakso	4,4 %	4,5 %	3,7 %	3,5 %	14,0 %
Päijät-Häme	4,1 %	4,1 %	3,4 %	3,2 %	12,9 %
Etelä-Karjala	1,0 %	1,0 %	0,8 %	0,8 %	3,1 %
Etelä-Savo	0,6 %	0,6 %	0,5 %	0,5 %	1,9 %
Keski-Suomi	1,7 %	1,8 %	1,5 %	1,4 %	5,6 %
Pohjois-Savo	2,1 %	2,2 %	1,8 %	1,7 %	6,7 %
Pohjois-Karjala	0,7 %	0,7 %	0,6 %	0,5 %	2,2 %
Kainuu	0,1 %	0,1 %	0,1 %	0,1 %	0,3 %

The potential number of trucks were then allocated to the tow-to-town routes. Based on this method, the largest volumes would be moving between Kouvola - Rakvere and Lahti - Rakvere (table 3.12.).

[30] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre For Maritime Studies of Brahea Centre at the University of Turku A 74.
[31] ibid.
[32] Räty P., Planting, A., Määttälä, A. & Kantele, S. (2013). HLJ 2015 Freight traffic in the Helsinki passenger ferry ports in autumn 2012. p. 20.
[33] Statistic Estonia (2019). Sales of industrial production to non-residents by county. http://andmebaas.stat.ee/index.aspx, retrieved 14.4.2020.

Table 3.12. Estimated division of truck potential within REFEC corridor towns (eastern Finland and northeastern Estonia).

Town	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	**Total**
Kouvola	153	38	40	49	48	**328**
Lahti	141	35	37	45	44	**302**
Lappeenranta	34	8	9	11	11	**73**
Mikkeli	21	5	5	7	7	**45**
Jyväskylä	61	15	16	19	19	**130**
Kuopio	74	18	19	24	23	**158**
Joensuu	24	6	6	8	8	**52**
Kajaani	3	1	1	1	1	**7**
Total	**511**	**126**	**134**	**164**	**160**	**1095**

The following step was to estimate overall costs of the traffic within the REFEC corridor based on the volumes between different FI-EE towns via available three ferry connections and the foreseen Loviisa-Kunda connection.

The mileage costs and time costs (inc. ferry travel time) were multiplied with annual calculated town-to-town number of trucks (table 3.13.).

Table 3.13. The composite costs (€) of cargo potential in REFEC corridor via different ports.

LOVIISA-KUNDA	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	32 519	10 814	11 449	11 489	13 805	
Lahti	33 621	10 864	11 508	11 757	13 867	
Lappeenranta	9 660	3 004	3 184	3 333	3 834	
Mikkeli	6 641	2 018	2 140	2 274	2 574	
Jyväskylä	23 270	6 840	7 258	7 879	8 727	
Kuopio	34 146	9 757	10 358	11 454	12 445	
Joensuu	11 995	3 394	3 604	4 011	4 329	
Kajaani	2 143	591	628	711	754	
Total	153 995	47 282	50 131	52 908	60 336	**Total**
						364 651

VUOSAARI-MUUGA	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	49 402	12 461	14 710	18 497	19 396	
Lahti	41 395	10 466	12 472	15 721	16 577	
Lappeenranta	13 843	3 475	4 021	5 030	5 212	
Mikkeli	8 504	2 134	2 469	3 088	3 199	
Jyväskylä	26 954	6 754	7 763	9 692	9 999	
Kuopio	40 393	10 088	11 436	14 224	14 546	
Joensuu	14 457	3 606	4 067	5 051	5 148	
Kajaani	2 439	607	679	842	854	
Total	197 387	49 591	57 618	72 146	74 929	**Total**
						451 671

WEST HARBOUR-OLD CITY	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	53 039	12 956	15 570	19 520	21 536	
Lahti	45 702	11 158	13 515	16 971	18 849	
Lappeenranta	14 673	3 590	4 218	5 264	5 695	
Mikkeli	8 953	2 191	2 574	3 213	3 476	
Jyväskylä	28 292	6 925	8 077	10 065	10 815	
Kuopio	42 305	10 367	11 892	14 768	15 626	
Joensuu	14 988	3 674	4 191	5 199	5 471	
Kajaani	2 531	621	701	868	905	
Total	210 483	51 482	60 739	75 869	82 373	**Total**
						480 946

HANKO-PALDISKI	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	
Kouvola	80 061	18 715	22 294	27 954	29 795	
Lahti	68 155	15 862	19 070	23 958	25 691	
Lappeenranta	20 679	4 869	5 712	7 139	7 530	
Mikkeli	12 320	2 898	3 408	4 261	4 502	
Jyväskylä	38 041	8 972	10 490	13 100	13 786	
Kuopio	54 558	12 954	14 931	18 587	19 365	
Joensuu	18 980	4 517	5 181	6 443	6 690	
Kajaani	3 107	742	844	1 047	1 081	
Total	295 899	69 529	81 930	102 488	108 440	**Total**
						658 286

Transportation companies would save on this basis nearly 100 000 € using Loviisa-Kunda route compared to Vuosaari-Muuga and even more compared with the other connections in REFEC corridor transports (table 3.14).

Table 3.14. Overall costs of truck traffic (€) based on mileage and time costs on different ferry routes in REFEC corridor.

Ferry route	**Annual cost**
Loviisa-Kunda	364 651
Vuosaari-Muuga	451 671
West Harbour-Old City	480 946
Hanko-Paldiski	658 286

3.4.4 Costs of transports transiting Estonia

Major part of Finnish cargoes on the ferries across the Gulf of Finland is transiting Estonia. To compare different routes the cost was calculated for each Finnish REFEC town to Pärnu via different ferry connections. This part of the trip shows the cost difference since south of Pärnu the route (and the cost) is the same. The cost calculation comprised the mileage and the time spent on the road and ferry (figure 3.5.).

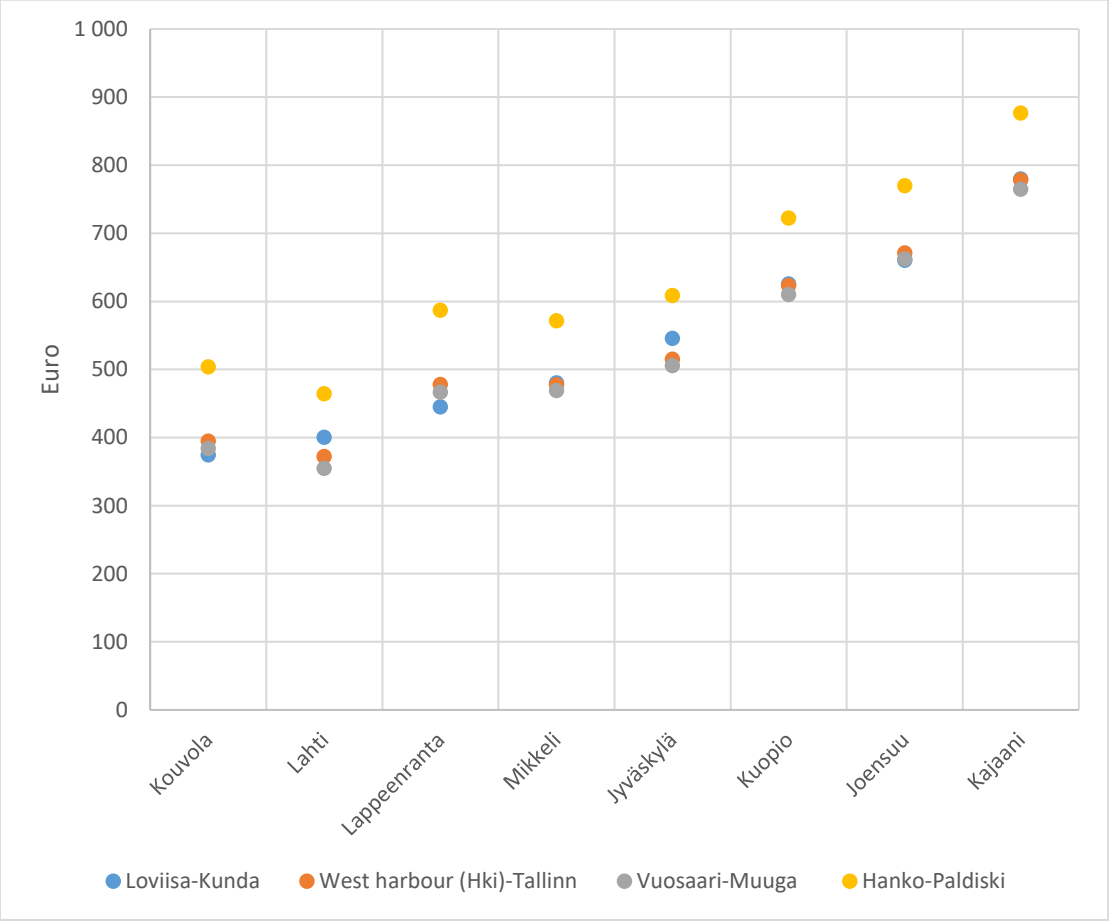

Figure 3.5. The cost of mileage and time of travel (€) from the Finnish REFEC towns via different ports to Pärnu (Road T5 and Via Baltica junction).

The same pattern can be seen as in travel time (figure 3.4 above) where Hanko-Paldiski route deviates from other routes. Trucking cost via Hanko-Paldiski is about 100 euros more expensive while the other three port options are nearly the same or in some cases (Lahti, Jyväskylä) at least well below 50 euros range from each other.

The costs can be compared also for the whole potential annual volume between the Finnish REFEC towns and Pärnu. The whole cargo potential in the corridor (using Loviisa-Kunda ferry) was estimated to settle in the range of 20 000-40 000 trucks. The same allocation of truck volume for different Finnish REFEC towns is used as above when costs were calculated within the REFEC corridor. The exemplary calculation was made for 20 000 trucks (table 3.15.).

Table 3.15. The overall cost of mileage and time (€) from the Finnish REFEC towns via different port connections to Pärnu (Road T5 and Via Baltica junction) for 20 000[34] trucks.

TOWN	Loviisa - Kunda	West Harbour - Old City	Vuosaari - Muuga	Hanko - Paldiski
Kouvola	2 244 130	2 366 732	2 301 693	3 021 437
Lahti	2 210 773	2 056 718	1 959 375	2 564 329
Lappeenranta	594 618	639 085	623 843	784 321
Mikkeli	392 237	390 031	382 982	466 900
Jyväskylä	1 295 161	1 222 390	1 200 590	1 444 445
Kuopio	1 803 150	1 795 365	1 757 714	2 081 316
Joensuu	622 014	632 233	623 580	725 182
Kajaani	105 858	105 641	103 792	119 039
Total	**9 267 940**	**9 208 197**	**8 953 569**	**11 206 970**
Share	**100 %**	**99 %**	**97 %**	**121 %**

For the calculated total volume Loviisa-Kunda route would be slightly more expensive (300 000€/year) than route via Vuosaari but remarkably cheaper than via Hanko. For an individual transport company the cost impact is naturally dependent on routes serviced. For example the travel to/from Kouvola or Lappeenranta is always cheaper via Loviisa-Kunda compared to other ports.

3.5 Summary of findings and limitations

This chapter summarises the results of comparative results related measurements of mileage, travel time and costs. Furthermore, it discusses the limitations of the study results.

The aggregate road distance within REFEC corridor towns on Loviisa-Kunda connection would be 30-85% shorter. For driving time the range is 20-78%. If the ferry travel is included, the whole travel time is about 10% longer in Vuosaari-Muuga and West Harbour-Old City, and about 40% longer via Hanko-Paldiski.

The traffic of Finnish REFEC towns which transits Estonia and continues southwards using Via Baltica has shorter trips to Port of Loviisa. However, they are leveled off with longer distance from port of Kunda to Pärnu where the routes from different Estonian ports (having ferry connection to Finland) meet. When the aggregate travel times are compared route Loviisa-Kunda is slightly longer (most cases under 30 minutes) than via Vuosaari-Muuga besides for trips from Kouvola and Lappeenranta. All in all, the travel times are very much the same with exception of Hanko-Paldiski which is clearly longer route (about 1-2 h). If the difference of mileage in selecting different ports is considered with reference to the whole trip to Central Europe, the relative differences between Loviisa-Kunda and Vuosaari-Muuga are marginal e.g.

[34] The lower end of the freight potential of 20 000-40 000 trucks for Loviisa-Kunda ferry connection.

for trips to Warsaw. The longer the trip the more relative differences even out. For trips to Vienna the relative difference of mileages with West Harbour-Old City longer are less than two percentage compared with Loviisa-Kunda.

The cost of using different routes were calculated with mileage-based vehicle costs, capital costs and travel time savings costs developed by Finnish Transport Agency. The truck volume within the REFEC corridor is estimated to be around 1100 trucks annually. This volume was allocated to town-to-town trips. The aggregate cost turned out to be nearly 100 000 € less using Loviisa-Kunda route compared to Vuosaari-Muuga and even more compared the other port connections. The same exercise was made between Finnish REFEC towns and Pärnu to estimate the cost difference of different routings. The volume of 20 000 trucks (the lower end of range of the REFEC cargo potential) was used in calculations. Loviisa-Kunda route aggregate cost proved to be somewhat more expensive than Vuosaari-Muuga and West Harbour-Old City (3% and 1 % respectively). However, the cost of individual trip like from Kouvola or Lappeenranta can be cheapest via Loviisa-Kunda.

The results provide crude estimation how the foreseen Loviisa-Kunda ferry connection compares with regard to mileage, travel time and costs. Within REFEC area it has a competitive edge, and for the transports transiting Estonia the differences with Vuosaari-Muuga and West harbor-Old City are more or less the same. However, there are various factors that could not be included in the calculations and have a role when considering the competitiveness of different port options. These uncertainties are twofold: the factors that were used in calculation and the factors that could not be operationalized in calculations.

The first reservation relates to the chosen weekday and time (Tuesday arrival at 9 o'clock) of which the data was collected. In real life the traffic flow is scattered over the whole day. The chosen timing probably somewhat degrades West Harbour-Old City routes position since the rush hour is most strongly felt there. Furthermore, the sea travel times (ferry schedules) vary depending on departure. The used durations in calculations were averages.

For the cost calculations the used values do not consider the possible variation on cost of ferry ticket between different routes or shipping companies. These components have importance for an individual transport company. The cost structure on the whole can vary a lot depending on the transportation company (nationality, age of fleet, capital costs etc). Another important issue, affecting the route and port choice, is the rest time regulation of truck drivers. The driver can drive a maximum of 4,5 hours which is followed with 45 minutes break. This can affect the overall schedule of transport and port choice. The decisions are also influenced by the available ferry schedules (time and frequency of departures). In spite of the various "real life" related reservations, the results can be considered to give a reasonable overview of the impacts of the foreseen Loviisa-Kunda ferry route in relation to the existing ferry connections.

4 IMPACT TO CO_2 EMISSIONS

4.1 Focus changing to CO_2 emissions

The focus of discussion on the emissions into air has been recently been much on the carbon dioxide emissions. The reason behind this alteration is the global climate change. The rise on global mean surface temperature is strongly dependent on cumulative carbon dioxide emissions. Among the emissions of shipping into air are carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur oxides (SO_x) and particulate matter (PM), while the SOx and NOx from ships contribute to the degradation of air quality regionally.[35]

There are two major agreements that pursue the CO_2 emissions reduction. One is the Paris Agreement in 2016 and the other is IMO's initial strategy on the reduction of greenhouse gas emissions from ships in 2018. These two agreements are interrelated, and IMO's strategy includes a specific reference to "a pathway of CO_2 emissions reduction consistent with the Paris Agreement temperature goals". [36]

The aim of the Paris Climate Agreement is to keep global average temperature rises well below two degrees relative to pre-industrial times and to work towards limiting global warming to less than 1.5 degrees. Unlike the IMO's strategy, the Paris Agreement does not include quantitative emission reduction obligations. Instead, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place to reach these ambitious goals. The Parties have an obligation to prepare nationally determined contribution, which have to strengthen continuously.[37]

Although, the reduction of the emissions from shipping has been important goal among the industry for a long time, IMO's strategy is a first statement where specific reduction targets for greenhouse gas emissions from international shipping are set. Annual absolute GHG emissions, despite the increase in traffic volumes, have to be reduced at least 50% by 2050. This can be achieved if carbon intensity of transport work (grams per tonnekilometers) is reduced at least 40% by 2030 and 70% by 2050 compared to 2008 levels. These restrictions apply to all maritime transport, not just new ships. [36]

A precondition to emission reduction is accurate data. The EU's MRV (Monitoring, Reporting, Verifying) emission measurement system is part of the measures to reduce emissions from shipping. CO_2 emissions from shipping are measured and monitored with vessel-specific accuracy and stored in a THETIS-MRV system. The results are reported to the European Commission. Besides the EU's MVR system, there is another data collection system (DCS) for

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[35] Gauss M. Gauss M., Jonson J.E, Moldanova J., Mellqvist J., Jalkanen J-P., Matthias V., Karl M. (2020). Air pollution from shipping. < https://cshipp.eu/publications>, retrieved 1.7.2020.
[36] IMO. Low carbon shipping and air pollution control. http://www.imo.org/en/MediaCentre/HotTopics/GHG/Pages/default.aspx
[37] United Nations (2015). The Paris Agreement. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement, retrieved 1.6.2020.

fuel oil consumption of ships, which is managed by IMO. The goal is to combine these two systems in the future.[38]

The Finnish Meteorological Institute (FMI) estimates exhaust gas emissions from the Baltic Sea shipping. The results are reported annually for HELCOM (Baltic Marine Environment Protection Commission) in its Maritime Working Group meetings. The latest comparison of emissions from the Baltic Sea Shipping reports the development of emissions in 2006-2018. The report[39] includes also analysis of energy efficiency of ships. Emissions are generated using the Ship Traffic Emission Assessment Model (STEAM)[40]. According to the emission estimated for 2017[41], ropax vessels had the highest emissions among the vessel types sailing in the Baltic Sea, on the average 132 g per tkm.

4.2 Methods used in CO_2 emission comparisons in REFEC

Assessment of environmental impact of the proposed Loviisa-Kunda route included the analysis and comparison of the CO_2 emissions of the current main road-sea routes with the alternative road-sea routes between towns situated in REFEC project area, as well as to/from the Finnish REFEC project area towns to Pärnu. Emissions on road legs in Finland and Estonia, and total emissions on the alternative road-sea routes were assessed, and the total amount of emissions was then compared between the routes. Sensitivity analysis complemented the assessment with different CO_2 emission factors for the sea transportation leg of the journey.

LIPASTO[42] is a unit emissions database developed by VTT Technical Research Centre of Finland. The database covers emission factors for road, rail, waterborne (including freight and passenger transport) and air transport as well as for other mobile machinery. For waterborne transport, also international traffic is included. Emission figures are available for different vessel types, vessel sizes and speed. For road transportation, figures are available for trucks and trailers, and separated for both highway and urban driving.

For waterborne transportation, CO_2 quantities (emission factors) in LIPASTO are given for example as grams per ton-kilometer (g/tkm, the transport of one net ton over one kilometre).

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[38] DNV GL (2020).EU MRV and IMO DCS. https://www.dnvgl.com/maritime/insights/topics/EU-MRV-and-IMO-DCS/index.html

[39] See e.g. Jalkanen, J.-P. & Johansson, L. (2019). Emissions from Baltic Sea shipping in 2006-2018. MARITIME 19-2019. INF 5-2. Submission date 29.8.2019. https://portal.helcom.fi/default.aspx, retrieved 1.7.2020.

[40] Johansson, L., Jalkanen, J.-P. & Kukkonen, J. (2017). Global assessment of shipping emissions in 2015 on a high spatial and temporal resolution. doi:10.1016/j.atmosenv.2017.08.042, retrieved 3.6.2020.

[41] Jalkanen, J.-P. & Johansson, L. (2018). Emissions from Baltic Sea Shipping in 2017. MARITIME 18-2018. INF 4-3. Submission date 14.9.2018. https://portal.helcom.fi/default.aspx, retrieved 1.7.2020.

[42] VTT (2017). LIPASTO. http://lipasto.vtt.fi/yksikkopaastot/indexe.htm, retrieved 5.5.2020.

Average CO_2 emissions for different sizes of roro and ferry ships are presented in the following table 4.1.[43]

Table 4.1. Average CO_2 emissions of a roro and ropax ship in 2016 in LIPASTO.

Type of vessel	**CO_2 [g/tkm]**
Roro with speed of 18 knots [kn] and trailer capacity of 200	142 g/tkm
Roro dedicated for paper transport, with speed of 18 knots [kn] and trailer capacity of 200	121 g/tkm
Ferry with speed of 18 knots [kn] and trailer capacity of 60	81 g/tkm
Roro with speed of 21 knots [kn] and trailer capacity of 300	101 g/tkm
Ropax with speed of 24 knots [kn] and trailer capacity of 300	145 g/tkm

For ferries, which carry both passengers and freight, 80% of emissions are allocated to passengers and 20% to passengers. For ropax ship carrying both freight and passengers, 84% of emissions are allocated to freight and 16 % to passengers. In the emission database, number of transport units (truck or trailer) is 80%, and one loaded transport unit contains on average 14 tonnes load, and share of the empty units is 15%. The values were applied in this study.

For REFEC impact assessment, the roro vessel with speed of 18 knots [kn] and trailer capacity of 200 was selected as the "model" vessel used in the comparison for the alternative sea transportation routes. Emissions of this vessel are 142 g per tkm. This vessel would have a capacity of around 2800 lane meters which is more than is assumed to serve in the Loviisa-Kunda route. However, the model vessel's type, capacity and speed were nearest to the foreseen vessel in the Loviisa-Kunda route available in the LIPASTO data.

For the routes between Kouvola and Rakvere, and Lappeenranta and Narva via different port connections, a sensitivity analysis was conducted by comparing the emission levels if a ferry with 81 g/tkm would be used instead of 142 g/tkm.

Regarding the road transportation, the emission factor of LIPASTO for trucks with semi-trailer is based to gross vehicle mass of 40 tonnes, and the pay load capacity of 25 tonnes (see example in table 4.2. below). Instead of using existing emission factors from LIPASTO, the emission factor for a truck loaded with 14 tonnes was calculated since it is the payload used in vessel emission calculations. The emission of 14 ton payload capacity was calculated with help of unit emission figures for empty and full loaded vehicles of LIPASTO[44]. The emission factors used in the study are 58 g/tkm for highway driving and 96 g/tkm for urban driving.

[43] http://lipasto.vtt.fi/yksikkopaastot/indexe.htm, retrieved 5.5.2020.

[44] The formula for partial truck load emission is available on LIPASTO web site http://lipasto.vtt.fi/yksikkopaastot/guide_tie.htm

Table 4.2. CO_2 emission factors of semi-trailer combinations in LIPASTO ref. own calculation.

Truck with semi-trailer, 25 [t]. Average in 2016 for EURO I-VI.	**Highway driving CO_2 [g/tkm]**	**Urban driving CO_2 [g/tkm]**
Fully loaded (25t load)	38	66
Partially loaded (e.g. 70%)	49	82
Partially loaded (14t load, own calculation)	58	96

First, CO_2 emissions of a truck with 14 tonnes of cargo were calculated on the different alternative road legs in Estonia and Finland, including both highway and urban driving. The waterborne emissions of the alternative sea routes were then added to get the total emission figures.

Besides individual town-to-town emission calculations, a summary calculation was done based to the allocation of annual volume of the trucks between the REFEC towns. This was also conducted for all the four alternative sea routes.

To estimate the share of freight transported between different regions, the results of the report on freight traffic in the Helsinki passenger ferry ports[45] was applied. There is no relevant O/D statistics on port hinterland transports. The annual cargo potential within Estonian REFEC area (four counties in northeastern Estonia) to/from Finland was estimated to be about 5 500 trucks[46]. About 20 % of all truck traffic in passenger ports in Helsinki arrive/leave from REFEC area in Finland. This 20%, (about 1 100 trucks) volume was further allocated to main Finnish towns of each county in REFEC corridor to get town-to-town traffic volume between Finland and Estonia. The town-to-town truck volumes are presented in table 4.3.

Table 4.3. The calculated annual truck volumes between the Finnish and Estonian REFEC towns.

	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva	**Total**
Kouvola	153	38	40	49	48	**328**
Lahti	141	35	37	45	44	**302**
Lappeenranta	34	8	9	11	11	**73**
Mikkeli	21	5	5	7	7	**45**
Jyväskylä	61	15	16	19	19	**130**
Kuopio	74	18	19	24	23	**158**
Joensuu	24	6	6	8	8	**52**
Kajaani	3	1	1	1	1	**7**
Total	**511**	**126**	**134**	**164**	**160**	**1095**

[45] Räty P., Planting, A., Määttälä, A. & Kantele, S. (2013). HLJ 2015 Freight traffic in the Helsinki passenger ferry ports in autumn 2012. 38 p.

[46] Helminen, R., Alhosalo, M., Suursoo, K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre For Maritime Studies of Brahea Centre at the University of Turku A 74.

4.3 CO_2 emissions and sensitivity analysis

4.3.1 CO_2 emissions of transportation of one truck in alternative routes

First, the CO_2 emissions of transporting one truck onboard a vessel in the sea routes were calculated using emission factor of 142 g/tkm (table 4.4). The CO_2 emissions are about 25 % higher on the route Loviisa-Kunda compared to the existing other routes.

Table 4.4. CO_2 emissions of transporting one truck onboard a vessel in the alternative sea routes between Finland and Estonia (142 g/tkm).

Sea routes	**km**	**tkm**	**One truck load 14 [t], CO2 [kg]**
Loviisa - Kunda	110	1 540	219
West Harbou - Old City	82	1 141	162
Vuosaari - Muuga	83	1 166	166
Hanko - Paldiski	83	1 166	166

For the road transportation legs, CO_2 emissions factors of 58 g/tkm for highway driving and 96 g/tkm for urban driving were used (see table 4.2 above). The emissions were calculated for allocated 1095 trucks (table 4.3). The CO_2 emissions of each route, including road legs and sea legs between the Finnish and the Estonian REFEC towns are presented in the tables below.

Table 4.5. CO_2 emissions [kg] of one truck load, 14 [t], on the alternative routes (inc. sea and road legs).

a) via ports of Loviisa and Kunda, CO_2 [kg]

	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
Kouvola	302	364	362	323	368
Lahti	318	380	378	338	384
Lappeenranta	367	430	428	388	433
Mikkeli	390	452	451	411	456
Jyväskylä	449	511	510	470	515
Kuopio	522	584	582	543	588
Joensuu	557	619	618	578	623
Kajaani	656	719	717	677	722

b) via West Harbour and Old City, CO_2 [kg]

Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
375	374	412	419	464
358	356	395	402	446
452	451	489	496	541
452	450	489	496	541
485	483	522	529	574
584	582	621	628	672
624	622	661	668	712
720	718	757	764	808

c) via Vuosaari and Muuga, CO_2 [kg]

	Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
Kouvola	347	352	383	391	434
Lahti	327	332	363	372	415
Lappeenranta	423	428	459	468	511
Mikkeli	427	432	463	471	514
Jyväskylä	459	464	495	504	547
Kuopio	552	557	589	597	640
Joensuu	598	603	634	642	685
Kajaani	688	693	724	732	775

d) via Hanko and Paldiski, CO_2 [kg]

Rakvere	Paide	Jõgeva	Kohtla-Järve	Narva
510	492	541	551	600
473	455	505	514	563
586	568	618	628	676
572	554	604	613	662
605	586	636	646	694
704	686	736	745	794
743	725	775	785	833
839	821	871	881	929

Compared with the route via West Harbour-Old City, the CO_2 emissions of one truck on the route via Loviisa-Kunda are lower between Rakvere, Jõgeva, Kohtla-Järve and Narva and all the Finnish REFEC towns. The CO_2 emissions are lower on the West Harbour-Old City route between Paide and Lahti, Mikkeli, Jyväskylä, Kuopio and with Kajaani. On the average, the emissions on the route via Loviisa-Kunda are 12 % lower than on the route via West Harbour-Old City.

Via Vuosaari-Muuga, the CO2 emissions of one truck are on the average 6% more than on the route via Loviisa-Kunda. Between the towns Rakvere, Kohtla-Järve and Narva and all the Finnish REFEC the CO2 emissions are on the average 11% lower than via Vuosaari-Muuga. On the contrary, the CO2 emissions are on the average 5% lower via Vuosaari-Muuga on the routes between Paide and all the Finnish REFEC towns, as well as between Lahti and Jyväskylä and Jõgeva. Compared with Hanko-Paldiski, CO2 emissions are on the average 38% lower for a truck moving via the ports of Loviisa-Kunda.

Although the CO_2 emissions on the sea leg between ports of Loviisa and Kunda are 25 % higher, they are compensated with lower CO_2 emissions from all the Finnish towns to the port of Loviisa (shorter road trip). In Estonia the road based emissions to the port of Kunda are always the lowest, except from Paide to Old City and Muuga.

4.3.2 CO_2 emissions of the annual freight potential of trucks in alternative routes

CO_2 emissions were calculated for the estimated freight potential, the annual volume of 1095 trucks in the REFEC corridor (table 4.6).

Table 4.6. CO_2 emissions of the annual volume of trucks on the alternative sea routes between Finland and Estonia (emission factor 142 g/tkm).

Sea routes	km	tkm	1095 trucks CO2 (t) with 14 [t] load
Loviisa - Kunda	110	1 540	239
West Harbour - Old City	82	1 141	177
Vuosaari - Muuga	83	1 166	181
Hanko - Paldiski	83	1 166	181

CO_2 emissions of the annual volume of trucks on the four alternative routes are presented in the table 4.7. The town-to-town routes contain the summed up emissions (road and sea) in Finland and Estonia.

Table 4.7. Total CO_2 [t] emissions of annual freight potential (1095 trucks) on the different routes.

a) via ports of Loviisa and Kunda

	Rakvere	Paide	Jõgeva	Narva	Kohtla-Järve	
Kouvola	46,2	11,5	12,1	14,5	14,8	
Lahti	44,8	11,1	11,8	14,0	14,3	
Lappeenranta	12,5	2,9	3,3	4,0	4,0	
Mikkeli	8,2	1,9	1,9	2,7	2,7	
Jyväskylä	27,4	6,7	7,2	8,5	8,5	
Kuopio	38,6	9,4	9,9	12,0	12,5	
Joensuu	13,4	3,3	3,3	4,5	4,5	
Kajaani	2,0	0,7	0,7	0,7	0,7	**Total**
						414

b) via West Harbour-Old City

Rakvere	Paide	Jõgeva	Narva	Kohtla-Järve	
57,4	14,2	15,0	18,0	18,4	
50,4	12,5	13,2	15,7	16,1	
15,4	3,6	4,1	5,0	5,0	
9,5	2,3	2,3	3,2	3,2	
29,6	7,3	7,8	9,2	9,2	
43,2	10,5	11,1	13,4	14,0	
15,0	3,7	3,7	5,0	5,0	
2,2	0,7	0,7	0,7	0,7	**Total**
					477

c) via Vuosaari and Muuga

	Rakvere	Paide	Jõgeva	Narva	Kohtla-Järve	
Kouvola	53,1	13,2	13,9	16,6	17,0	
Lahti	46,1	12,1	12,8	15,3	15,6	
Lappeenranta	14,4	2,8	3,1	3,8	3,8	
Mikkeli	9,0	1,7	1,7	2,4	2,4	
Jyväskylä	28,0	5,2	5,5	6,6	6,6	
Kuopio	40,9	6,2	6,6	8,0	8,3	
Joensuu	14,4	2,1	2,1	2,8	2,8	
Kajaani	2,1	0,3	0,3	0,3	0,3	**Total**
						410

d) via Ports of Hanko and Paldiski

Rakvere	Paide	Jõgeva	Narva	Kohtla-Järve	
78,0	19,4	20,4	24,5	25,0	
66,7	16,6	17,5	20,8	21,3	
19,9	4,7	5,3	6,5	6,5	
12,0	2,9	2,9	4,0	4,0	
36,9	9,1	9,7	11,5	11,5	
52,1	12,7	13,4	16,2	16,9	
17,8	4,5	4,5	5,9	5,9	
2,5	0,8	0,8	0,8	0,8	**Total**
					613

As for the annual volume of trucks on REFEC corridor, CO_2 emissions are lower between the all Finnish-Estonian REFEC towns on the route via Loviisa-Kunda compared to the route West

Harbour-Old City (15%). The CO_2 emissions of allocated trucks are higher on all routes via Hanko-Paldiski, 48% more than on the routes via Loviisa-Kunda. The CO_2 emissions are slightly lower, by 1%, via the route Vuosaari-Muuga route than via the route Loviisa-Kunda. This is due to the longer sea leg in Loviisa-Kunda (i.e. more emissions) which is not counterbalanced with shorter road legs when compared with Vuosaari-Muuga.

4.3.3 CO_2 emissions when using Pärnu as a crossroads for transports transiting Estonia

The overall CO_2 emissions of one truck trip from Finnish REFEC towns to Pärnu were calculated for the four alternative sea routes. The results are presented in table 4.8. The figures contain the emissions of the entire journeys (road and sea).

Table 4.8. CO_2 emissions [kg] of one truck from Finnish REFEC towns to Pärnu.

Town	Loviisa-Kunda	West Harbour - Old City	Vuosaari - Muuga	Hanko - Paldiski
Kouvola	441	414	393	496
Lahti	457	397	374	459
Lappeenrant	507	491	470	572
Mikkeli	529	491	474	558
Jyväskylä	588	524	506	590
Kuopio	661	623	599	690
Joensuu	696	663	645	729
Kajaani	795	759	734	825

CO_2 emissions [kg] of transporting one truck between the Finnish REFEC towns and Pärnu are on the average 7% lower on the route West Harbour-Old City and on the average 11 % lower on the Vuosaari-Muuga route than on the route Loviisa-Kunda. When compared with Hanko-Paldiski route, Loviisa-Kunda has on the average 5% lower CO_2 emissions. The position of Loviisa-Kunda route is here further weakened by the longer road leg from Kunda to Pärnu when compared to other port to Pärnu road legs.

The annual emissions were also calculated for the potential truck volume between the Finnish REFEC towns and Pärnu via different ports. The Loviisa-Kunda route volume was estimated to be 20 000- 40 000 units per year in the freight potential report[47]. For illustrative purposes the

[47] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre For Maritime Studies of Brahea Centre at the University of Turku A 74.

annual volume of 20 000 trucks was used in calculation. The annual amount of trucks is available in table 4.9, and the CO_2 emissions [t] of the entire route in table 4.10.

Table 4.9. Division of 20 000 annual trucks between Finnish REFEC towns and Pärnu.

Region	Share of volume in REFEC regions (%)	Annual amount of
Kymenlaakso	30	5 994
Päijät-Häme	28	5 522
Etelä-Karjala	14	2 881
Etelä-Savo	7	1 336
Keski-Suomi	12	2 373
Pohjois-Savo	5	942
Pohjois-Karjala	4	817
Kainuu	1	136
Total	**100**	**20 000**

Table 4.10. Total CO_2 emissions [t] of calculated annual volume of trucks (20 000) between Finnish REFEC towns and Pärnu.

Pärnu	Loviisa - Kunda	West Harbour - Old City	Vuosaari - Muuga	Hanko - Paldiski
Kouvola	2 642	2 482	2 358	2 971
Lahti	2 522	2 191	2 064	2 534
Lappeenranta	1 459	1 415	1 353	1 648
Mikkeli	707	656	633	746
Jyväskylä	1 395	1 243	1 200	1 400
Kuopio	622	587	564	650
Joensuu	568	541	526	595
Kajaani	108	103	100	112
Total	**10 024**	**9 220**	**8 798**	**10 657**

CO_2 emissions of the annual volume of trucks to Pärnu are around 10%[48] higher on Loviisa-Kunda route than on the routes via West Harbour-Old City and Vuosaari-Muuga. However, the emissions on the route via Hanko-Paldiski North are higher than via Loviisa-Kunda route.

The CO_2 emissions on the sea leg are 25 % higher on the route Loviisa-Kunda than on the alternative sea routes. The distance from Kunda to Pärnu is longer than from other Estonian ports, thus generating more CO_2 emissions on road transportation legs. Transportation of one truck to/from Pärnu generates from 25% to 31% more CO_2 emissions to Kunda than to other Estonian ports in the comparison. In Finland the CO_2 emissions of road transportation to Loviisa

[48] The difference here (800-1200 tons CO2 per year) equals approximately the amount which about 100 Finns generate annually. See https://data.worldbank.org/indicator/EN.ATM.CO2E.PC or https://www.openco2.net/fi/co2-muunnin.

are less than to other ports. This, however, does not level off the longer road transportation from Kunda.

4.3.4 Role of vessel emissions in total CO_2 emissions

Sensitivity analysis focuses on how the different vessel CO_2 emission factors (different vessel types) impact on the emissions in entire transportation routes. The analysis was carried out for the alternative routes between the REFEC towns Kouvola-Rakvere and Lappeenranta-Narva since the previous studies indicate that these cases have reasonable truck volumes, and furthermore, they also have differing road mileages. In addition, sensitivity analysis was carried out for routes between Pärnu-Kouvola and Pärnu-Lappeenranta.

These calculations explore the impact of different level of CO_2 emission on sea leg to the entire transportation chain, while the road transportation emissions remain the same. The emission factor used in the former calculations, 142 g/tkm of a roro vessel was compared with another model vessel in LIPASTO - a ferry with speed of with the CO_2 emission factor of 81 g/tkm (see table 4.1).

The comparison in shares of emissions (sea and road) in transportation of one truck between Kouvola-Rakvere and Lappeenranta-Narva is presented in figure 4.1.

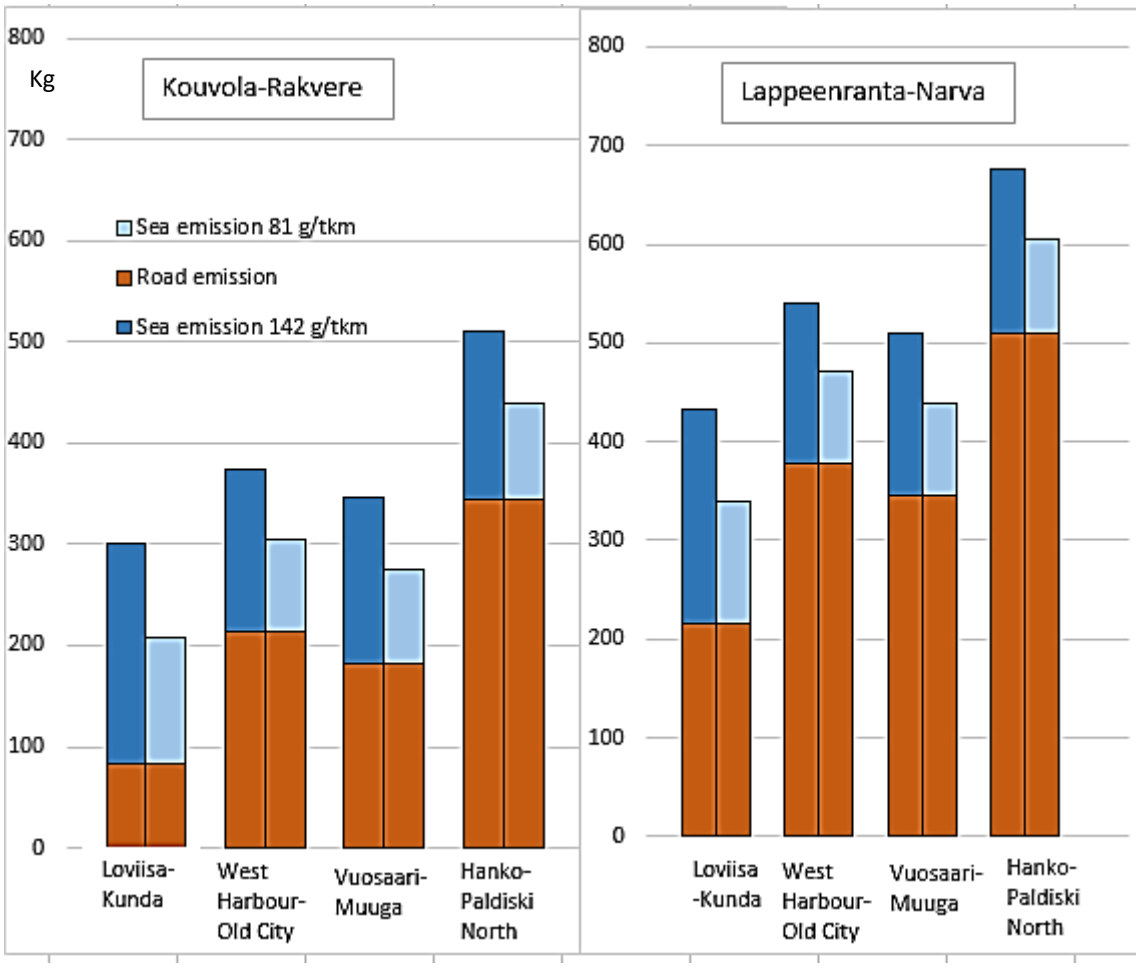

Figure 4.1. CO_2 [kg] emissions of sea transportation of one truck between Kouvola-Rakvere and Lappeenranta-Narva with vessel emission factors of 142 g/tkm and 81 g/tkm.

For Kouvola-Rakvere the share of sea emissions in the whole trip is largest via Loviisa-Kunda. With 142g/tkm emission it is 72% of the trip and if the emission factor decreases to 81 g/tkm it is 60% of the whole trip (table 4.11). The respective figures in West Harbour are 43% and 30%.

Table 4.11. Sea leg share of the total CO_2 emissions (%) in different routes.

Route	Loviisa - Kunda	West Harbour - Old City	Vuosaari - Muuga	Hanko - Paldiski
Kouvola-Rakvere, 81 g/tkm	60 %	30 %	34 %	22 %
Kouvola-Rakvere, 142 g/tkm	72 %	43 %	48 %	32 %
Lappeenranta-Narva, 81 g/tkm	37 %	20 %	21 %	16 %
Lappeenranta-Narva, 142 g/tkm	50 %	30 %	32 %	24 %
Kouvola-Pärnu, 81 g/tkm	36 %	27 %	29 %	22 %
Kouvola-Pärnu, 142 g/tkm	50 %	39 %	42 %	33 %
Lappeenranta-Pärnu, 81 g/tkm	30 %	22 %	24 %	19 %
Lappeenranta-Pärnu, 142 g/tkm	43 %	33 %	35 %	29 %

In the case of Lappeenranta-Narva, the share of CO_2 emissions on the sea leg is smaller than on the route Kouvola-Rakvere. This is obvious since the road transportation leg in case of Lappeenranta-Narva is longer than in Kouvola-Rakvere. The share of CO_2 emissions on the sea is 50% of the emissions with 142 g/tkm vessel, and it would decrease to 37% with 81 g/tkm vessel. West Harbour – Old City the responding figures are 30 % and 20 %.

The vessels with lower emission factors improve the position on Loviisa-Kunda route since it has about 25% longer sea leg compared with other connections. Naturally, the relative share of sea-based emissions decrease when the road transportations are longer.

According to comparison of emissions of transporting one truck between Kouvola and Rakvere, the difference in favour of route via Loviisa-Kunda was e.g. via West Harbour – Old City route 24 % with emission factor on sea 142g/tkm (see table 4.12 below). With 81g/tkm, the difference increases into 47%. In case of Lappeenranta-Narva, the difference between the emissions factors is smaller, due to longer distances on road.

Table 4.12. Difference of CO_2 emissions (%) between Loviisa-Kunda (100%) and the alternative transportation routes with different emission factors on the sea leg, Kouvola-Rakvere and Lappeenranta-Narva.

CO_2 emission factor on sea route Kouvola-Rakvere	**West Harbour - Old City**	**Vuosaari - Muuga**	**Hanko - Paldiski**
81g/tkm	147 %	133 %	211 %
142g/tkm	124 %	115 %	169 %
CO_2 emission factor on sea route Lappeenranta-Narva	**West Harbour - Old City**	**Vuosaari - Muuga**	**Hanko - Paldiski**
81g/tkm	139 %	129 %	178 %
142g/tkm	125 %	125 %	156 %

When analyzing the impact on the alternative routes to/from Pärnu, the share of CO_2 emissions on the sea is expectedly highest on the routes via Loviisa-Kunda. However, when compared with the responding shares in the alternative routes, the difference is smaller than in the previous cases. In particular on the route Kouvola-Pärnu, the share of sea emissions is 50% with 142g/tkm CO_2, decreasing to 36% with 81g/tkm, whereas e.g. on the route via West Harbour-Old City the responding figures are 39% and 27%. In the case of the route via Vuosaari-Muuga, the figures are 29% and 42%.

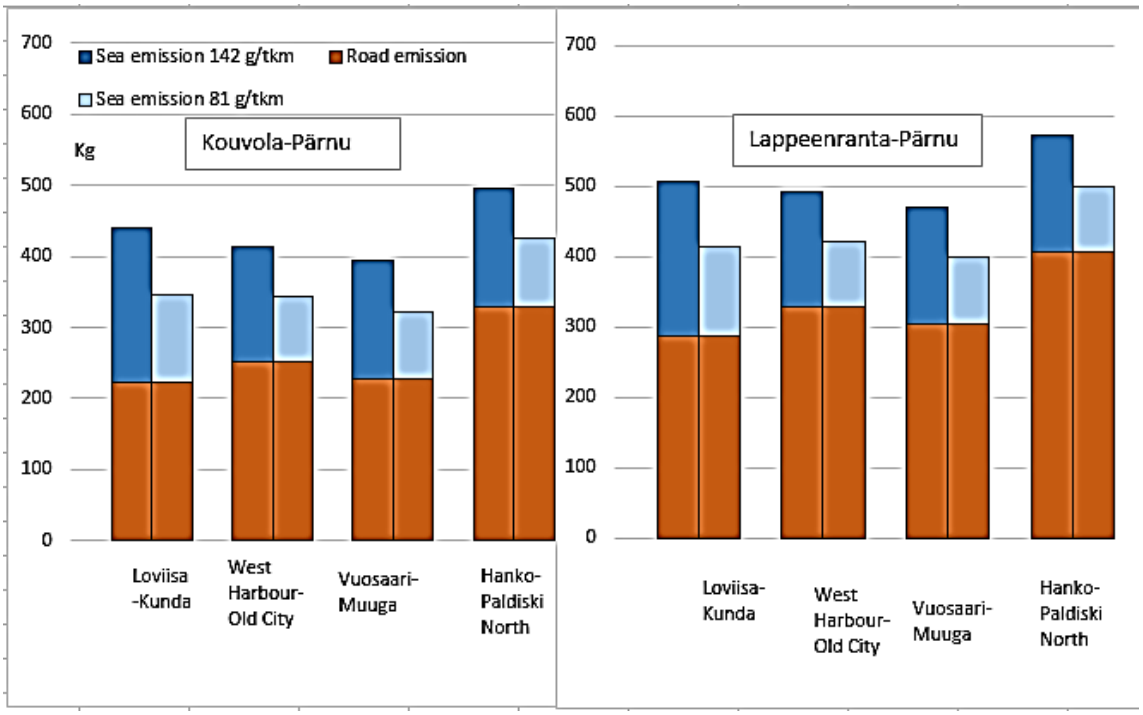

Figure 4.2. CO_2 [kg] emissions of sea transportation of one truck between Kouvola-Pärnu and Lappeenranta-Pärnu with vessel emission factors of 142 g/tkm and 81 g/tkm.

On the route Lappeenranta-Pärnu, the share of sea emissions is 43 % of the emissions on the route with 142g/tkm CO_2 and with 81g/tkm 30 %, whereas on the route via West Harbour-Old City the responding figures are 33 % and 22 %. In case of the route via Vuosaari-Muuga, the figures are 35 % and 24%.

In Table 4.13 total emissions Loviisa-Kunda is compared with other sea routes. In the case of Kouvola-Pärnu, the amount of the CO_2 emissions is 6 % smaller via West Harbour-Old City route to Pärnu than via Loviisa-Kunda route, and with the lower CO_2 emission factor of 81 g/tkm, there is only a slight difference between the entire emissions of the routes. The emissions via the route Vuosaari-Muuga are the smallest compared with Loviisa-Kunda route, however, the difference becomes smaller with the lower CO_2 emission factor of 81 g/tkm, being 7 %. Hanko-Paldiski has clearly more emissions with both emission factors.

Table 4.13. Difference of CO_2 emissions (%) between Loviisa-Kunda (100%) and the alternative transportation routes with different emission factors on the sea leg, Kouvola-Pärnu and Lappeenranta-Pärnu.

CO_2 emission factor on sea route Kouvola-Pärnu	**West Harbour - Old City**	**Vuosaari - Muuga**	**Hanko - Paldiski**
81g/tkm	99 %	93 %	122 %
142g/tkm	94 %	89 %	112 %
CO2 emission factor on sea route Lappeenranta-Pärnu	**West Harbour - Old City**	**Vuosaari - Muuga**	**Hanko - Paldiski**
81g/tkm	102 %	96 %	121 %
142g/tkm	97 %	93 %	113 %

On the route Lappeenranta-Pärnu, CO_2 emissions with the emission factor 142 g/tkm are 3% smaller when the route via West Harbour – Old City is used. However, if the vessel is switched to emitting 81 g/tkm, the Loviisa-Kunda route would have 2% less CO_2 emissions. Vuosaari-Muuga route continues to have less CO_2 emissions with both emissions factors. The CO_2 emissions via route Hanko-Paldiski are larger in both cases, with 21% to 13% more CO_2 emissions.

Summary

The conducted sensitivity analysis complements the emission analysis with exploring the impact of the different emissions factors on the sea leg emissions. The lower vessel emission factor is improving the position of Loviisa-Kunda route especially for shorter trips in REFEC corridor like Kouvola-Rakvere. In longer trips like Lappeenranta-Narva the impact is naturally smaller due to the longer driving distances on land.

In case of trips to Pärnu the road legs are longer but the logic remains the same as in REFEC corridor trips. The lower emission factor improves the position of Loviisa-Kunda. Especially in comparison with West Harbour-Old City route the differences are narrowing. Transport via West Harbour-Old City has a little less emissions, besides Lappeenranta-Pärnu trip. On the whole, Vuosaari-Muuga route has least emissions, while the Hanko-Paldiski has clearly more emissions than Loviisa-Kunda route.

5 IMPACT TO CONGESTION IN HELSINKI AND TALLINN

The cities are often established and grown around the ports. On many occasions, the gradually grown port originated traffic has been conceived as a challenge. While the new residential areas have been developed in or close to the traditional port areas the ever growing port related traffic has emerged as a source of tension between the ports and the city[49]. The issue has been addressed by various ways of traffic planning and management, or even relocating the ports or at least some of the port activities into new locations.

Partial, incremental and temporary improvements in managing traffic can be, however, achieved by using different means as is suggested in OECD Discussion Paper "Traffic Planning in Port-Cities". Different approaches were classified into the categories of planning, pricing, mode and system, land use, hinterland routes, and terminal gate. In each category 3-4 solutions were suggested. Loviisa-Kunda as an alternative, congestion-free route would match best to the category "hinterland route" although it actually would provide a re-routing option.

5.1 Port traffic in Helsinki

The port traffic contributes partly to the e.g. rush hour congestion in port cities. The ports (port authorities as port managing bodies) have, however, limited possibilities to influence the externalities of the port related urban traffic beyond the port borders. The pricing policy is one tool, which the port of Helsinki has taken into use to channel rush hour trucking to and from the passenger ports to Vuosaari harbour outside the city[50]. The arrival time slot system adopted in Vuosaari is also a solution to smooth the truck flow to the port. This practice suits, however, better to collecting and delivering trailers whereas the Finland-Estonia roro traffic is dominantly truck traffic. Furthermore, the slot system aims mainly to prevent congestion at port gate rather than in local road network.

According to the international Inrix study the duration of congestion has decreased in Helsinki 2018 to 2019[51]. Helsinki published 2018 a study on the ease of flow of traffic in Helsinki 2010-2017[52] based on the TomTom historic traffic statistics. The ease of traffic flow had improved 2017 compared to the previous years in the whole city area. However, in Helsinki peninsula area (the most inner part of the city) where the passenger ports are located the traffic fluency had slightly decreased. This is outwardly contradictory with another Helsinki commissioned study[53]

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[49] Hall, P. (2018), "Traffic Planning in Port-Cities", Discussion Paper, OECD/International Transport Forum.
[50] Port of Helsinki (2020). https://www.portofhelsinki.fi/en/port-helsinki/whats-new/news/port-helsinkis-truck-traffic-price-steering-working-intended, retrieved 23.3.2020.
[51] Inrix (2019). Scorecard. https://inrix.com/scorecard/, retrieved 24.3.2020.
[52] Blomqvist, P. (2018). Autoliikenteen sujuvuus Helsingissä 2010–2017. Kaupunkiympäristön julkaisuja 2018:7.
[53] City of Helsinki (2019). Liikenteen kehitys Helsingissä 2018. Kaupunkiympäristön julkaisuja 2019:12.

which illustrates that the vehicle traffic to Helsinki peninsula has been decreasing during 2008-2018. The traffic volume and the ease of traffic are, however, different measures, and traffic fluency can be slowed by e.g. street construction although the volume is simultaneously decreasing. The changes in route selection and some other variables can also affect ease of flow.

The perceptions of ease of traffic flow in Helsinki are highlighted in triennial Traffic barometer[54] (Liikennebarometri). The ease of traffic was assessed somewhat decreased in 2019 barometer compared the years 2013 and 2016. The residents had markedly more positive opinions on ease of traffic than enterprise respondents.

The heavy traffic (over 12 m) without special permit is banned in the large part of the Helsinki peninsula[55]. This leaves basically two main routes for trucks to access the passenger ports which are also suggested by the port authority. They are via Lapinlahti (West Harbour) and Hakaniemi bridges (Katajanokka terminal). City of Helsinki publishes data on traffic volumes on certain locations in the street network. Based on this, statistics is produced on the traffic crossing specified city regions like Helsinki peninsula. In 2018 the average weekday volume entering Helsinki peninsula was 1321 trucks. The traffic count points in the two bridges give 1318 which is in practice the same figure[56] (table 5.1.).

Table 5.1. The truck traffic over the bridges leading to the Helsinki passenger ports.

KAVL*	Hakaniemi bridge	Lapinlahti bridge	Total
To centre	159	552	**711**
From centre	127	480	**607**
Total	**286**	**1032**	**1318**
Share	22 %	78 %	

* Average daily traffic calculated for weekdays during 24 hour traffic based on the counting 25.9.2019 at 7.00-19.00.

If the daily truck figures on the bridges are counted with number of weekdays of a year (52*5=260) it results to around 340 000 trucks[57] which is close to the figure provided by the official statistics[58] for Helsinki- Tallinn truck and semitrailer traffic for 2019 which was 315 000 units. In conclusion, the traffic counts seem to match fairly well with the statistics on Helsinki-Tallinn roro traffic.

[54] City of Helsinki (2020). Liikennebarometri 2019. Kaupunkiympäristön julkaisuja 2020:6.
[55] City of Helsinki (2020). Moottoriajoneuvoliikenteen määrät. https://www.hel.fi/helsinki/fi/kartat-ja-liikenne/kadut-ja-liikennesuunnittelu/tutkimus-ja-tilastot/moottoriajoneuvoliikenteen-maarat/, retrieved 20.5.2020.
[56] City of Helsinki (2020). Risteys ja kehälaskennat. https://www.hel.fi/static/liitteet/kaupunkiymparisto/liikenne-ja-kartat/kadut/liikennetilastot/autoliikenne/Liikennelaskennat/Laskennat.html, retrieved 15.5.2020
[57] This includes also Helsinki – Stockholm volume which is around 40 000 units.
[58] Finnish Transport and Communications Agency (2020). Carriage of vehicles and other transport equipment by sea by port.

The foreseen Loviisa-Kunda ferry would have potential of 20 000 to 40 000 trucks in REFEC corridor[59]. If this were re-routed from passenger ports of Helsinki that would mean 83-167 trucks less on the streets per weekday (table 5.2.).

Table 5.2. The potential to decrease truck traffic to Helsinki passenger ports if part of it would reroute to Loviisa-Kunda ferry.

			Bridges 2019 KAVL		**Decrease potential if re-routed**		
HKI-TLL volume 2019	Trucks rerouted	Share	Hakaniemi	Lapinlahti	Hakaniemi	Lapinlahti	Total
315 000	20 000	6,3 %	286	1032	18,2	65,5	**83,7**
	40 000	12,7 %			36,3	131,0	**167,4**

Would this ease the flow of traffic in the city decisively? Probably not, but decrease of truck traffic especially if falling on rush hours could be tangible. The foreseen 6-12% decrease in truck volume compares to the port of Helsinki tariff revision in 2019 which steered 4% of the heavy traffic from passenger ports to Vuosaari[60].

The annual passenger car volume generated by mainly Estonian commuters to Finland was estimated to be 30-40 000 vehicles[61] for the foreseen Loviisa-Kunda ferry connection. The total annual volume of passenger cars on ferries between Estonia and Finland is around 1,4 million[62]. Thus, the foreseen share of passenger car re-routing would be only about 3 percentages of total volume. However, there would be probably also other but commuter traffic onboard. This would for its part have positive but limited impact to congestion.

The cargo traffic on ropax ferries between Helsinki and Tallinn is an organic part of the business model of the shipping companies. Therefore, single solutions to solve traffic flow issues are now few since the central underground tunnel option was voted down by the Helsinki city council[63]. The cargo traffic on ropax ferries between Helsinki and Tallinn is an organic part of the business model of the shipping companies. Therefore, single solutions to solve traffic flow issues are now

[59] Helminen, R., Alhosalo, M., Suursoo K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre for Maritime Studies of Brahea Centre at the University of Turku A 74.
[60] Port of Helsinki (2020). https://www.portofhelsinki.fi/en/port-helsinki/whats-new/news/port-helsinkis-truck-traffic-price-steering-working-intended, retrieved 23.3.2020.
[61] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre for Maritime Studies of Brahea Centre at the University of Turku A 74.
[62] Ibid.
[63] Yle (2019). City council rejects Helsinki underground tunnel. https://yle.fi/uutiset/osasto/news/city_council_rejects_helsinki_underground_tunnel/10991497, retrieved 25.3.2020

few since the central underground tunnel option was voted down by the Helsinki city council[64]. Thereafter, (November 2019) the mayor of Helsinki requested the port a study on different options to locate the roro related cargo and passenger traffic. The study was finished in June 2020[65]. The reports are analyzing alternatives on relocating the traffic within different Helsinki port facilities, or continuing with current composition of traffic. The scenarios do not include any reference to relocate part of traffic to Loviisa[66] [67]. However, the study foresees the truck and trailer volume to grow nearly 50% from the current level by 2040. Consequently, the congestion will remain in the agenda in city planning also in the future.

5.2 Port traffic in Tallinn

According to monitoring data, the total volume of street traffic has increased by 9.5% between 2012 and 2017 in the city of Tallinn and by 26% at the border of the city. However, the average annual number of cars in traffic directions related to the city centre has decreased by 1.2%.[68] In Tallinn, traffic jams occur only in the morning and evening peak times, they are mainly caused by cars (figure 5.1.). The share of trucks is small, approximately 4-5% from the traffic flow.[69]

[64] Yle (2019). City council rejects Helsinki underground tunnel. https://yle.fi/uutiset/osasto/news/city_council_rejects_helsinki_underground_tunnel/10991497, retrieved 25.3.2020

[65] Port of Helsinki (2020). Scenario work completed on the impact of the location of Helsinki port operations. https://www.portofhelsinki.fi/en/port-helsinki/whats-new/news/scenario-work-completed-impact-location-helsinki-port-operations, retrieved 19.8.2020.

[66] Port of Helsinki (2020). Helsingin sataman 3 skenaariota vuoteen 2040. Selvityksen julkinen loppuraportti.

[67] Ojala, L., Leviäkangas,P., Solakivi, T., Friman, E., Paimander, A. & Kairinen, I. Helsingin Sataman rahti- ja matkustajaliikenteen vaihtoehtoiset järjestelyt (HESARAMA).

[68] Tallinna Tehnikaülikool (2018). Tallinna liikluse muutuse monitooring automaatse seiresüsteemi andmete põhjal IV kvartal 2017. a., kogu 2017. a., I – III kvartal 2018. a., lk 36 ja 42. - https://uuringud.tallinn.ee/uuring/otsing, retrieved 28.3.2020

[69] Estimation by Professor Dago Antov, Tallinn University of Technology in interview 1.4.2020.

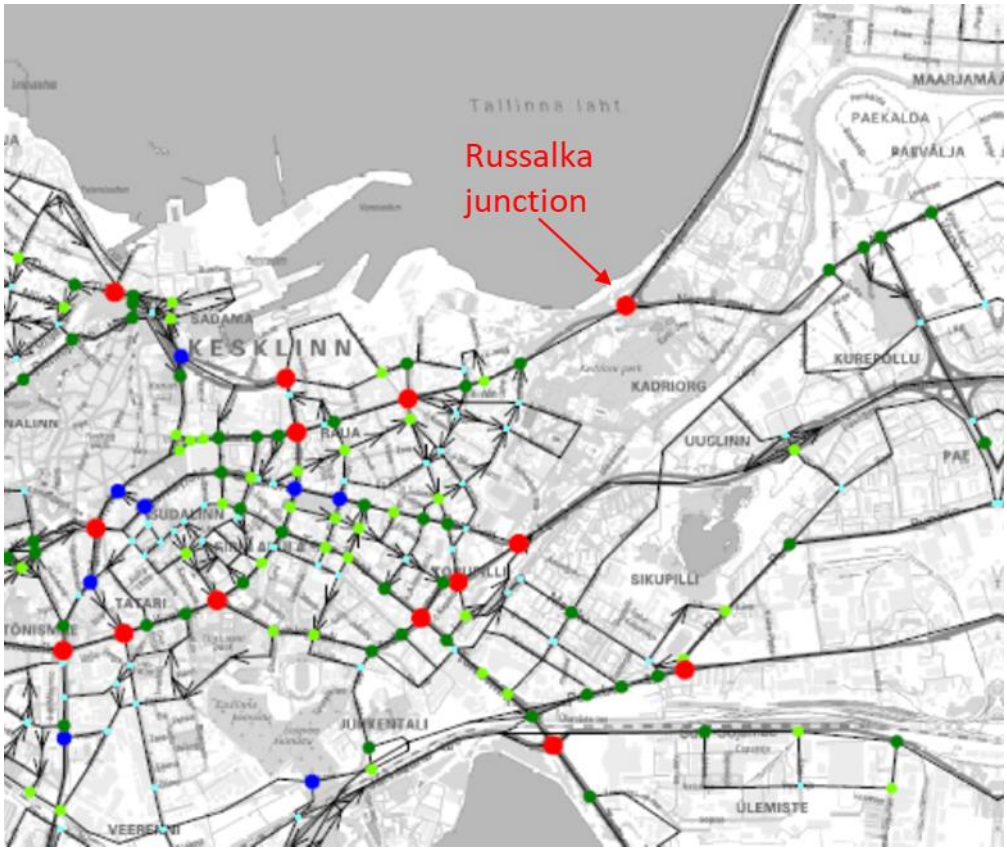

Figure 5.1. Congestion on crossroads in Tallinn. Red: the capacity of the junction at rush hour is exhausted; blue: capacity at rush hour used over 90%. Russalka – junction where trucks travelling to/from the Old City Harbour are directed. (Source: Stratum Ltd, based on monitoring data of 2018.)

After the re-independence of Estonia (1991), the harbour area close to the city centre, which had been closed to the public during the Soviet period, became one of the fastest growing areas of Tallinn due to increased marine traffic. In the early 2000s, it was stated in a comprehensive spatial plan, that the existing street network in the seaside area had been developed in accordance with the norms in force during the Soviet era and the number of means of transport of the period, when the flow of goods through the ports was minimal. It was assumed that the traffic flows of heavy vehicles to the Old City Harbour should decrease in the future, as the function of the cargo port will decline and be increasingly replaced by the function of a passenger and cruise port. At the same time, it was stated that heavy traffic from the harbour will not disappear completely, as the aim is to maintain a ro-ro connection with other Baltic Sea ports.[70]

The City of Tallinn has acted to streamline the heavy traffic related to the Old City Harbour and reduce its load on the general traffic frequency. The entire city centre region outside the Old City Harbour area is banned for heavy transport. The flow of heavy vehicles is directed to the

[70] Entec OÜ (2003). Paljassaare ja Russalka vahelise ranna üldplaneering. Seletuskiri, lk 11-12. - https://www.tallinn.ee/rannaala/ranna_web/seletuskiri.pdf , retrieved 28.3.2020

harbour from the northeast, from the Tallinn ring road through the Lasnamäe district along Narva maantee (Narva Road). Until the opening of Reidi tee (Reidi Street) in the end of 2019, the final section of the access to the harbour passed from the so-called Russalka junction (crossroad of Narva maantee - Pirita tee) to the Narva maantee - Jõe Street junction (figure 5.2.).

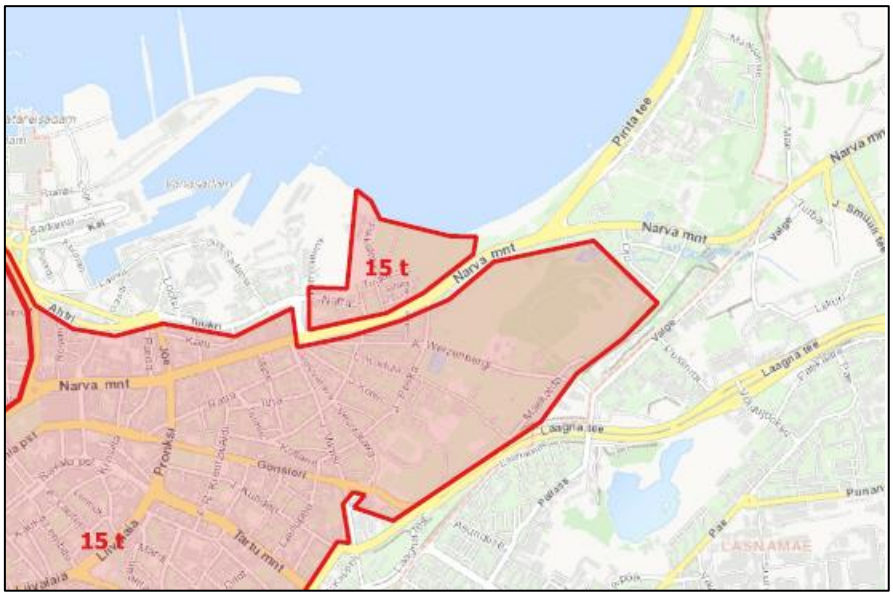

Figure 5.2. Areas closed for heavy transport and access for them to the Old City Harbour along Narva maantee in Tallinn before 2020. Source: Raskeveokite liikumise keeld Kesklinnas ja Kalamajas 2015. - https://www.tallinn.ee/Rasketransport

At the same time, the Russalka junction has been one of the most important dead ends in Tallinn. Congestion was mainly caused by cars from the Pirita district of Tallinn and the neighbouring Viimsi municipality, but the situation could also be aggravated by trucks to/from the harbour if they moved during rush hours. At the end of 2019, a new street - Reidi tee along the coast has been opened (figure 5.3.), to which all heavy transport to/from the harbour was directed. Towards the centre of Tallinn, Narva maantee is closed to heavy vehicles from the intersection with Reidi tee. The total length of Reidi tee is 1.93 kilometers.[71]

[71] ERR (2019). Tallinnas avati pidulikult Reidi tee. - https://www.err.ee/1008709/tallinnas-avati-pidulikult-reidi-tee, retrieved 9.4.2020.
[71] Tallinna Tehnikaülikool (2019). Hinnang Reidi tee põhiprojekti liiklusolukorra kohta lahenduse valmimisel, lk 4-5. - https://uuringud.tallinn.ee/uuring/otsing, retrieved 28.3.2020
[67] Tallinna Tehnikaülikool (2019). Hinnang Reidi tee põhiprojekti liiklusolukorra kohta lahenduse valmimisel, lk 4-5. - https://uuringud.tallinn.ee/uuring/otsing, retrieved 28.3.2020.

Figure 5.3. Reidi tee in Tallinn.

In addition to the highway, a half-kilometre-long promenade with two viewing platforms, a new cycle path and several kilometres of sidewalks and a specially paved running track were built. Recreation areas, outdoor café areas and playgrounds, swing areas and an outdoor gym have been built along the entire road. The new cycle path is connected to the Pirita promenade, which provides an opportunity to further develop bicycle traffic.

According to the traffic permeability forecast (2019), however, temporary congestion is possible at the Russalka junction (Narva maantee-Reidi tee intersection) during peak hours.[72] The existing traffic solution and mobility pattern will work without any major problems until no more than approximately half of the all planned real estate developments on Pirita tee and Merivälja tee (in the easter direction from the crossroad) are realized. After that, the traffic load values would reach the permeability limits.

Trying to assess the possible impact of the Kunda-Loviisa ferry line on Tallinn traffic – i.e. 83-167 truck journeys through the city per day, we can compare it with the forecasted traffic demand at the Russalka junction at morning and evening rush hour, which is (in opposite directions) either 3504 or 3723 vehicles per hour.[73] This indicates that the port truck traffic has fairly limited impact, and can be felt only if most of these trucks pass through the junction during the peak hours.

6 THE FORESEEN NEW FINLAND-ESTONIA FERRY CONNECTION IN REGIONAL DEVELOPMENT STRATEGIES AND ACTION PLANS

In addition to the established Helsinki-Tallinn and Hanko-Paldiski ferry routes there has been a short term roro connection between Kotka and Sillamäe 2006-2007. The REFEC project has been active since 2017 to support the launch of Loviisa-Kunda ferry connection. The regional development documents (comprehensive and transport related) were explored in both countries to discover whether the ports of Loviisa and Kunda have been noted in the plans and strategies as a potential ferry connection.

6.1 Finnish strategies and action plans

Finnish strategy documents do not include any references to new ferry connections over the Gulf of Finland. The national vision for regional structure and transport system by 2050[74] foresees the further twin city development of Helsinki and Tallinn with Rail Baltica and possible tunnel connection. This national vision is used by regional administrations to produce more detailed transport system plans. The East-Uusimaa transport strategy[75] (2009) does not include any indications for new ferry connections between Finland and Estonia. The plan is now being updated and will be ready in 2021. The ferry connection as a future option would be, however, included to the transport strategy only when the ferry connection has reached the decision stage[76].

The neighbouring region to Uusimaa, Kymenlaakso had a ferry connection from Kotka to Sillamäe 2006-2007. Since ending of the ferry service there has been occasional initiatives to restore the ferry connection to Estonia (e.g. TRiK project[77]). Nevertheless, a ferry connection to Estonia has not been included in the regional transport strategy[78]. The only reference on a ferry connection is on the web site of Kymenlaakso region. As for the Baltic Sea cooperation a ferry connection is stated as the common interest of Kymenlaakso with Lääne-Virumaa and Ida-Virumaa[79].

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[74] Ympäristöministeriö (2015). Uusiutumiskykyinen ja mahdollistava Suomi. Aluerakenteen ja liikennejärjestelmän kehityskuva 2050.
[75] Uudenmaan liitto (2009). Itä-Uudenmaan liikennestrategia 2030.
[76] Petri Suominen, Traffic Planning Manager, Helsinki-Uusimaa Regional Council. Phone call 20.5.2020.
[77] Hyyrynen J., Paukku P., Rantavuo E., (2013). TRIK -HANKE. Kotkan, Kundan ja Kronstadtin välisen laivareitin matkustaja- ja rahtipotentiaalin selvitys. Kymenlaakson ammattikorkeakoulun julkaisuja B 112.
[78] Kymenlaakson liitto (2015). Kymenlaakson liiton liikennestrategia 2035.
[79] Kymenlaakson liitto (2020). Itämeren alueen yhteistyö. https://www.kymenlaakso.fi/yhteistyoe-ja-kansainvaliset-tehtavat/kansainvaeliset-tehtaevaet/viro, retrieved 8.6.2020.

Maritime Spatial Planning for Sustainable Blue Economies (2016-2019, PLAN4BLUE[80]) project focused on blue growth and maritime spatial planning. The project was conducted by the key Finnish and Estonian maritime planning actors and experts. The foreseen Loviisa-Kunda ferry connection was included in the elaboration of alternative futures of the Gulf of Finland. Simultaneously, maritime spatial planning obliged by the EU directive (2014/89) was underway by the coastal regional councils. Maritime spatial plan in Finland is on the draft level and will be completed by March 2021[81]. The draft version outlines three different scenarios. None of them include any reference to the foreseen ferry connections (while same plan in Estonia does[82]). However, the Helsinki-Tallinn rail-tunnel and Rail Baltica are included. The foreseen ferry connection was probably on a too detailed level for a relatively generic plan.

6.2 Estonian strategies and action plans

Estonian planning and strategy documents include regular shipping connection from port of Kunda to Finland on different administrative levels.

The National Spatial Plan "Estonia 2030+"[83] focuses on the entire land and water area of Estonia as well as on its spatial connections with other countries. The plan emphasizes the development of international transport corridors and sees the nodes like ports as a natural locations for logistics centres providing income and contributing to the balanced regional development of the country. Figure 6.1. on the foreseen transport network in Estonia highlights the port of Kunda having connection to Finland (figure 6.1.).

[80] Interreg Central Baltic funded PLAN4BLUE project website. https://www.syke.fi/en-US/Research__Development/Research_and_development_projects/Projects/Maritime_Spatial_Planning_for_Sustainable_Blue_Economies_PLAN4BLUE, retrieved 10.6.2020.
[81] Ministry of Environment (2020). Maritime Spatial Planing. https://www.ymparisto.fi/en-US/Living_environment_and_planning/Maritime_spatial_planning, retrieved 9.6.2020.
[82] Rahandusministeerium (2020). Merealapalaneeringu seletuskiri. p 60. https://www.rahandusministeerium.ee/sites/default/files/Ruumiline_planeerimine/2020-02-13_pohilahendus_portaali.pdf, retireved 9.6.2020.
[83] National Spatial Plan Estonia 2030+. https://eesti2030.files.wordpress.com/2014/02/estonia-2030.pdf, retrieved 9.6.2020.

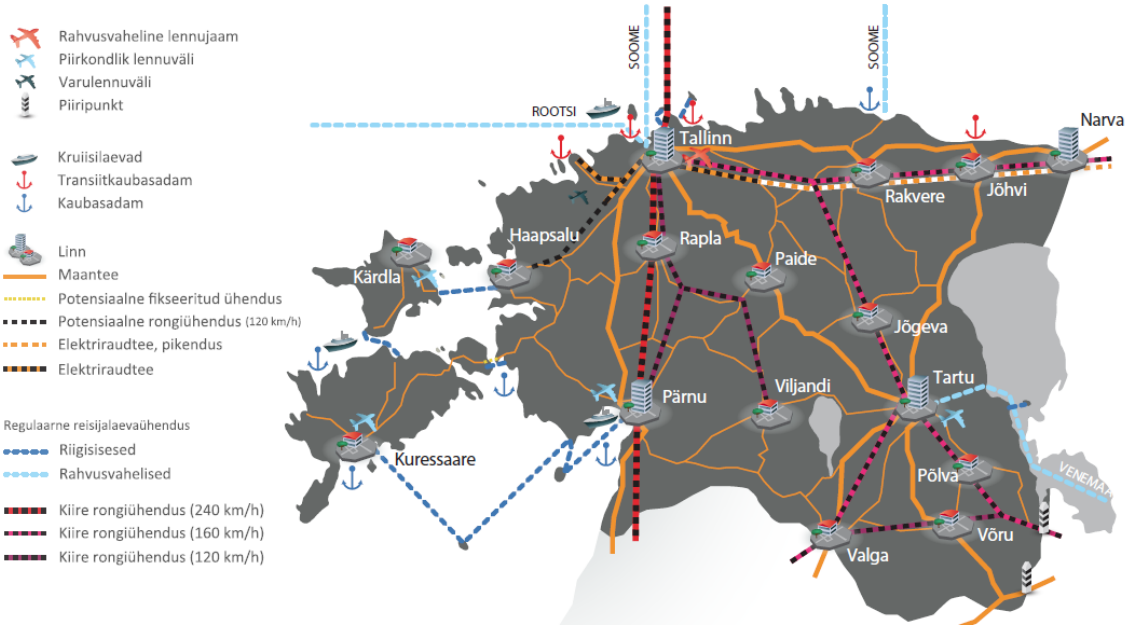

Figure 6.1. The structure of transport network where port of Kunda has connection to Finland (source: Estonia 2030+).

The regional level development strategy 2030+ of Lääne-Viru county[84] argues strongly for transport and logistic industry and the development of transport corridors in the region. The ferry connection to Finland is highlighted in the strategy and listed also in the regional action plan. Lääne-Viru county plan 2030+ specifies the spatial planning priorities. Kunda-Finland ferry connection is included in the plan.

Viru-Nigula has a municipal development plan for years 2019-2026. Promoting an attractive economic environment is one of the main development issues. Port of Kunda and the foreseen ferry connection to Finland is specifically mentioned as a future possibility as well as the neighboring industrial area which the municipality wants to support.

Estonian maritime spatial plan process has outlined regional sea-land clusters where each coastal region has a specific profile[85]. The Kunda region is named as Finland connection cluster where the Kunda-Loviisa/Kotka ferry plays essential role (figure 6.2).

[84]Lääne-Viru Omavalitsuste Liit (2018). Lääne-Viru maakonna arengustrateegia 2030+. https://www.tapa.ee/documents/100755/6241726/L%C3%A4%C3%A4ne-Viru+maakonna+arengustrateegia+2030-.pdf/dd03f49c-c301-46eb-911d-e5203e1168a4, retrieved 9.6.2020.

[85] Rahandusministeerium (2020). Eesti merealaplaneeringu seletuskiri. p 60. https://www.rahandusministeerium.ee/sites/default/files/Ruumiline_planeerimine/2020-02-13_pohilahendus_portaali.pdf, retrieved 9.6.2020.

Figure 6.2. Estonian sea-land clusters. (Source: Mereala planeeringu seletuskiri, 2020)

Besides the above planning documents which explicitly name the port of Kunda having a regular shipping connection to Finland there are some other documents which implicitly can be seen supporting the new ferry connection. These include Strategy for regional development 2014-2020[86], Development plan for transport and mobility 2021-2030[87] and Estonian maritime affairs policy 2012-2020[88].

[86] Eesti Siseministeerium (2014). Eesti regionaalarengu strateegia 2014-2020. https://www.siseministeerium.ee/sites/default/files/dokumendid/eesti_regionaalarengu_strateegia_2014-2020.pdf, retrieved 10.6.2020.

[87] Majandus- ja Kommunikatsiooniministeerium (2019). Transpordi ja liikuvuse arengukava aastateks 2021–2030 koostamise ettepanek. https://www.valitsus.ee/sites/default/files/content-editors/arengukavad/transpordi_ja_liikuvuse_arengukava_2021-2030_koostamise_ettepanek.pdf, retrieved 10.6.2020.

[88] Majandus- ja Kommunikatsiooniministeerium (2012). Eesti merenduspoliitika 2012–2020. https://www.mkm.ee/sites/default/files/merenduspoliitika.pdf, retrieved 10.6.2020.

7 IMPACT OF A NEW FERRY CONNECTION TO REGIONAL DEVELOPMENT

The impact of the foreseen Loviisa-Kunda ropax service and consequent activation of eastern Finland – eastern Estonia transport corridor was estimated on the basis of literature, official planning documents and interviewing relevant stakeholder organisations in public and private sectors including NGOs. The emphasis of the expected impacts is based on the interviews. In total, 12 interviews were conducted in Finland and 18 in Estonia (list interviewees in appendix 2). The interview covered issues like impact to

- the economic activities in the port, as well as in different local and regional industries
- environment
- land use and planning
- impacts of improved accessibility and closer regional communication between Estonia and Finland

Furthermore, the interviewees were asked to name the most likely and the strongest impacts during the following 10 years after the launching of the ferry service (the interview topics in detail in appendix 3).

7.1 Regional impact of ferry connection in Finland

7.1.1 Impact to economic activities: manufacturing and transport

The new ferry connection could attract new light industry close to the port. Municipality of Loviisa is working on attracting manufacturing in the area. The ferry connection would support this activity. Only some of the interviewed wanted to estimate the impact of ferry line to the employment in detail in the port. The impact of new traffic in the port community could itself employ approximately 10-15 persons. Depending the number of daily departures (1-2) the cargo operations could generate annually around 2 million € turnover in the port community. The indirect employment impact of increased employment in port is even harder to estimate. A recent study on the impact of port of Helsinki indicates that a sector including warehousing and other transport related services (stevedoring, forwarding, chartering etc) generate 1,5 indirect jobs per one direct job in the port[89]. This would consequently result in 15-22 indirect full time jobs. The total of generated jobs in port and its hinterland would thus be around 25-37. Furthermore, there would be indirect employment impact in other sectors which was not estimated in this study. This would generate also municipal tax income mainly to Loviisa and neighboring municipalities. The median monthly income of a male worker in private sector in 2018 was 3381€[90]. The municipal tax in Loviisa is 20,25% (2020). These values were used in tax

[89] Karvonen, T. & Jousilahti, J-P. (2019). Helsingin sataman vaikuttavuus. p. 19.
[90] Statistics Finland (2020). Palkat ja työvoimakustannukset. https://www.tilastokeskus.fi/tup/suoluk/suoluk_palkat.html#Kokonaisansiot%20ty%C3%B6nantajasektorin%20mukaan, retrieved 26.5.2020. Male worker income is used here since men form currently a clear majority of the port workers.

rate calculator of Finnish tax administration[91]. The calculator gives the amount that can be deducted from gross income. The remaining share is used for calculating the municipal tax. As a result the above employment impact would generate about 170 000 - 250 000 euros taxes to local municipalities. If the new ferry service would lead to the establishment of few new manufacturing enterprises by the surroundings of the port, they could employ at a guess around 50-100 persons.

As for wider regional impacts, a new ferry line would be a positive signal to the economic actors and improve the attractiveness of the eastern Uusimaa region. That might increase the investment decisions of even those companies who would not need ferry transport services. This would translate to new jobs and increased economic attractiveness of the region. The other obvious impact would be the industry in eastern Finland starting to use the new competitive ferry service. Efficient marketing of the connection to the transport sector and cargo providers especially in eastern Finland is essential.

7.1.2 Impact to economic activities: tourism and other industries

Ferry link would not necessarily create much demand in tourist sector in Finland since the tourism between the countries is mainly Finns visiting Estonia, not the other way. However, some new demand and tourist services could be designed in Uusimaa around the eastern round trip concept (bicycle, car, culture, food, accommodation). This could be designed and piloted initially with project funding. Furthermore, Estonians could use the ferry route for cottage holidays during summer in the Lakeland area and for skiing holidays in winter. It would be a good approach to promote short distance, sustainable countryside vacationing as an alternative to flight based holidays. Overall, the ferry connection would stimulate the sales in catering, accommodation and retail sector in Loviisa.

7.1.3 Impact to environment and land use

The interviewees did not see much externalities raising from the ferry or truck traffic to the port. The road that departs from E18 highway and leads to the port of Loviisa is bypassing the town with a fair distance to the housing, and especially west of the road there are hardly any housing. Therefore, the environmental impact was considered marginal. On the seaside the ferry connection does not increase the vessel traffic between Finland and Estonia on the whole, so the impact is neutral. On the other hand, the heavy traffic channeled via port of Loviisa would partly decrease the congestion in Helsinki. Regarding tourism, the ferry route provides an

[91] Finnish tax administration (2020). Tax percentage calculator. https://www.vero.fi/en/individuals/tax-cards-and-tax-returns/tax_card/tax-percentage-calculator/, retrieved 11.6.2020.

opportunity for short distance tourism which is usually a more climate friendly alternative to air travel.

The land use planning around the port is currently underway even if the ferry line would not appear in the future. Therefore, there will be possibilities for industrial actors to locate to the port and its surroundings. The ferry line would probably increase the interest towards the industrial lots in Loviisa on the whole. New ferry line and new companies would support the vitality of the whole port community leading to a cluster type development which creates mutual benefits in the area. The ropax connection would naturally mean rearrangement of port activities, creation of truck park at the port etc. The foreseen ferry connection was not estimated to increase the price of land since there is land available and the demand is not currently high.

The road number 178 leading to the port is on good condition. The increased truck traffic would probably add motivation to construct the planned walk and bicycle way at the side of the road.

The national road 55 would be used by the Lahti direction traffic. The ramp from national highway 4 (E75) to road 55 has traffic lights fairly close to the ramp entrance. The traffic is not, however, considered that intense that it would cause congestion there.

The fairway to the port is deep enough for ropax vessels. The width is not either an issue with the current vessel volume.

7.1.4 Impact to the public sector and development plans

The regional transport strategy (transport system plan) is a medium term strategy prepared by the regional councils in cooperation with other authorities. It is setting the framework for transport development objectives of Uusimaa region. The foreseen ferry connection would affect the development objectives and action plans only when the realisation of the ferry connection has progressed on decision stage. This approach is different from Estonia where the national and regional plans already include the ferry connection from Kunda to Finland as a policy objective. Once the ferry connection initiative matures it would then give support to the other transport infra policy objectives of eastern Uusimaa. One example is the eastern coastal railway initiative or maintenance of Lahti – port of Loviisa railway. Another case is the level of icebreaking services on Loviisa fairway.

The ferry connection would give boost to industrial policy planning in Loviisa and would highlight the role of the port in town strategy as an engine of economic growth.

7.1.5 Impacts generated based on better accessibility and interaction

The new ropax connection would most probably increase interaction between the concerned regions. There could be some new region-to-region commuting in addition to some re-routing of commuter traffic between capital areas to Loviisa-Kunda ferry route.

All year round tourism might increase (cottage rent, camping, housing). Some cooperation could develop between Finnish and Estonian (summer) event organizers. There could be also other forms of cultural cooperation due to the improved connection, e.g. friendship town activities. The interviewees did not, however, believe in establishing new common public services based on better accessibility of regions.

7.1.6 Summary of the most important expected impacts

- Positive impact to the employment in the port and Loviisa region. Approximately 25-37 new jobs (direct and indirect) and 170 000 - 250 000 euros in municipal taxes.
- The industrial activities would increase in port and near the port. This would also benefit the already existing businesses and support the operation and infra maintenance of the port.
- Traffic flows of eastern Finland manufacturing enterprises would at least partly be re-routed via Loviisa as well as logistics centres east or northeast of Helsinki.
- The vessel connection would probably lead to the growth of popularity of short distance tourism (opposed to flight holidays). Estonians could visit Loviisa region and eastern Finland more than before.
- Positive impact on Helsinki region (easing congestion, air quality, traffic safety) by transferring some of the heavy traffic to the congestion-free roads.
- Overall, the ropax connection to Estonia would increase dynamism of local economy and create a positive image for the eastern Uusimaa region which could attract new investments.

7.2 Regional impact of ferry connection in Estonia

7.2.1 Impact to economic activities: manufacturing and transport

The interviewed argued that the main benefit from the anticipated Kunda-Loviisa roro shipping line in Estonia would be the improvement of the operating environment of the manufacturing industry in eastern and southern Estonia. The ferry line would offer more favourable opportunities for the supply of production inputs (raw materials, spare parts etc.) and for transport of the products to Finland, eventually leading to the growth of exports. This hopefully would lead to an increase in the productivity and profitability of manufacturers, their suppliers, as well as the road transport and forwarding companies.

The foreseen ferry connection would lead to more transport companies using the Port of Kunda. The main impact would be in transports in the regions of Lääne-Viru, Ida-Viru, Jõgeva, Järva but also in other regions.

The strongest positive impact on the operating environment of manufacturers is expected to occur in town of Kunda. Viru-Nigula municipality looks to developing the industrial area by the side of the port of Kunda into a logistics centre[92], where several companies would build, acquire or rent warehouse space for storage and transportation of goods. These companies are expected to invest in the industrial area. For example, Kuusakoski AS, the leading scrap metal receiver and recycler in Estonia, has shown interest in building its infrastructure there.

In connection with servicing roro ships, about 10-20 jobs were estimated to be added in the port and the industrial area. With indirect impact[93] in total 25-50 would be created. Furthermore, there would be indirect employment impact in other sectors which was not estimated in this study. With using the Estonian average monthly wage of 1 472€[94] and municipal tax share 11,96%, the municipalities in the area would obtain in total 40 000 - 80 000 € in taxes (calculation in appendix 4).

It is hoped that in the ten-year perspective, the regular shipping line will become an important development engine supporting the business in Lääne-Viru county. According to the managers of the companies interviewed, the benefits of opening the shipping line for their company is seen primarily in terms of savings in transport costs and transport time although the saving might be relatively limited. The cargo transport to/from Finland of most of the companies whose managers were interviewed is mainly related to the Helsinki and Turku areas. They estimate that a lesser share of their cargo traffic would eventually move to the Kunda-Loviisa ferry. The manufacturing firms estimated that in some cases the cost savings might benefit the transportation company but not end to the cargo owner.

The companies that were contacted are located in North-Eastern Estonia (Lääne-Viru, Ida-Viru, Jõgeva and Järva counties). Those companies who were interested in using Kunda-Loviisa shipping line are operating on various industries (pulp production, aerated concrete products, chipboards and melamine faced boards, hooklift containers, plywood, rapeseed oil and cakes, grains sales). There are more than 3 000 truck transports connected with the interviewed companies across the Gulf of Finland each year. A part of them would probably be transferred to the Kunda-Loviisa route. However, the companies are not able to estimate the size of this part more since information on the cost level is not available. It is noteworthy that many of these

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[92] Geographical grouping of independent companies and bodies which are dealing with freight transport (for example, freight forwarders, shippers, transport operators, customs) and with accompanying services (for example, storage, maintenance and repair), including at least a terminal. - https://stats.oecd.org/glossary/detail.asp?ID=6254

[93] As for indirect impact, the multiplier 1,5 used in Finnish side estimation is used here as well.

[94] Statistics Estonia (2020). Wages and salaries. IV quarter 2019. http://andmebaas.stat.ee/index.aspx, retrieved 3.6.2020.

same companies gave a much smaller figures two years ago in the Kunda-Loviisa cargo potential study. Besides exporting their products to Finland the companies would import production inputs like chemicals, spare parts, maintenance components and raw materials to Estonia. One company was interested in establishing a warehouse to the port of Kunda if the ferry line is realised. Furthermore, the ferry connection would benefit the truck drivers who need to follow the work and rest time regulation. Kunda-Loviisa ferry being a faster option would make drivers to avoid overnight stays on the way for trips to eastern Finland.

In conclusion, the companies seem interested in Kunda-Loviisa regular shipping line and see it as an opportunity to save their transport costs and transport time.

7.2.2 Impact to economic activities: tourism and other industries

There is a general consensus that regular shipping to Finland servicing people travelling by car would boost tourism in Lääne-Viru county and Ida-Viru county and beyond. It would contribute to the development of tourism related services and spatial dispersion of travelling which is now focused mainly in Tallinn and western Estonia.

Finnish tourists are an important part of clientele for North-East Estonian spas (AQVA Hotel & Spa in Rakvere, Toila SPA Hotel and Narva-Jõesuu town spas), museums and nature tourism. However, Narva-Jõesuu town situated on the eastern border of Estonia, has fewer spa visitors from Finland due to distance from Tallinn where the tourists currently arrive from Finland. A new trend in spa tourism is to stay shorter time, two to three nights, instead of whole week and then travel elsewhere in Estonia. In addition to spa tourism there is also some hunting and sauna tourism in the region.

The shipping line could appeal more to family tourists traveling by car, camper van or caravan. Bus tourism coming directly to Eastern Estonia could also grow, as it would be rational to assemble bus tourism groups in Eastern Finland. Tourism companies would expand their range of package tours, which would include overnight stays in different locations and make better use of the potential of local attractions, nature tourism, leisure and entertainment activities. It is considered that chiefly spas and manors of Lääne-Viru county would attract more visitors. The number of tourists who travel by car from Eastern Finland through Estonia, even to Riga, may increase too.

Spas and museums expect, however, a rather modest increase in total number of their visits and revenue due to the launch of the new shipping line, estimated at two to five percent. Spas and museums do not feel the need to expand their activities by creating new jobs or investing since the growth would be fairly limited. At the same time, some of the interviewees thought that a certain amount of jobs could be created in town of Kunda and further afield in catering, accommodation and leisure time services. The flow of trucks and cars would provide also additional work for car repairs and maintenance.

As expected the Kunda-Loviisa shipping line was seen to contribute to the development of tourism and diversify the economic structure and employment of town of Kunda.

7.2.3 Impact to environment and land use

The interviewees do not anticipate the deterioration of Kunda's environmental condition due to the launch of a regular shipping line. It was noted that the port complies with environmental requirements, has a water use permit and the environmental impacts of the port have been assessed.

The development of the port and launch of a regular shipping line would create a certain amount of new jobs, which will increase employment on the site. The companies that save their operating costs by transporting goods through the Port of Kunda would generate investments in Kunda by buying/renting warehouse space for this purpose. Viru-Nigula municipality expects to have more resources to invest in the living environment and environmental values. Generally, it is expected that the development of Port of Kunda and the tourism and leisure industry is likely to be accompanied by creation a positive image of Kunda town.

In the comprehensive plan of the municipality currently in preparation, the local government will reserve land for the industrial area and the residential area. The real estate market is expected to recover somewhat and additional high-quality housing would be built. Furthermore, it is believed that Finnish pensioners would be interested in buying or renting apartments or cottages in Kunda region.

7.2.4 Impact to the public sector and development plans

The expectations connected to opening of the Kunda-Loviisa shipping line has already influenced the preparation of current public sector development documents and the nature of activities arising from them[95]. The development of the Port of Kunda and the establishment of a regular ship connection with Finland is a priority project in the current development plan of Viru-Nigula municipality 2019-2026 and in the Development Strategy of Lääne-Viru County 2030+. In the ten-year perspective, the development of the port and the creation of new industrial jobs are important for Kunda.

The comprehensive plan of the municipality in preparation will foresee traffic arrangements (including the bypassing of Kunda centre to the port), spatial solution of the industrial area and infrastructures related to the development of the port. The need for thorough processing of the development and expanding of the port of Kunda, as well as the development of the port as part

[95] More detailed in chapter 9.

of the network of small ports in the Gulf of Finland, is emphasized in principles guiding the preparation of this plan.

7.2.5 Impacts generated based on better accessibility and interaction

One major impact of the ferry line would be easier access from Eastern Estonia to the Finnish labour market. This affects mainly for jobs located east of Helsinki. Labour commuting would bring additional tax revenue to local government budgets on the Estonian side. Another impact could be facilitating smaller Estonian construction companies to offer their full service in Finland and that the maintenance staff of several companies could start moving back and forth across the gulf. Furthermore, it is expected that Finnish industrial investment in Estonia could increase to a certain extent.

The development of maritime economy and logistics in Kunda would improve opportunities for opening of Lääne-Viru region even more to the sea sector. Inter alia, maritime economy related curricula could be introduced at Kunda upper secondary school, thus supporting the specialization of the school. In this context, young people could have better prospects of acquiring education locally and start working in their hometown and home county.

With the support of the shipping line, East-Estonian co-operation with Finnish entrepreneurs, non-profit associations and the public sector could grow. Increased contacts would probably facilitate joint participation in the European Union's Baltic development programmes, including environmental cooperation.

7.2.6 Summary of the most important expected impacts

- The main expected impact of the Kunda-Loviisa shipping line is the improvement of the operating environment of the industry in the hinterland of the Port of Kunda.
- The direct and indirect employment impact is estimated to be 35-70 jobs creating tax income of 40 000 - 80 000 euros for local municipalities.
- Most of the industrial companies affected by the opening of the route see savings in transport costs and transport time as the main benefit for them.
- The movement of car/bus passengers would increase the tourism from Finland to north-eastern Estonia. This would promote more active use of the regional tourism potential and the diversification of labour market.
- There would be some job creation in and around Kunda town due to the development of industrial area beside the port and companies serving tourism and transport. The opportunities for residents to work on site would improve.
- No significant negative environmental impact associated with the opening of the shipping line is expected. Kunda's attractiveness as a place to live would be rather increasing.

- Viru-Nigula municipality is already contributing to the expansion of the port's activities through development planning.
- Facilitation of labour force commuting from Estonia to Finland is expected to be one of the important effects of opening of the shipping line.
- It is expected that opening of the Kunda-Loviisa line contributes positively to the image of Kunda and supports its internationalization.

8 SUMMARY AND CONCLUSIONS

This report was made as a part of the project Reinforcing Eastern Finland – Estonia Transport corridor (REFEC) funded mainly from the Interreg Central Baltic programme of the European Union. The REFEC project aims specifically activating the transport corridor by supporting the establishment of the Loviisa-Kunda roro ferry line.

The aim of the study was to analyze the impact of the foreseen Loviisa-Kunda ferry connection which would in practise activate the Eastern Finland – Eastern Estonia transport corridor. The specific focus was on the impacts on mileage, travel time and costs of cargo transports. The changes to travel distances affect the fuel consumption which consequently affects CO_2 emissions. CO_2 emissions were calculated for different ferry routes. Besides emissions, the impact to congestion in Helsinki and Tallinn was estimated. Finally, the socio-economic impact was evaluated. The impact of the foreseen ferry route for jobs and turnover was estimated, and for the different aspects of regional development in the Loviisa and Kunda regions.

The data for physical distances and transportation times between the major towns in REFEC corridor and ports of Loviisa and Kunda, and the ports having currently roro connection over the Gulf of Finland was collected with Google Maps. Some transport routes needed to be manually corrected since Google Maps does not provide heavy traffic routes that often differ for the most direct car routes. Furthermore, comparison was made between different weekdays (Tuesday and Thursday) and arrival times (9, 12 and 16 o'clock) to the port to select most appropriate time for further elaboration. There was not much difference between the two weekdays. As for the hour, a two-fold variation was observed. Firstly, there were variation between travel times on different hours (9/12/16), and secondly, variation between the provided minimum and maximum travel times. Eventually, arrival by 9.00 to the port and maximum travel time provided by Google Maps was selected for closer analysis since it provided largest variation. Transportation time was also calculated with the distance and average speed (km/h) to allow comparison with Google Maps results. The data collection method proved to be feasible although laborious. The produced data was used in mileage, travel time and travel cost calculations.

The comparison of mileages from REFEC area towns between Finland and Estonia expectedly shows that Loviisa-Kunda ferry would provide shorter mileage (km) compared to the existing ferry services. The aggregate distance between REFEC area major towns in Finland and Estonia via Loviisa-Kunda is 30%-85% shorter compared to other port connections. As for travel time, including ferry travel, the Loviisa-Kunda route's relative advantage narrows but it is faster than other alternatives. The very southeastern Finland cargoes would get the best advantage of the foreseen new ferry connection.

The majority of eastern Finland transports crossing the Gulf of Finland transit Estonia southwards. This formed basis for another impact calculation. The mileage and time difference between the routes emerge from legs between Pärnu and Finnish REFEC area towns where different port connections make the difference. In Pärnu different routes converge. As for

mileage, shorter mileage of REFEC towns to port of Loviisa is set off by longer mileage from the port of Kunda to Pärnu. As a result, Loviisa-Kunda, West-Harbour-Old city and Vuosaari-Muuga have about the same mileage whereas Hanko-Paldiski route has clearly longer trip. The travel time follows approximately the same model as the mileage. West-Harbour has longer driving times (due to slower urban driving in Helsinki), besides Hanko, but this is compensated with a faster ferry trip compared to other port-to-port connections.

The examples from REFEC area towns to two Central European cities (Warsaw and Vienna) for mileage were calculated. The relative differences in mileages in case of Warsaw were within 5% and for Vienna within less than 2% besides for Hanko-Paldiski route where they were understandably somewhat larger. On this basis, Loviisa-Kunda seems a competitive alternative between Central Europe and Finnish REFEC area transportations.

The cost calculation of the trips was based on the Finnish Transport Agency guidance on calculating the benefits of the transport infrastructure projects. The mileage and time cost components were included in the calculation. The costs were calculated for the freight potential within the REFEC corridor. The annual number of trucks (around 1 100) was further allocated to individual town-to-town trips based on previous research[96]. The aggregate costs for the whole volume via different ports were compared. The Loviisa-Kunda connection would save about 100 000 euros (nearly 24%) in transport costs annually compared to the next lowest routing alternative.

A similar exercise was made for trips from Finnish REFEC area to Pärnu for a volume of 20 000 trucks which was estimated as the lower end of Loviisa-Kunda route cargo potential. The aggregate cost of Loviisa-Kunda route was almost the same as in West Harbour-Old City and Vuosaari-Muuga route (having 99% and 97% of costs respectively). Hanko-Paldiski route was clearly more expensive. Although the Loviisa-Kunda route in general was slightly more expensive it, however, provided lowest cost for trips from Kouvola, Lappeenranta and Joensuu.

The calculations on trip costs between different port options indicate that Loviisa-Kunda route is in general a competitive alternative of transports between eastern Finland and northeastern Estonia, as well as for Central Europe and beyond. However, many components affect the eventual cost in real life like the cost of ferry ticket, the cost structure of the transport company (age of fleet etc.), the actual ferry schedules (calculations used averages), how driver's previous driving time and ferry schedule match with the driving and rest time regulation, thus affecting the aggregate travel time just to name few examples.

The CO_2 emissions are very much in line with the distance of origins and destination. The emissions consist of road and sea components where the longer sea voyage in Loviisa-Kunda is compensated by shorter mileage to these two ports. Transports in eastern area of REFEC

[96] Helminen, R., Alhosalo, M. & Suursoo, K. (2018). Freight potential of eastern Finland – eastern Estonia transport corridor. Publications of the Centre For Maritime Studies of Brahea Centre at the University of Turku A 74.

corridor via Loviisa-Kunda have less CO_2 emissions than the other port alternatives. Transports from Finnish REFEC area towns to Pärnu via Loviisa-Kunda emit more CO_2 than via Vuosaari-Muuga or West Harbour-Old City (on average 11% and 7% respectively) but less than via Hanko-Paldiski (5%). If the vessel emissions are calculated with a vessel type which has lower emission level the Lovisa-Kunda gap to the nearest alternative routes would narrow since it has the longest sea leg.

A major share of heavy traffic in centres of Helsinki and Tallinn is port related truck traffic. The activation of Loviisa-Kunda ferry service would re-route around 6-12% of the Helsinki-Tallinn ferry related truck traffic away from in the centres of Helsinki and Tallinn. However, the new ferry connection would not solve the port related heavy traffic issue but would ease the traffic flow in capitals especially if the decrease would fall on rush hours. Furthermore, new connection would also slightly decrease ferry related car traffic.

The Finnish transport strategies or maritime spatial plans include no indication of the foreseen new ferry connection while the Estonian strategy documents (spatial and maritime spatial plans) on national, regional and local level have been explicitly included port of Kunda having a ferry connection to Finland. The Finnish approach is to include new connections to the planning documents only when the operation of ferry route has reached decision level.

The socio-economic impacts of the new ferry line consist of estimations on new employment, generated turnover in port activities and local taxes, and other presumable qualitative impacts to regional development in Loviisa and Kunda regions. The latter impacts were mainly derived from the stakeholder interviews.

Finland

In Loviisa and its surroundings, the ferry line would generate 25-37 direct and indirect jobs in logistics sector and turnover of around 2 million euros in the port. Furthermore, there would be indirect employment impact in other sectors which was not estimated in this study. Moreover, local municipalities would gain about 170 000 - 250 000 euros in taxes.

The ferry line was seen as a positive signal to the economic actors and improve the attractiveness of the eastern Uusimaa region for new investments even by companies who would not use the ferry service. Ferry connection would probably increase interest to the industrial lots of Loviisa. The main beneficiary of the new ferry connection would be manufacturing and logistics sectors. Tourism and related services would also benefit to some extent. The new ferry line and new companies would support the vitality of the whole port community leading to a cluster type development which would create mutual benefits in the area.

Negative impacts (emissions, noise, dust, traffic safety etc.) to the environment were not expected since the overall traffic between Finland and Estonia would not increase due to the ferry connection. On the contrary, it would somewhat ease the congestion in Helsinki and Tallinn.

The hinterland connections (road and rail) to Loviisa are on good level – no remarkable improvements are expected if the ferry connection starts. The ferry connection would impact the Uusimaa transport strategy which currently do not note the possibility of the new connection.

The ferry connection would increase accessibility with respective regions in many levels. Some new cooperation project would probably arise in private and public sector if the ferry line is realized.

Estonia

In Kunda and its surroundings, the ferry line would generate 25-50 direct and indirect jobs in logistics sector and turnover of around 2 million euros in the port. Furthermore, there would be indirect employment impact in other sectors which was not estimated in this study. Moreover, local municipalities would gain about 40 000 - 80 000 euros revenues in taxes.

The main impact of the ferry line would be the improvement of the operating environment for the manufacturing industry in eastern and southern Estonia, and especially in Kunda. The ferry line would improve the supply chain of the industry. The local companies would save in transport costs. Furthermore, a new ferry line would improve access of smaller Estonian construction companies to Finnish market. The ferry would also improve the access to Finnish labour market. Finnish investments are expected to increase in northeastern Estonia if the ferry service starts to operate.

The movement of cars and bus passengers would increase the tourism from Finland to north-eastern Estonia. This would promote more active use of the regional tourism potential and the diversification of labour market. Finns would also probably buy or rent houses and apartments in the area. The stakeholders do not expect any negative environmental impact, on the contrary, Kunda would be more attractive place to live.

Estonian planning documents on national, regional and local level foresee already the future ferry line. The stakeholder expect the local cooperation across the Gulf of Finland to increase. In general, the opening of the Kunda-Loviisa line would contribute positively to the image of Kunda and supports its internationalization.

In conclusion, the activation of eastern Finland and Estonia transport corridor by initiating a ferry connection would provide many positive impacts in the target area. Furthermore, the ferry connection would probably benefit transports also outside the defined transport corridor. In Estonia, the transports of Tartu, Võru, Valga and Otepää, and in Finland the industries of the Helsinki region and southern Finland would supposedly use the Loviisa-Kunda ferry.

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APPENDICES

Appendix 1. Mileage and travel times between towns.

Distance in km (measured in GoogleMaps)

Finland	Loviisa	West Harbour	Vuosaari	Hanko
Kouvola	69	151	126	264
Lahti	88	129	101	220
Lappeenranta	150	246	220	358
Mikkeli	177	245	224	340
Jyväskylä	249	285	263	379
Kuopio	338	406	377	501
Joensuu	382	456	434	550
Kajaani	505	575	545	669

Distance in km (measured in GoogleMaps)

Estonia	Kunda	Muuga	Old City	Paldiski North
Rakvere	28,1	91,4	100,0	153,0
Paide	107,0	101,0	95,1	133,0
Jõgeva	104,0	138,0	147,0	193,0
Kohtla-Järve	53,6	148,0	156,0	210,0
Narva	108,0	202,0	210,0	264,0
*Tartu**	*152,0*	*186,0*	*186,0*	*224,0*
*Võru**	*222,0*	*259,0*	*253,0*	*291,0*

**not included in the study*

Maximum transport time in minutes
Tue 24 February 2020, arrival at 9.00
(measured in GoogleMaps)

	Loviisa	West Harbour	Vuosaari	Hanko
Kouvola	70	170	110	220
Lahti	100	150	80	190
Lappeenranta	120	230	170	280
Mikkeli	160	230	170	270
Jyväskylä	210	260	200	300
Kuopio	270	340	280	390
Joensuu	290	380	320	430
Kajaani	390	460	400	510

Maximum transport time in minutes
Tue 24 February 2020, arrival at 9.00
(measured in GoogleMaps)

	Kunda	Muuga	Old City	Paldiski North
Rakvere	30	75	100	140
Paide	90	80	90	110
Jõgeva	90	110	130	160
Kohtla-Järve	45	120	140	170
Narva	90	160	180	210
*Tartu**	130	150	160	180
*Võru**	190	200	210	230

**not included in the study*

Distance between Estonian ports to Pärnu (Via Baltica and T5 junction)
(measured in GoogleMaps)

Kunda	Tallinn	Muuga	Paldiski
201	151	152	138

Appendix 2. List of interviewees.

FINLAND

Loviisa town	Jan D. Oker-Blom	Mayor
Posintra	Topi Haapanen	Director of regional development
Helsinki-Uusimaa Regional Council	Petri Suominen	Traffic planning manager
Port of Loviisa	Tiina Vepsäläinen	Managing director
Loviisa Forwarding and Stevedoring (LFS)	Martti Sajama	Project manager
Eastern Uusimaa Chamber of Commerce	Mauri Molander	Managing director
Loviisa town	Järvinen Lilian	Secretary of tourism
Finnish Sawmills Association	Kai Merivuori	Managing director
The Finnish Transport Infrastructure Agency (Väylä)	Jukka Peura	Transport system specialist
Uusimaa Centre for Economic Development, Transport and the Environment	Elisa Fagerström	Transport system specialist
Finnish Transport and Communications Agency (Traficom)	Marko Mäenpää	Transport system specialist
Visit Finland	Liisa Renfors	Development specialist

ESTONIA

Association of Estonian International Road Carriers	Lauri Lusti	Head of TIR department
Bauroc AS	Andres Kalvik	Marketing Director
Birger OÜ	Aleksei Männiste	CEO
Estonian Plywood OÜ	Ando Jukk	Managing Director
Foundation Lääne-Viru Development Centre	Heli Eigi	Member of Management Board
Foundation Museums of Virumaa	Viljar Visse	Member of Management Board
Kunda Nordic Tsement AS	Meelis Einstein	Managing Director
Lajos AS	Erko Vallbaum	CEO
Lammasmäe Puhkekeskus OÜ	Meelis Parijõgi	Member of Management Board
Ministry of Economic Affairs and Communications	Katrin Andre	Head of Maritime Division
OÜ Avena Nordic Grain	Malle Valdur	Logistician
Union of Lääne-Viru Municipalities	Sven Hõbemägi	Managing Director
Viking-Windows AS	Tanel Kookmaa	Sales Director
Viru-Nigula Rural Municipality	Einar Vallbaum	Mayor
Viru-Nigula Rural Municipality	Eve Ojala Bakradze	Development Manager
Repo Vabrikud AS	Sven Paist	Commercial Manager
Scanola Baltic AS	Jarmo Randmaa	Logistics Manager
Toila Sanatoorium AS	Anneli Põdra	Head of Sales Department

Appendix 3. Interview topics - Likely impacts of opening of the Kunda-Loviisa ferry connection

1. What are the impacts on business in the Port of Kunda and on development of the industrial estate near the port: for example, on employment, investments, nature of products and services (synergies / conflicts), competitiveness of companies, activities of existing and potential new companies (e.g. logistics center)?

2. What are the impacts on business in the production and transport companies of REFEC region (in Estonia or Finland) for example, on employment, investments, competitiveness of companies, activities of existing and potential new companies? Attention is especially focused on companies exporting to Estonia/Finland.

3. What are the impacts on the business and esteem of the region in the other business sectors of the four counties? Employment and investments in catering, accommodation, trade, tourism, leisure services, etc., especially in the town (of Kunda/Viru-Nigula or Loviisa). Do they affect the educational preparation of the population for coping in the labor market?

4. What are the impacts on the living environment: road safety, noise, air pollution, the impacts of waves on the coastal area, etc.?

5. What are the impacts on land use and use of mineral resources: changes in real estate prices, land use planning (incl. development of residential areas) etc.

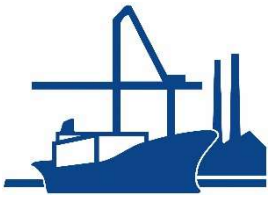
6. What are the impacts on public sector activities: adjustment of development plans, investments in improving the living environment, tourism and recreation, technical infrastructure (roads, railways), etc.?

7. What are the impacts of improved accessibility and closer regional communication between Estonia and Finland: e.g. migration, visits and commuting to the neighboring country, business relations, better market access, tourism, joint cross-border public services (e.g. maritime rescue, environmental services), cultural ties, common cultural heritage resuscitation (“friend trade”, etc.)?

8. What are the most likely impacts you mentioned over the next 10 years? Name up to 3-5 impacts. Which of the impacts you mentioned are the strongest in 10 years' time? Name up to 3-5 impacts.

Appendix 4. Calculation of municipal tax sum.

Gross Salary	1 472	Estonian average, IV quarter 2019, Statistics Estonia (2020). Wages and salaries.
12 months	17 664	
Tax free payments for funded pension (II pillar) and unemployment insurance (employee), together 3,6%	636	
Annual tax free amount	4 187	If income higher than 14 400 euros, tax free share is calculated with the following formula: 6000 – 6000 / 10 800 × (person's income – 14 400)
Income Tax 20%	2 568	See also e.g. calculator https://www.calkoo.com/en/salary-calculator
From that to local government 11,96 percentage points	1 536	
25 employees	38 396	
50 employees	76 792	



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