Social analysis - final

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Executive Summary

The present report is deliverable D7.8, Social analysis-final, in the context of WP7, Cost benefit analysis, and specifically Task 7.4, Social analysis. It is an evolution of an earlier, preliminary report on the social analysis, report which the present document supersedes. It is also the continuation of the work done in Task 7.1, Identification of KPIs, and presented in deliverable D7.2 (Report on KPIs) [1]. Task 7.4 runs parallel to Tasks 7.2 and 7.3, which are the economic analysis and the environmental analysis, respectively. All three use cases, A, B, and C are covered in this report.

It should be noted that although a maximum effort has been given to collect reliable data in this analysis, many related data proved impossible to acquire. In fact, the nature of the social analysis is such that much of the data for the analysis would become available only after the implementation of the AEGIS system. These indicatively include data on safety, security, resilience and recovery from cyber-attacks. In the absence of such data, many parts of the social analysis are by necessity inconclusive.

Despite these difficulties, in general we can conjecture that with the implementation of the AEGIS system, and mainly by moving some of the European road freight traffic to AEGIS vessels, we will see a reduction in road accidents and fatalities, for which we have attempted to make some quantitative estimates. This is, we believe, a significant social benefit that can be ascribed to AEGIS.

The results of the social analysis also show that the implementation of the AEGIS does not make a significant change in the unemployment of personnel. In fact, the AEGIS system is expected to create some higher paying jobs, for personnel tasked to be employed in the AEGIS control centre and in other positions. We provide estimates of the wages of such personnel.

Definitions and abbreviations

AG: Advisory Group

CBA: Cost-Benefit Analysis

CEMT: European Conference of Ministers of Transport

EU: European Union

FEU: Forty-foot Equivalent Unit

IWW: Inland Water Way

KPI: Key Performance Indicator

LoLo: Lift-on Lift-off

RoRo: Roll-on Roll-off

SAR: Search and Rescue

SOLAS: Safety of Life at Sea

SSS: Short Sea Shipping

STCW: Standards of Training, Certification and Watchkeeping

TEU: Twenty-foot Equivalent Unit

THC: Terminal Handling Costs

UC: Use Case

WP: Work Package

1 Purpose and structure of this report

Whatever solutions are contemplated in AEGIS, it is imperative to assess them holistically so as to capture the effects of all conceivable cross-linkages and interdependencies and hopefully obtain what we call "win-win" solutions. For that purpose, the main objectives of Work Package 7 (WP7) are to:

- Define Key Performance Indicators (KPIs) to do a quantitative Cost-Benefit Analysis (CBA)
- Perform analyses of economic, environmental, and social effects of AEGIS proposals
- Combine to overall CBA, covering all three factors, and compare it with today's solutions
- Identify "win-win" solutions that give the best overall benefits at the lowest possible cost

The present report is deliverable D7.8, Social analysis - final. It is the context of Task 7.4 (social analysis) and is an evolution of an earlier, preliminary report on the economic analysis, report which the present document supersedes. It is also the continuation of the work done in Task 7.1, Identification of KPIs, and presented in deliverable D7.2 (Report on KPIs) [1]. Task 7.4 (social analysis) runs parallel to Tasks 7.2 and 7.3, which are the economic analysis and the environmental analysis, respectively. All three use cases, A, B, and C are covered in this report.

The rest of this document is organized as follows. Section 2 presents and describes each of the three AEGIS use cases which serve to conduct the CBA. Section 3 presents the methodology for the evaluation of the social KPIs. Section 4 presents the results of the CBA for the three use cases, and Section 5 presents the conclusions. Finally, Annex A shows the data templates circulated to the AEGIS partners.

A clarifying note is due on other AEGIS deliverables, some of which are cited in this report. Some of these deliverables are classified as "public", hence the reader of this deliverable (which is also public) will have full access to them. For those AEGIS deliverables that are classified as "confidential", a public executive summary will be available, which will also be accessible to the reader of this deliverable.

2 Description of the three use cases

The three AEGIS use cases serve here to compute the predefined KPIs, which represent the criteria under which the set of solutions developed under AEGIS will be evaluated and carry out the cost-benefit analysis (CBA) to assess any solutions further contemplated in AEGIS. The three use cases, including their scenarios and base cases, are presented and described in this section.

An important note is that all three scenarios of use cases (baseline and AEGIS) were continuously evolving during the course of this analysis. The same can be said regarding the data for these scenarios. This section describes the use cases, and associated data, as these were known at the time of the analysis.

A related note is that the degree of completeness of the associated data in the three use cases is by no means uniform as regards the availability of data in these scenarios for the purposes of WP7. Some use cases are more developed than others use cases. In cases data to compute some KPIs were missing, some assumptions and approximations were made, and these are stated in this report.

2.1 Use Case A

This section heavily draws from deliverable D8.2 (Transport system specification– Case A) [2].

Use Case A (UCA) covers transport from the large port of Rotterdam to smaller destinations along a less populated coast of Norway. It will focus on short sea and rural terminals mainly based on a LoLo service. The objectives of UCA are depicted in Figure 1.

The results from the initial cargo volume analysis presented in deliverable D8.1 (Cargo Volume Analysis – Case A) [3] indicate a potential for implementing the AEGIS concepts. Trends that will be important to follow, such as it seems like the volume of 45-feet containers are increasing compared to 40 feet, which again will pose requirements to the vessel design and cargo handling equipment, have been identified. This report points to some of those trends. Based on the results from the logistics studies, the concept has estimated available cargo from the Trondheimsfjord region. The calculations in the report are based on volumes from existing transport routes from the west coast of Norway to the Netherlands, with data from statistics, previous projects, port statistics, and direct input from transporters and cargo owners. The container transport to international regions outside Europe, 60 - 70 % of NCL's international cargo, is mainly carried out by shipping to the big European ports, such as Rotterdam, where it is transshipped to deep-sea vessels. Hence, the NCL sailings are vulnerable to delays in the deep-sea sailing schedules. On average, eight vessels sail out of Rotterdam to the west coast of Norway weekly. The average capacity for the fleet is estimated to be about 750 TEUs per vessel, hence a total weekly capacity of about 6,000 TEUs. The cargo volume for bigger terminals is quite stable, but it varies significantly for the smaller ports. The Trøndelag region in Norway can be served on a weekly basis and include Rørvik and the inner ports of the fjords if introducing feeder lines, such as daughter vessels.

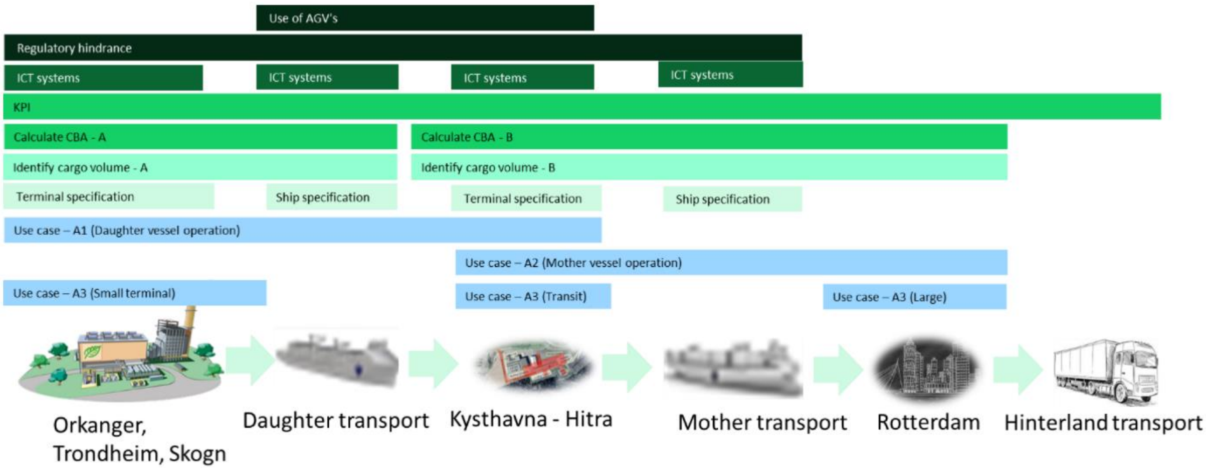


Figure 1: UCA objectives and transport systems (source: Deliverable D8.2 (Transport system specification– Case A) [2].)

According to the cargo analysis carried out in deliverable D8.1 (Cargo Volume Analysis – Case A) [3] has defined two scenarios:

1. The transport between Rotterdam (The Netherlands) and Hitra Kysthavn, Sandstad (Norway). Seen in Figure 1 as region 1.
2. The transport within the Trondheimsfjorden region (Norway). Seen in Figure 2 as region 2.

Figure 2: Use Case A, International and domestic trade.

Furthermore, the use case A transport system will, as indicated in Figure 1 and deliverable D8.2 (Transport system specification– Case A) [2], consist of mother and daughter vessels exchanging cargo at a transshipment terminal and be divided into three segments, A1, A2, and A3:

A1: Transport within the Trondheimsfjorden region, Norway

A2: The transport between Rotterdam, Netherlands, and Hitra Kysthavn (Sandstad), Norway

A3: The terminal activities at the port of Hitra Kysthavn (and Orkanger, Trondheim, Skogn), Norway

The AEGIS concept requires a different operating method than today's practice. The idea behind the concept is to have one or several mother vessels sailing between Rotterdam and Norway with large cargo volumes and a higher level of automation to achieve benefits due to economy of scale. When the mother vessels travel along the west coast of Norway, a number of daughters can accommodate the transport of cargo between a set of regional ports and the mother vessel. In this project, we will focus on the Trondheimsfjord, but the concept can be adapted to other parts of the further route south on the west coast of Norway down to Rotterdam, as well as other regions worldwide. There are several reasons for introducing the mother–daughter concept. The distance between Rotterdam and the Trondheimsfjord and further north will not allow operation by only one vessel with a fixed, regular weekly schedule. The distance is significant, about 800 nm between Rotterdam and Trondheim, which is estimated to be more than two days of sailing one way with a speed of 15 knots. The average loading speed of containers is 30 per hour. The distance from Hitra to Trondheim is 48 nm, which means it takes an extra three hours to sail the distance, and to Skogn, it will be about 72 extra nm which means 5 hours extra sailing time with a speed of 15 knots in one direction out of Hitra. This means that the utilization of a mother will be much better if the cargo can be picked up in Hitra, at the same time as it will take too long time to visit smaller and remote ports to pick up a small number of containers.

Additional to the sailing and cargo handling time, we should also consider mooring time, which will be significant. A roundtrip between Hitra Kysthavn and Skogn via Orkanger and Trondheim takes 16 hours at a speed of 12 knots. Mooring, loading, and discharging time will come on top of this. The daily operational cost of a mother is higher than for a daughter, as a larger vessel consumes more energy (among other things). A daughter vessel will be significantly smaller and allowed to operate at a lower speed, which reduces energy consumption. The daughter vessel will not have the same time constraints as the mother, as it only operates within the fjord and transports cargo between the local ports in the region. In the studies, we are also simulating the possibility of having more than one daughter in operation.

A mother vessel must operate with a higher speed due to time and transport constraints with respect to requirements in Rotterdam, such as reaching the deep-sea schedules. Another factor is that some of the smaller ports are too small for a mother vessel, and the quay capacities or infrastructure cannot allow port calls by a bigger vessel. To secure a successful transport system with a mother and daughter vessel, cargo transshipment must be efficient, cost control, and optimized. This requires an efficient transshipment terminal that can provide services for both mothers and daughters, and not least to the cargo owners.

In the rest of this section, the baseline scenario and AEGIS scenario for mother and daughter ships will be explained. Finally, the specification of new ships for both scenarios will be introduced.

2.1.1 Mother vessel case

The mother vessel route is defined as the existing NCL route from Rotterdam along the Norwegian coastline and finally ends in Orkanger, which visits many ports (up to 22). As baseline, Use Case A uses existing vessels operated by NCL for studies regarding continental transport, region 1 in Figure 2. These are LoLo vessels with a capacity of around 800 TEUs. On the other hand, for this use case, In the AEGIS scenario, the focus is on the limited part of the existing route: Rotterdam – Hitra Kysthavn, as illustrated in Figure 3. The route is 800 nm, and with an average sailing speed of 15 knots, it will take 53.4 hours. The distance from Hitra Kysthavn to Orkanger is 48 nm, and an average sailing speed of 15 knots takes 3.2 hours. If the mother vessel can drop the sailing to Orkanger, it can save around 6.5 hours of sailing. The total saved time can be significant if the mother-daughter concept is implemented in several regions of the coast, resulting in either shorter turnover time for the route or the possibility of sailing further north for more cargo.

Figure 3: The mother ship route (only Rotterdam - Hitra Kysthavn).

The mother vessel use case (A2) is listed in Table 1. It should be noted that in the AEGIS scenario the vessel fleet will consist of four ships, two new concept vessels, and two of the existing (NCL) vessels. On the other hand, the non-AEGIS scenario consists of four NCL vessels that voyage during the week between the route mentioned.

Table 1: Scenario Rotterdam – Hitra Kysthavn (mother vessel).

Element	Description
Scenario title	Rotterdam – Hitra Kysthavn
Distance and sailing time	Rotterdam – Hitra Kysthavn: 800 nm, average sailing speed: 15 knots Sailing time: 800 nm /15 knots = 53.4 hours
Cargo Type (containerized)	Abrasive grain Silicon carbide Hydrogen Peroxide Wastepaper General cargo Paper, silicone, alloys for the foundry industry, carbon and micro silica.
Transport Requirements	Container vessel, LoLo, with own cranes (two), used at Norwegian terminals (in this case, Hitra Kysthavn) Terminals/quays • No cranes or other container handling equipment in Norwegian terminals • For port of Rotterdam, shipboard cranes cannot be used Dependent on deep-sea schedule for carriers out of Rotterdam

2.1.2 Daughter vessel case

The scenario is shown in Figure 4 and is a route that serves the terminals with the biggest cargo volume potential in the Trondheimsfjord. The route goes from Hitra Kysthavn via Orkanger and Trondheim and completes its journey in Skogn. The transport distance is about 100 nm one way. The daughter vessel can serve the mother vessel(s) with cargo originating from ports in the region and, of course, supply the ports in the area with cargo from the mother vessel(s). If, for instance, containers from rail transport are unloaded in Trondheim or Skogn, the containers can be transported by the daughter's vessel to Hitra Kysthavn, where they will be further transported by the mother vessel.

Figure 4: Skog n Trondheim Orkanger Hitra Kysthavn (incl. Holla), map and route from Logistics Analysis tool.

The route in Figure 4 has been further divided into four different routes, as shown in Figures 5 to 8.

It is anticipated that some of the smaller terminals along the route will have to offer self-service, which means that the daughter vessel autonomy level must enable moving a container from the quayside onto the vessel without human involvement at the quayside. It is therefore necessary with a geared daughter vessel that can handle containers at any terminal in the fjord.

In summary, the fleet and corresponding routes have been chosen as follows for the AEGIS scenario:

1. 2 vessels with a capacity of 60 TEUs
2. Daughter vessel 1 sailing route 2 and 3 with corresponding cargo volume
3. Daughter vessel 2 sailing route 1 and 4 (to Orkanger and Holla from Hitra Kysthavn)
4. Sailing speeds: 8 knots for vessel 1 and 5 knots for vessel 2
5. Frequency of sailings: Twice a week for vessel one and three times a week for vessel 2

Figure 5: Route 1: Hitra Kysthavn – Orkanger- Hitra Kysthavn.

Figure 6: Route 2: Hitra Kysthavn – Orkanger – Trondheim – Skogn- Hitra Kysthavn.

Figure 7: Route 3: Hitra Kysthavn – Trondheim - Skogn- Hitra Kysthavn.

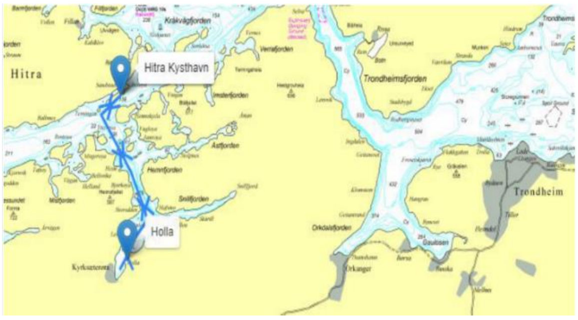


Figure 8: Route 4: Hitra Kysthavn – Holla- Hitra Kysthavn.

It should be mentioned that the baseline scenario in this case (region 2 in Figure 2) is trucks that serve the region today. Based on deliverable D8.2 (Transport system specification– Case A) [2], the (round trip) distance for these four routes in both scenarios is addressed in Table 2.

Table 2: Distances for the daughter case (sea and road).

Number of routes	AEGIS (vessels)	Baseline (trucks)
Route 1	96 nm	138 km
Route 2	183 nm	368 km
Route 3	162 nm	361 km
Route 4	28 nm	154 km

2.1.3 Ships specification

In WP4 (Green advanced vessels), low-energy, low-emission, and logistics-adapted advanced vessel concepts are investigated and developed with the aim of enabling more efficient and green waterborne transport. Its most recent deliverable is D4.2 (Specification of vessel types for use cases) [4]. Its main objective is the development of advanced green vessel concepts which fulfill the requirements of the three different use cases. For the report state of concept development, several vessel types for each use case are presented in detail, for example, in propulsion specification and onboard handling systems.

The actual envisioned vessel concepts for Use Case A are presented in Tables 3 and 4. A mother-daughter concept was identified as a feasible solution for this use case. Hitra, an island outside the

Trondheim fjord, was chosen as the hub for the transshipment between the mother and the daughter vessels.

For the mother vessels, we considered a new short-sea shipping from Rotterdam to the Trondheim region with a capacity of approx. 1100 TEU. Also, the propulsion system of this conceptual ship would be a hybrid of methanol and battery (the main fuel is methanol).

For the daughter vessel in use case A, we considered a self-propelled (fully electric) shuttle with a capacity of approx. 60 TEU. For this case we have two ships that can run inside the Trondheim fjord, collecting cargo at different smaller ports or industry sites.

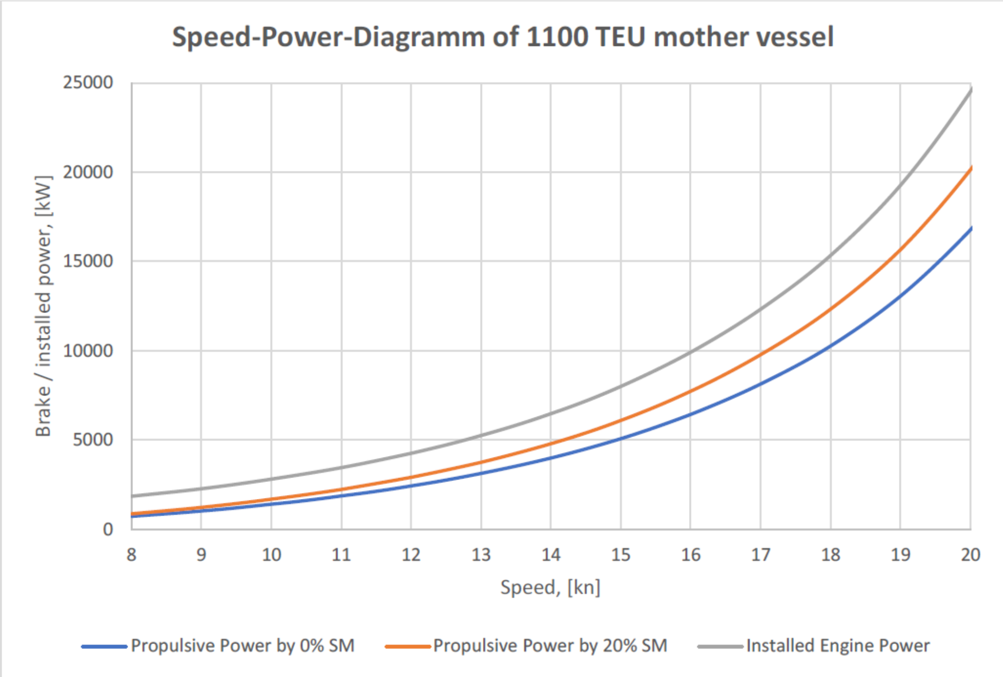
Table 3: Use Case A mother vessels.

Data	Mother Vessel
Vessel Description	1100 TEU Container Ship, incl. places for 20, 40, 45 foot and reefer containers
Vessel Type	Container SSS vessel
Route deployed in	Rotterdam - Hitra
Length Overall, Loa	143.90 m
Length Waterline, Lwl	142.20 m
Length between perpendiculars, Lbp	133.20 m
Beam Overall, Boa	25.50 m
Beam Waterline, Bwl	25.50 m
Design Draft, T	8.16 m
Depth to main deck, D	14.10 m
Displacement	18,997 tonnes
Gross Tonnage	10,890 GT
Wetted Surface	4422.50 m^2
Waterplane Area	2797 m^2
Bulb Area	15.40m^2
Half Entrance Angle	19.76°
Stern Type Coefficient	-25
Main Engine Type	Methanol combustion engine (“methanol ready”) and battery support for Norwegian Fjords
Main Engine Fuel Type	Methanol and battery
Design Speed	15 knots
Vessel capacity	1100 TEU
Cargo Handling Equipment	2 triple-joint cranes (CT/MCG), reach 32m and SWL of 45t
Autonomy Level	Medium autonomy level (2)

Table 4: Use Case A daughter vessels.

Data	Daughter Vessel
Vessel Description	60 TEU, incl. places for 20, 40 feet containers
Vessel Type	Container vessel for TA1-2, maybe up to TA3
Route deployed in	Daughter 1: Hitra Kysthavn – Orkanger – Trondheim – Skogn & Kysthavn – Trondheim - Skogn Daughter 2: Hitra Kysthavn – Orkanger & Hitra Kysthavn – Holla
Length Overall, Loa	65.00 m
Length Waterline, Lwl	65.00 m
Length between perpendiculars, Lbp	62.70 m
Beam Overall, Boa	11.45 m
Beam Waterline, Bwl	11.45 m
Design Draft, T	2.20 m
Depth to main deck, D	5.00 m
Displacement	1,270 tonnes
Gross Tonnage	895 GT
Wetted Surface	843 m^2
Waterplane Area	670 m^2
Half Entrance Angle	30.8°
Stern Type Coefficient	-22
Main Engine Type	Fully electric
Main Engine Fuel Type	Battery
Design Speed	Daughter 1: 8 knots Daughter 2: 5 knots
Vessel capacity	60 TEU
Cargo Handling Equipment	On-board Reach Stacker (placed on lift + ramp)
Autonomy Level	High autonomy level (3-4)

Furthermore, based on information provided by ISE, the speed-power diagram for the mother and daughter vessels is shown in Figures 9 and 10, respectively.



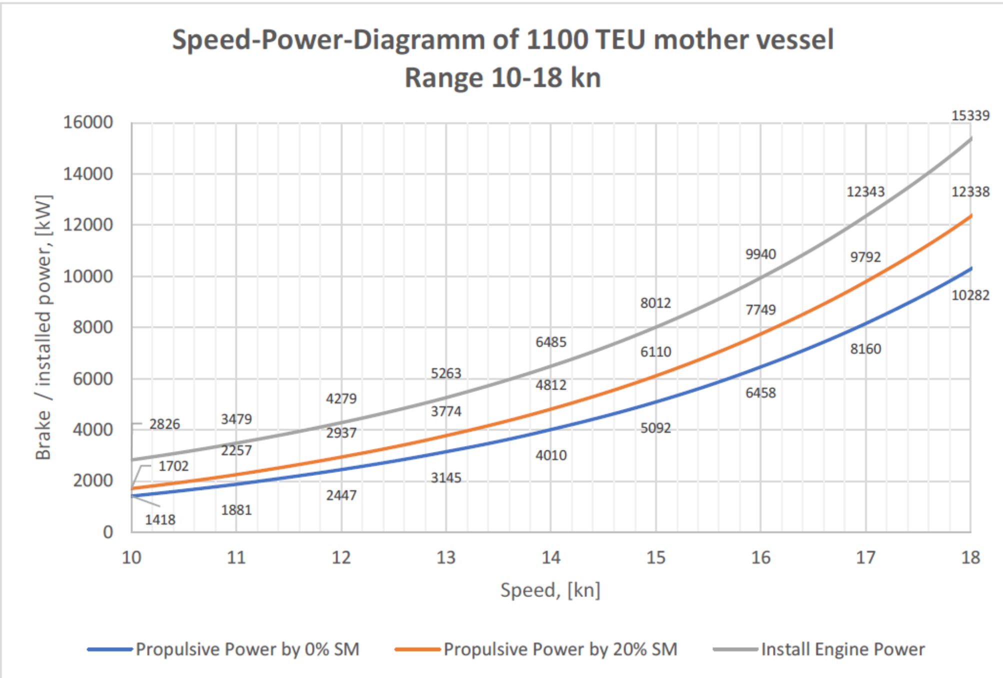


Figure 9: Use Case A, speed-power diagram of mother vessel. Source: ISE.

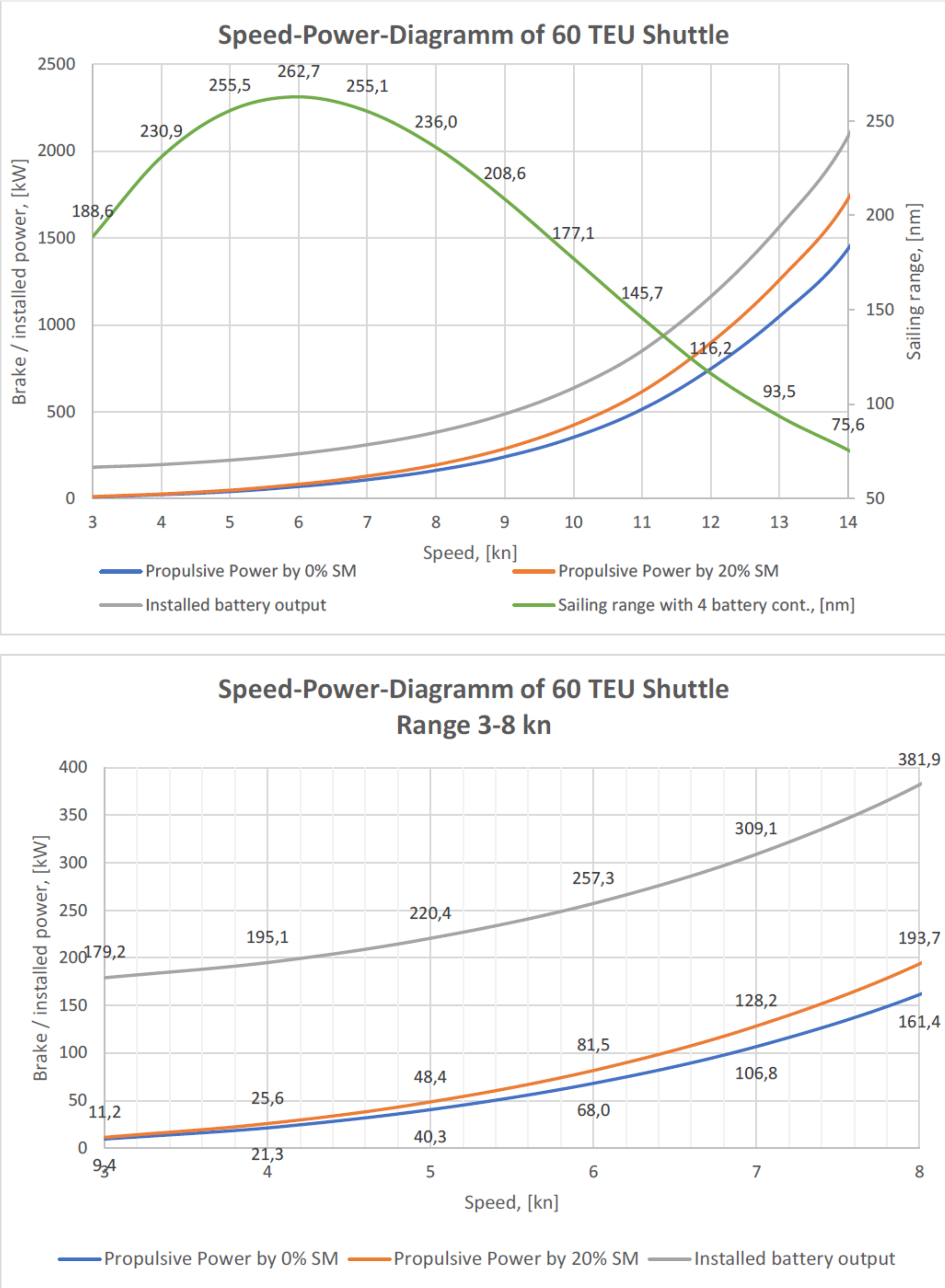


Figure 10: Use Case A, speed-power diagram of daughter vessel. Source: ISE.

2.2 Use Case B

Use Case B examines Belgium and Netherlands's short sea and inland interface. The two countries are significant hubs for cargo transportation from and to Europe. Rotterdam, located in the Netherlands, is the largest port in Europe and one of the largest ports in the world, with shipping lines established to all corners of the globe. Everything from dry bulk to liquid bulk, containers, and breakbulk, in which category one finds RoRo cargo, is passing through the port, constituting a total of 436,800,000 tonnes of cargo in 2020. The second busiest European port is Antwerp, in Belgium. Furthermore, the port of Ghent is part of the so-called North Sea Port – a conglomeration of Vlissingen, Terneuzen, and Ghent (see Figure 11). Consequently, the port extends over 60 kilometers, 9.100 hectares (ha), across two countries: Belgium and the Netherlands. It is ranked number 9 of all European seaports measured in the volume of goods and number 6 of seaports in the Hamburg – Le Havre range also measured in the volume of goods. Freight transportation through the inland waterways is already well developed, but there is still space for more cargo to be distributed via waterways. This region is ideal for the purposes of AEGIS, and this is why it was chosen for this Use Case B.

Figure 11: The ports within North Sea Port (Source: Deliverable D9.1 (Analysis of transport needs – Case B) [5]).

In summary, the objectives of UCB are to:

- Apply and validate the results from WPs 2-7 into use-case B, which examines the short sea and inland interface in Belgium and Netherlands, with partner DFDS being involved as a WP leader. The area under examination involves the ports of Rotterdam, Antwerp, Ghent, and Zeebrugge.
- Use the above results to bring cargo as close to the end destination as possible with small vessels with zero emission propulsion (battery, fuel cells, etc.).
- Address possible administrative and regulatory challenges and bottlenecks that should be tackled for efficient and environment-friendly solutions.

The main objective of the transport system for use case B is to shift cargo from the road to an inland waterway barge service, as illustrated in Figure 12. With this goal in mind, the transport system for use case B was understood as an interaction of advanced inland navigation vessels serving two specific flows in the region of Belgium and the Netherlands, of routes within these flows, of the ports along these routes, and of the transshipment from vessel to port.

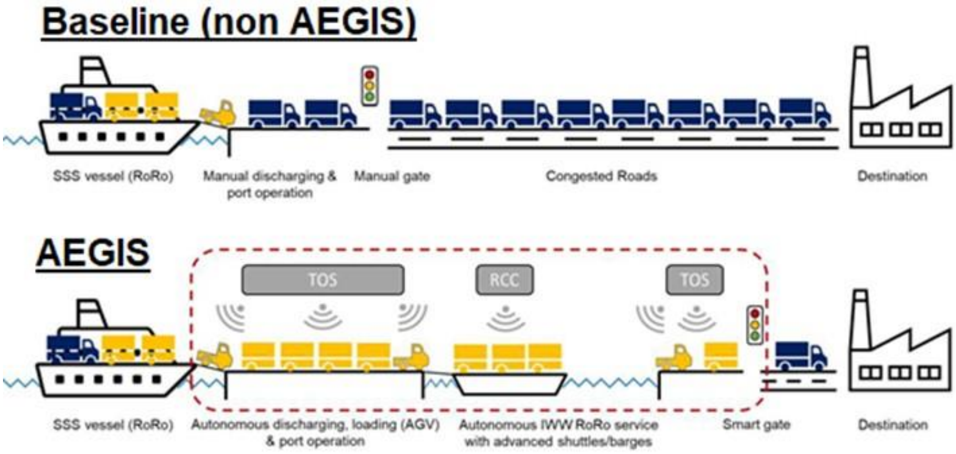


Figure 12: Baseline vs AEGIS scenarios. Source: DFDS.

Use case B involves two scenarios (Figure 12):

a) The baseline (non-AEGIS) scenario, which involves shipping cargo from Ghent to Rotterdam (and vice versa) by truck.
b) The AEGIS scenario, in which cargo is moved from Ghent to Rotterdam (and vice versa) via a canal onboard an AEGIS vessel (Figure 13).

Figure 13: Rotterdam – Ghent route scenario for UCB

A main reason for selecting this route is because DFDS has terminals both in Rotterdam and Ghent – terminals which both are experiencing increasing cargo volumes and expansion projects in order to keep up with this cargo volume. Therefore, potentially redirecting cargo between the terminals into the short sea shipping, especially from Rotterdam to Ghent, would help alleviate these issues and could potentially have a broader, positive influence on the general flow overseas of cargo in and out of the terminals.

2.2.1 Ships specification

The envisioned vessel concepts for Use Case B are presented in Table 5. RoRo vessel concepts, i.e. for trucks, trailers, or other "rollable" cargo units, of the CEMT class VI concept w/transversal loading (double deck) was developed for this use case. It was tried to keep the draught as low as possible (in the range of 4.5 m) to be able to sail even on low water levels during summer periods. For CEMT class IV+, a transversal loading of trucks or trailers can be realized. Therefore, a RoRo concept with a capacity of 69 trucks/trailers was designed with a resulting vessel breadth of 18.1 and 15 m for trucks and trailers, respectively.

Table 5: Use Case B vessel

Data	Vessel
Vessel Description	IWW CEMT Class VI
Vessel Type	RoRo IWW vessel
Route deployed in	Rotterdam - Ghent
Length Overall, Loa	139.20 m
Length Waterline, Lwl	125.50 m
Length between perpendiculars, Lbp	124.30 m
Beam Overall, Boa	15.00 m
Beam Waterline, Bwl	15.00 m
Design Draft, T	4.50 m
Depth to main deck, D	9.35 m
Displacement	6,716 tonnes
Gross Tonnage	4,630 GT
Wetted Surface	2,569 m^2
Waterplane Area	1794 m^2
Half Entrance Angle	43.60°
Stern Type Coefficient	-23
Main Engine Type	Fully electric, swappable batteries
Main Engine Fuel Type	battery
Design Speed	7- 8 knots
Vessel capacity	69 trailers/trucks (incl. 2–3 battery trailers/containers)
Cargo Handling Equipment	Lift and ramp; optional AGV (if only trailer)
Autonomy Level	high autonomy level (3-4)

Furthermore, based on information provided by ISE, the speed-power diagram for the vessel is shown in Figure 14.

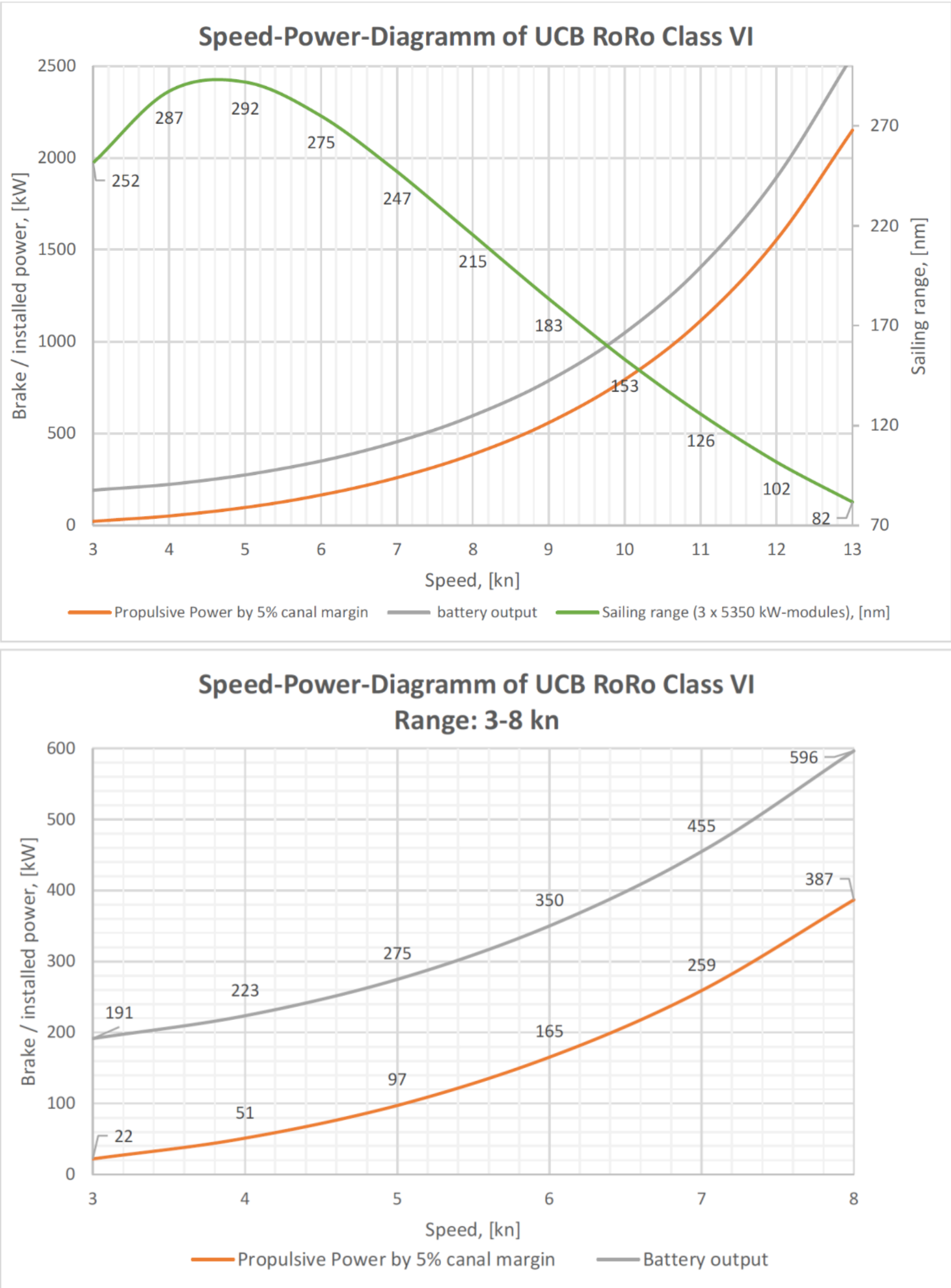


Figure 14: Use Case B, speed-power diagram of CEMT class VI vessel. Source: ISE.

2.3 Use Case C

Use Case C examines cargo traffic in the areas around Vordingborg and Aalborg and looks at possibilities to increase the use of waterborne transport by increasing automation of cargo handling and some types of ships. It will also look at possibilities for restructuring the terminal network and also increase inbound and outbound transport to the rest of Europe, in particular, Germany and possibly the Baltic states.

The objectives of UCC are to:

- To validate outputs from WPs 2-7 in two Danish ports, the Port of Vordingborg and the Port of Aalborg.
- To use the ports of Vordingborg and Aalborg as practical test sites for the application of the technical developments of AEGIS in redesigning logistic systems, developing new terminal concepts, applying automatic cargo handling, and improving digital connectivity.
- To use the ports of Vordingborg and Aalborg to address regulatory challenges and constraints to enhance new waterborne logistics solutions.

In the first Use Case C deliverable, D10.1 (Potential transfer from road transport to short-sea-shipping in Denmark) [6], the potential gross volume that can be shifted from road transport to short-sea shipping in Denmark, categorized by different goods types, was examined. This encompasses analyses of the price structure for transportation of the goods by both road transport and short-sea shipping, including an analysis of last mile delivery. The report analyses all relevant goods in Denmark, including national and international goods. To have a comparable price structure baseline, it was found that any road transport would need to be more than 150 km in order for a shift to short-sea shipping to be economically viable. This included a last-mile analysis. For national goods, emphasis is put on the region of Northern Jutland as well as the Capital Region and Zealand, due to the case focus of the ports of Aalborg and Vordingborg, as well as the distance between these regions. Approximately 1 million tonnes of goods are transported to/from Northern Jutland (mostly of relevance to Port of Aalborg) and Zealand (mostly of relevance to Port of Vordingborg). Applying a scenario-based analysis, it was estimated that 177,540 tonnes of national goods, covered by 9,899 truck movements, could be shifted to sea yearly in Denmark.

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

Deliverable D10.2 (SWOT analysis for Port of Vordingborg and Aalborg) [7] conducted a SWOT analysis for the Port of Aalborg and the Port of Vordingborg. The report concluded that Port of Aalborg has a strong financial position compared to the closest competitors. This provides great long-term opportunities to invest in new, autonomous port solutions. Short-term, it can be expected that the closest geographical competitors (the Port of Hirtshals and the Port of Frederikshavn) on RoRo would have a solid counter-reaction for a potential RoRo route. However, due to the CAPEX bindings of these two ports, it is assessed that the Port of Aalborg would have better long-term maneuverability for RoRo and overall terminal investments. Furthermore, the Port of Vordingborg has recently undergone vast development, including a large port expansion. This provides great opportunities yet simultaneously gives financial constraints in terms of investment capacity in the coming years. Possible short-term solutions would be to capitalize on goods that can be overtaken by decommissioned ports in the vicinity and carefully analyze a “virtual terminal» concept for possible RoRo activities.

After several discussions with the partners of this project and examination of several scenarios, the following scenarios for both ports were considered.

For Aalborg:

a) The baseline (non-AEGIS) scenario involves shipping cargo from the port of Gothenburg to the port of Hamburg (and vice versa) by truck. Specifically, this route consists of Gothenburg to Malmö, Malmö to Copenhagen, and Copenhagen to Hamburg and would be around 644 km.

b) In the AEGIS scenario, cargo is moved from the port of Gothenburg to the port of Aalborg (and vice versa) via an AEGIS vessel and then from the port of Aalborg to the port of Hamburg by trucks. The distance of the sea route is 160 km, and the land-based route is nearly 458 km.

For Vordingborg:

a) The baseline (non-AEGIS) scenario involves shipping cargo from the port of Vordingborg to the port of Rostock in Poland by ships and then from the port of Rostock to the port of Elblag in Poland (and vice versa) by trucks. The distance of the sea route is around 49 km, and the land-based route is 750 km.

b) In the AEGIS scenario, cargo is moved from the port of Vordingborg to the port of Elbląg (and vice versa) via an AEGIS vessel (the one specified for use case C- Vordingborg scenario). The distance of the route is 573 km.

2.3.1 Ships specification

According to deliverable D4.2 (Logistics analysis tool initial version) [4], the envisioned vessel concepts for Use Case C are presented in Tables 6 and 7. The diverse cargo and route options lead to the development of different vessel concepts for Use Case C. For the Aalborg case, a RoRo short-sea shipping vessel was studied using Use Case B synergies. A truck/trailer vessel can be adopted from a design for inland waterway conditions to be feasible for short-sea shipping between Denmark and South Sweden. As for use case B, a double-decker solution (combined with a lift system) is used to achieve a capacity of 50 – 60 trucks or trailers. For the Vordingborg case, a mixed container and bulk vessel concept with approx. 3500 tonnes were considered.

Table 6: Use Case C Aalborg case vessels.

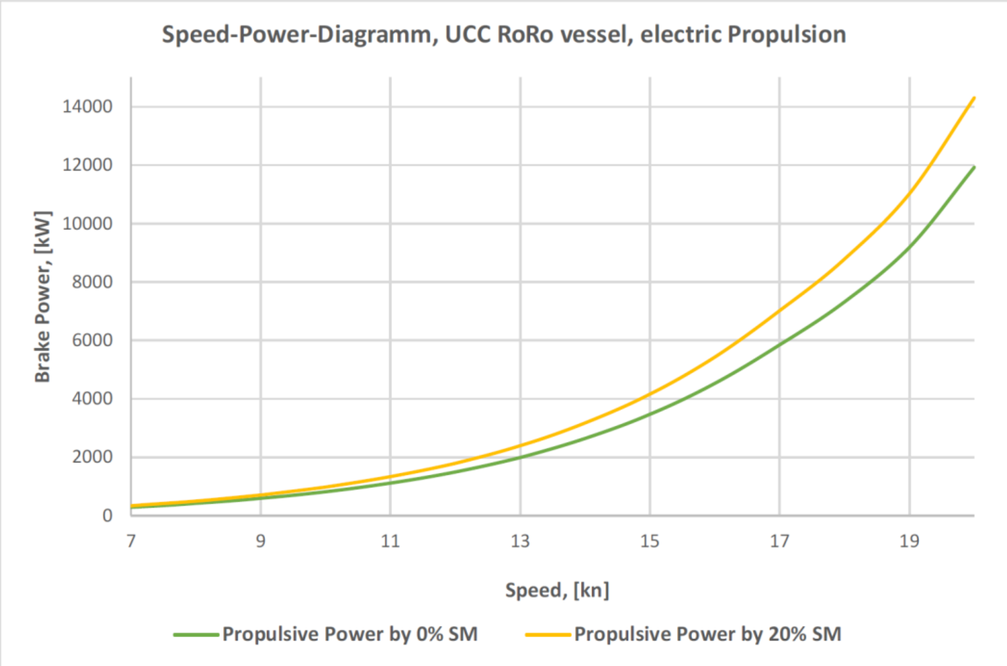
Data	Vessel
Vessel description	AHL-case: 55 units SSS RoRo vessel
Vessel Type	SSS RoRo
Route deployed in	Aalborg - Hamburg
Length Overall, Loa	127.47 m
Length Waterline, Lwl	127.42 m
Length between perpendiculars, Lbp	123.40 m
Beam Overall, Boa	16.90 m
Beam Waterline, Bwl	16.90 m
Design Draft, T	4.50 m
Depth to main deck, D	6.35 m

Displacement	8,394 tonnes
Gross Tonnage	5,700 GT
Wetted Surface	2876.21 m^2
Waterplane Area	1919.48 m^2
Half Entrance Angle	19.76°
Stern Type Coefficient	-25
Main Engine Type	Fully electric or Methanol propulsion system
Main Engine Fuel Type	Battery or Methanol
Design Speed	8 knots
Vessel capacity	55 trailers/trucks (37 main deck + 18 tank top)
Cargo Handling Equipment	Lift and ramp; optional AGV (if only trailer)
Autonomy Level	Medium autonomy level (2-3)

Table 7: Use Case C Vordingborg case vessels.

Data	Vessel
Vessel Name	VH-case: Combined SSS/IWW LoLo concepts for bulk & containers
Vessel Type	SSS/IWW LoLo
Route deployed in	Vordingborg - Elbląg
Length (max)	99.00 m
Breadth	15.00 m
Design Draft, T	3.90 m
Max airdraft	9.10 m
Main Engine Type	Methanol propulsion system
Main Engine Fuel Type	Methanol
Design Speed	10 knots
Vessel capacity	3500 tonnes (170 containers)
Cargo Handling Equipment	crane
Autonomy Level	2

Furthermore, based on information provided by ISE, the speed-power diagram for the vessels of Aalborg case for battery and methanol are shown in 15 and 16, respectively. For the Vordingborg case this is shown in Figure 17.



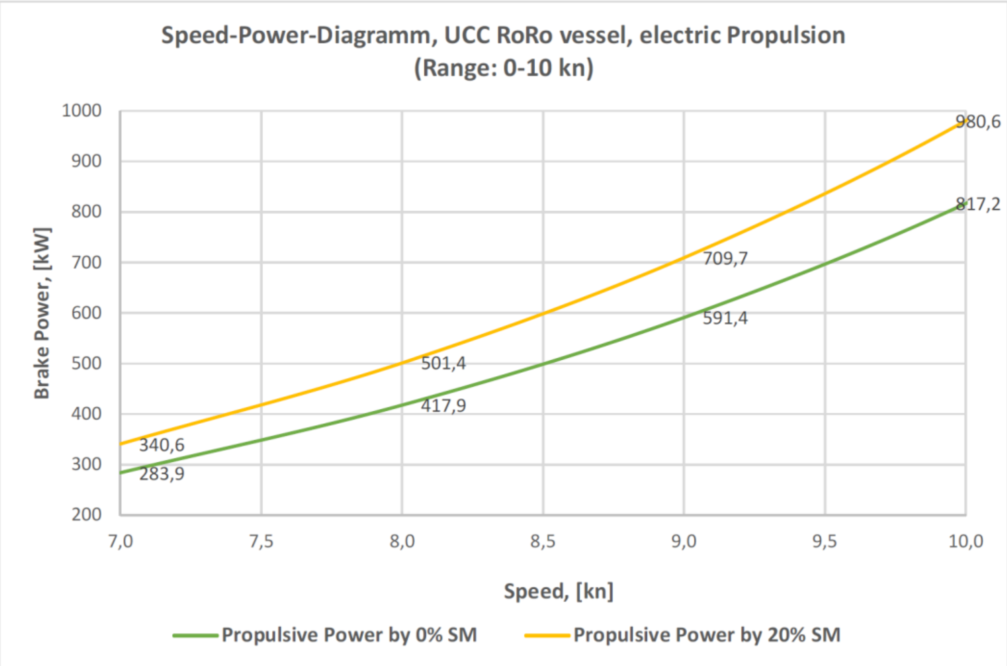


Figure 15: Use Case C, speed-power diagram of Aalborg case vessels (Electric system). Source: ISE.

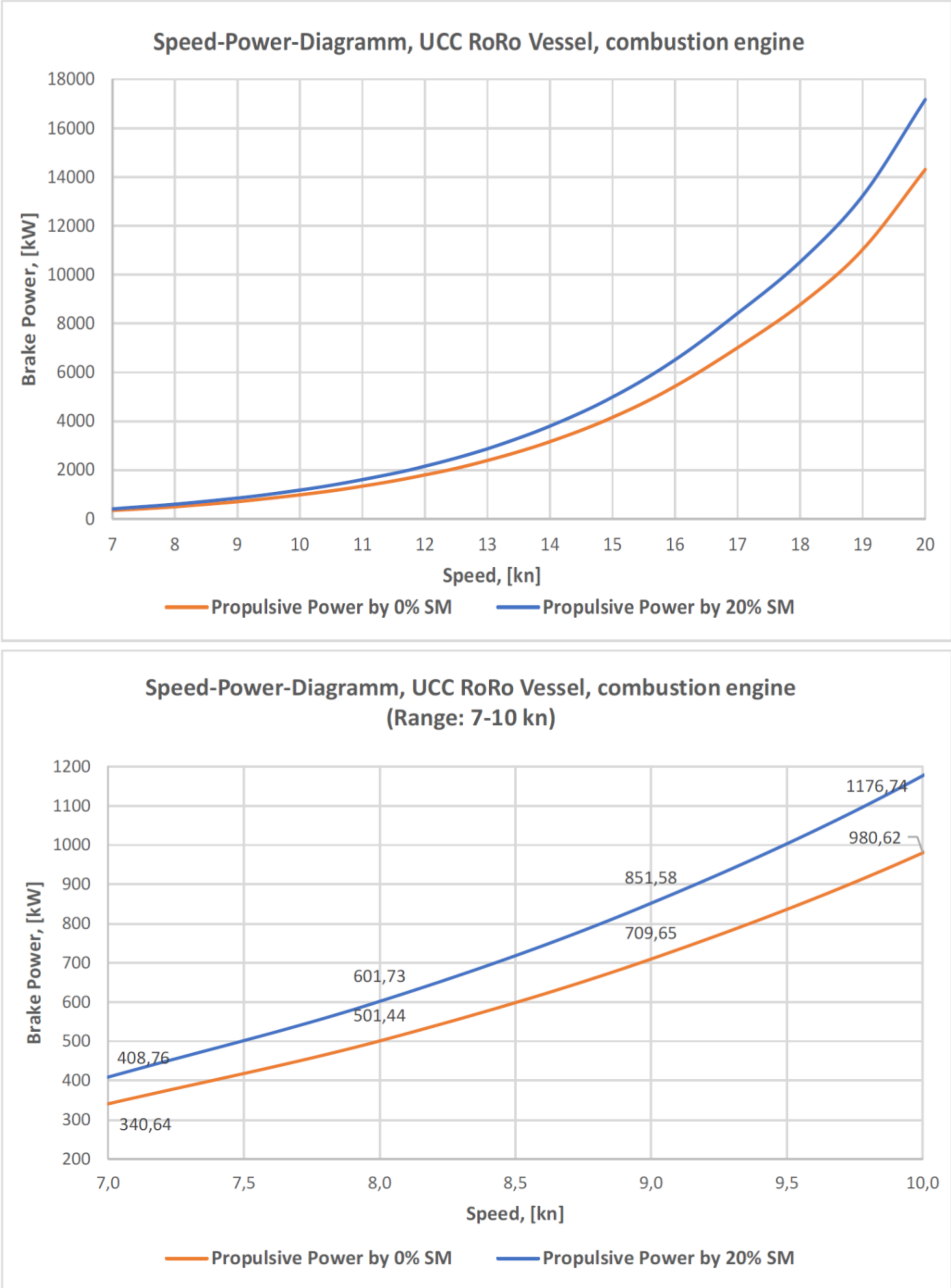


Figure 16: Use Case C, speed-power diagram of Aalborg case vessels (Methanol system). Source: ISE.

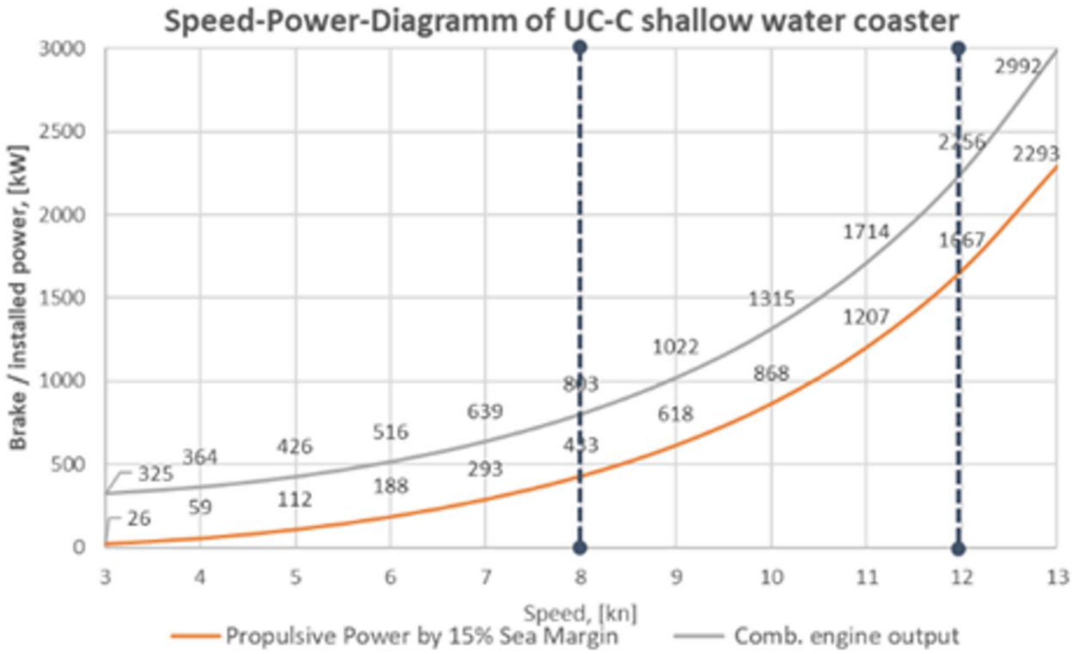


Figure 17: Use Case C, speed-power diagram of Vordingborg case vessel. Source: ISE.

3 Methodology: evaluation of social KPIs

3.1 Preamble

The purpose of this section is to present the methodology for evaluating social KPIs. The methodology describes how the data assembled for each use case scenario are used to perform the economic CBA and assess the social KPIs.

It is to be understood that any such methodology has two main components or parts:

(a) A general part, which is more or less independent of the use case under consideration.

(b) A specific part, which depends on the use case under consideration.

The above distinction is important, as it is conceivable that the data that is assembled for each use case may ultimately influence and customize the method to conduct the CBA.

The rest of this section first presents how the social KPIs are calculated based on the data template input that we requested from AEGIS partners. We start by introducing the quantitative modelling framework and the equations that link data input with the required KPIs.

It should be noted that although a maximum effort has been given to collect reliable data in this analysis, many related data proved impossible to acquire. If this was true for the economic and for the environmental analysis, it is even more true for the social analysis. In fact, the nature of the social analysis is such that much of the data for the analysis would become available only after the implementation of the AEGIS system. These indicatively include data on safety, security, resilience and recovery from cyber-attacks. In the absence of such data, many parts of the social analysis are by necessity inconclusive.

3.2 General framework for the estimation of social KPIs

Deliverable D7.2 (Report on KPIs) [1] pertaining to the outcome of Task 7.1, presented the different KPIs for evaluating the AEGIS solutions and their comparison with existing transportation options. The process concerned several rounds of discussions, work between the consortium partners and Advisory Group (AG) members, and prioritization of retrieved KPIs. Table 8 is adapted from the above deliverable and presents the finalized social KPIs that we aim to analyze in this document. It is recalled that the above deliverable stated that these KPIs might be adjusted in the CBA, depending on the availability and quality of data.

Table 8: Social KPIs (adapted from Table 6 of D7.2: Report on KPIs [1]).

KPI Level	KPI Sublevel	KPI Name	KPI Unit	KPI Description
Social	Security /Safety	Accidents	#	Number of unfortunate incidents resulting in damage or injury
Social	Security /Safety	Fatalities	#	Number of occurrences of death by accident
Social	Security /Safety	Fire incidents	#	Number of incidents involving smoke, heat and flames causing damage

Social	Security /Safety	Crime	#	All actions which constitutes an offence and is punishable by law
Social	Work-life	Labor conditions	Work-life-balance	Quality of working environment
Social	Work-life	Employment	% of change	Influence on the occupational rate
Social	Work-life	Income	% of change	Influence on earnings
Social	Work-life	Worker commuting time	Distance ship-home	Total journey employees take from home to work and back again
Social	Work-life	Training	Time/worker	Time invested in teaching an employee a particular working skill
Social	Others	Traffic	# TEU/port call	Amount of goods transported in ports/terminals
Social	Others	Citizen complaints	#	Total number of society protests against some of the AEGIS proposals' activities
Social	Others	Area used for port operations	m^2	Total amount of surface needed to operate AEGIS solutions successfully

3.3 Data templates

Unlike the case with the economic KPIs and the environmental KPIs, social KPIs are not linked with the fuel consumption data and information on the actual energy sources powering the vessels. In addition, it is currently impossible to estimate the number of potential accidents, fatalities, cyber-attacks (crime KPI) or fire incidents before the AEGIS solutions have been rolled out for a sufficient timeframe. Therefore, and in a strict sense, in order to estimate many of the social KPIs values, it is necessary to implement the solution and observe the relevant data. The data template that was circulated to the three use case leaders (for reference, see Annex A) also contained some data fields relevant to social KPIs. A snapshot of the template is shown in Figure 18, where we highlight (in yellow) the data input necessary for calculating social KPIs. Annex A presents the full data template.

At the same time, data on salaries of personnel used in the AEGIS control centre, which are part of the analysis of the present report, are aligned with similar data in the economic analysis report.

Data	Units	ENTER INPUT HERE	COMMENT
Name of port/terminal	Name		
Number of berths	#		
Storage capacity	TEUs, LMs		
Shore cargo handling equipment (if any): name	Name		
Shore cargo handling equipment; number	#		
Cargo handling rate (per cargo handling unit)	TEUs/hour, LM/hour		
People on shore needed to operate cargo handling equipment	#		
Other people on shore needed for operation	#		
Number of successful Cyber-Attacks per Year	#/year	no data available yet	
Number of intended Cyber-Attacks per Year	#/year	no data available yet	
Recovery Time due to Crime (cyber-attack…) from detection to recovery	hours		
Restored Level of Performance after a Cyber-Attack	% of Original Level of Performance		
Education Level Employees Needed	No Degree/BSc/MSc/PhD	no data available yet	
Maximum Noise Emitted Vessel + Port	dB		
Use of Renewable Energy Sources of the total Energy Required	%		
Accident Rate	#/year	no data available yet	
Fatality Rate	#/year	no data available yet	
Fire Incidents	#/year	no data available yet	
Crime (thefts, piracy…)	#/year	no data available yet	
Training time per worker	hours/worker	no data available yet	

Figure 18: The data template circulated to the AEGIS use case leaders.

3.4 Mapping KPIs in terms of use case relevance and context

The complete list of social KPIs, as seen in Table 8, should be seen as generic for the overall AEGIS project. Some of the KPIs may be more or less relevant for each use case, depending on the overall objective of the use case and the involved stakeholders (and potential decision makers). In addition, the required input data needed to calculate each KPI may not be available in all use cases. This is because we are working with concepts and not actual operations. The latter is most evident when assessing the "to-be solutions" but also for the various "as-is solutions". A lack of reliable and valid input data may pose a challenge. Figure 19 shows this procedure.

In section 4, where the KPIs are applied to each use case, we present the final list of KPIs that are relevant and obtainable for the specific use case.

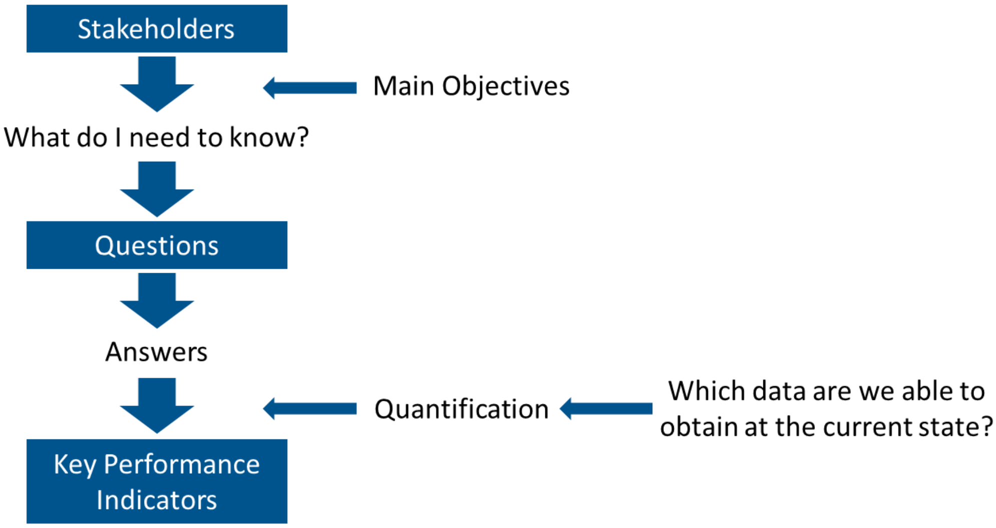


Figure 19: Mapping KPIs in terms of use case relevance and context.

3.5 KPIs calculation

As shown in Figure 18, part of the critical input data for computing the social KPIs is related to the number of staff required for the different tasks at the port during loading and unloading operations and to cybersecurity issues that might arise during the operation of the AEGIS vessels. The last sub-category of social KPIs requires data on the number of incidents and accidents occurring annually. Once this information is collected during the first years of operation of the system, it will be possible to obtain a better understanding of the impacts of the AEGIS solution compared to the business-as-usual case.

An additional clarification is in order here, with respect to the assessment of safety-related KPIs. Whereas a variety of statistics is available on road accidents and fatalities in Europe (and elsewhere), nothing much is available in terms of data on possible incidents, accidents and fatalities for the AEGIS system, as the system is new and yet to be implemented. This makes the quantitative determination of the risk (probability and consequences) associated with an AEGIS system inherently difficult. There exist methodologies such as IMO's Formal Safety Assessment (FSA) to assess such risk, even from first principles [8]. In addition, AEGIS WP5 (Digital Connectivity and Cybersecurity) has developed comprehensive related methodologies for assessing risk for the AEGIS system. However, no actual projected estimates of accidents or fatalities, or of other consequences of unwanted events of the AEGIS systems have been made.

A related point concerns the safety level (accidents, fatalities, etc) *of other vessels* once the AEGIS system is implemented. For instance, the master and crew of conventional vessels has the obligation to provide assistance to ships in distress and to humans who may be missing at sea, in the context of the SOLAS and SAR conventions of the IMO[1]. How that obligation can be implemented if the ship to provide the assistance is unmanned is not entirely clear. At a minimum, it is subject to regulatory reformulation and might also necessitate technical guidelines that would make such an assistance possible. This is also outside the scope of this document.

[1] SOLAS: Safety of Life at Sea. SAR: Search and Rescue.

4 Application of social KPIs on Use Cases

4.1 Preamble

In this section we attempt to quantitatively and qualitatively explain what we would expect with the transition from conventional transport options to the AEGIS proposed solutions for each use case.

Although AEGIS also focuses on promoting better efficiency and environmental shipping practices, which overall benefit the quality of life for workers and coastal city residents, the most contentious issue from a societal impact perspective is the introduction of "advanced" technologies, namely digitalization and automation of navigation and of port operations. Automation would eventually result in negative social externalities, namely *"offloading the costs of redundant workers on public unemployment or social security schemes, together with tax revenues from employment foregone"* [9]. The reduction of dock work and the automation of less intensive work may, for example, undermine intergenerational solidarity and cause social conflict. On the other hand, that same source also points to the fact that positive externalities associated with port innovation (e.g., lower emissions and smaller spatial footprints) are not linked to automation per se but rather to electrification. Thus, from a societal KPI perspective, it is proposed that ex-ante assessment of the implementation of AEGIS concepts considers broader societal costs, namely the transition of the workforce to new types of occupation and how it impacts social security expenses, in case of redundancies, and tax revenues foregone, when port workers are replaced by machines [9]. Such an assessment is, however, outside the scope of the AEGIS project.

The above is to be counter-balanced by the fact that the AEGIS system will also create some jobs, direct or indirect, that are, by the nature of the knowledge and technical expertise required, higher paid and thus more desirable from a social perspective than the jobs lost because of AEGIS.

Autonomous or remotely controlled vessels and cargo handling equipment at ports will definitely decrease hand-operated/manual operations. Removing the human factor can result in safer operations due to the minimization of the risk of human errors, as well as by simply moving the operations away from humans that could be injured during these procedures. In waterborne transportation, the IMO (2018) [10] estimates that around 80% of accidents in the sea can be attributed to the human factor. Human errors that can result in incidents and/or accidents cannot be entirely eliminated but only be reduced through improved procedures planning. Thus, with a transition to unmanned shuttles (and potentially cargo handling equipment), these operations would have no casualties.

Wróbel et al. (2017) [11] also discuss the potential limitations of autonomous ships. For example, there are several occasions during accidents or incidents when seafarers can prevent navigation accidents or react in a timely manner to ongoing events and can shift their focus to protect the vessel, the cargo, and the safety of humans. These recovery actions must also be carefully examined, and reliable control systems must be developed for autonomous ships to secure safety in the event of an incident. At the same time, shifting towards autonomous vessels will result in a negative social impact, with some jobs (mainly seafarers and potentially stevedoring staff) being lost due to the lack of need for humans. Moreover, the European Commission (Directorate-General for Mobility and Transport) published 2020 a study entitled "Social aspects within the maritime transport sector" [12]. This study includes an item on the effects of "digitalization and automation." It was found that the IMO STCW convention[2] is not

[2] STCW: Standards fpr Training, Certification and Watchkeeping (of Seafarers).

tackling the latest technologies and high levels of automation already being used today in some vessels. Training seafarers to the minimum requirements of STCW is deemed not to be the right approach in the view of experts on maritime education. The conclusions point to the need for training for novel technologies and a better transition from sea to shore.

As already noted in a previous EU-funded research project*, "the main challenge for the transportation sector is whether it can attract new employees, as well as equip the existing ones with the required skills required for meeting the needs of the already occurring or emerging changes"* [13]. In the case of maritime transport, the challenge will be to ensure that the workforce necessary to sustain the transition from road to sea is available, namely people equipped with digital skills to operate vessels and terminals remotely. One crucial variable in this is the potential for night operations and how this may be perceived differently by different generations and workers from various sectors.

More autonomy in the maritime sector would also introduce new areas of concern, particularly cybersecurity, since autonomous ships might be more prone to cyberattacks. Therefore, operators must be ready to counter these attacks to ensure that their vessels would not be hacked. Piracy might also be a factor, although manned vessels may be more prone to these types of attacks due to the obligation to ensure the safety of the crew onboard. In the event of a piracy attack on an autonomous vessel, there is no risk for the crew. In the aforementioned cases, some jobs might be created (cybersecurity roles), as well as more positions might be generated due to the emerging legal and insurance matters that will undoubtedly change with the new ships.

The next subsections attempt a preliminary discussion and evaluation of the social KPIs defined in deliverable D7.2 (Report on KPIs) [1], in the context of the three use cases.

4.2 Use Case A

The final list of relevant and obtainable KPIs for the specific UCA for the mother and daughter cases are presented in Table 9. This is the result of the Mapping of the KPIs in terms of use case relevance and context, as previously described. Also, the description of scenarios is explained in Section 3.4.

Table 9: Social KPIs for Use Case A (adapted from Table 6 of deliverable D7.2 (Report on KPIs) [1]).

KPI Level	KPI Sublevel	KPI Name	KPI Measurement	KPI Description
Social	Security /Safety	Accidents	#	Number of unfortunate incidents resulting in damage or injury
Social	Security /Safety	Fatalities	#	Number of occurrences of death by accident
Social	Security /Safety	Fire incidents	#	Number of incidents involving smoke, heat and flames causing damage
Social	Work-life	Income	Monthly	Influence on earnings
Social	Work-life	Training	Time/worker	Time invested in teaching an employee a particular working skill

In Table 9, in order to compute the number of accidents and fatalities a suitable "exposure variable" needs to be defined. More details are later in this section (equations 1 and 2). No data on fire incidents were available.

In the following, according to the routes explained in section 2.1, the results obtained in both scenarios (baseline and AEGIS) for the mother, daughters are respectively in Tables 10 and 11.

Table 10: Results of mother vessel in UCA.

<table>
<tr><th rowspan="3">KPI</th><th rowspan="3">KPI Name</th><th rowspan="3">KPI Measurement</th><th colspan="3">Result</th><th rowspan="3">Description</th></tr>
<tr><th colspan="2">AEGIS (Rotterdam-Hitra)</th><th rowspan="2">Baseline (Rotterdam-Orkanger)</th></tr>
<tr><th>New Vessel (Methanol + Battery)</th><th>NCL</th></tr>
<tr><td>Security /Safety</td><td>Accidents</td><td>#</td><td>Inconclusive</td><td>Inconclusive</td><td>Inconclusive</td><td>Per year</td></tr>
<tr><td>Security /Safety</td><td>Fatalities</td><td>#</td><td>Inconclusive</td><td>Inconclusive</td><td>Inconclusive</td><td>Per year</td></tr>
<tr><td>Security /Safety</td><td>Fire incidents</td><td>#</td><td>Inconclusive</td><td>Inconclusive</td><td>Inconclusive</td><td>Per year</td></tr>
<tr><td>Work-life</td><td>Income-operator of control centre or crew of vessel</td><td>Monthly- €</td><td>8,400</td><td colspan="2">3,600</td><td></td></tr>
<tr><td>Work-life</td><td>Training</td><td>Time/worker</td><td>No data</td><td>No data</td><td>No data</td><td>No data</td></tr>
</table>

By "inconclusive" in Table 10 and the rest of this document we mean that, due to the reasons outlined in Section 3.5, we are unable to provide a quantitative estimate of the specific KPIs. Our conjecture however, and this is based on our expert opinion, is that for these cases the AEGIS solution KPIs are probably lower than the non-AEGIS solution, baseline KPIs.

Inconclusive is also any estimate of the risk of the NCL baseline case, due to lack of related data. Again, our conjecture is that this likely to be low, as no accidents, incidents and fatalities have been reported.

Table 11: Result of daughter vessel in UCA.

KPI	KPI Name	KPI Measurement	Result		Description
			AEGIS	Baseline-Truck	
Security /Safety	***Accidents***	#	Inconclusive	34.35	Per year

Security /Safety	***Fatalities***	#	Inconclusive	0.04	Per year
Security /Safety	***Fire incidents***		Inconclusive	Inconclusive	
Work-life	***Income-operator of control centre or driver***	Monthly- Euro	8400	3750	For one operator of control centre and one driver
Work-life	***Training***	Time/worker		---	

The reasoning regarding the use of the word "inconclusive" in Table 11 is the same as before.

As described in section 2.1, this case study concerns the deployment of mother vessels (sailing from Rotterdam to Hitra Kysthavn) and daughter vessels that act as feeder services in the Norwegian Trondheimfjorden region, with Hitra Kystahvn as the hub port. The mother vessels would essentially absorb transport demand from existing services between the two ports with automated vessels (medium autonomy level-2) that do not call at other ports. The technical aspects of the vessels are shown in Tables 3 and 4.

It is expected that a control centre would be necessary to monitor the voyage of the AEGIS vessels (mother and daughters). It is not necessary to build the control centre near the ports, and it is anticipated that the control centre could be responsible for both mother and daughter vessels. At least six employees with a rotating schedule are necessary to operate that control room[3], and DFDS estimated that salary costs are estimated at around € 50,000 per month, which means it should be around € 8,400 per person per month.

We have also assumed that 15 crew members[4] are needed for the conventional container ships, with a yearly salary per person is 460,774 NOK (€ 41,900) in Norway[5] and € 44,600 in the Netherlands[6], which would be around € 3,600 per month on the average.

On the other hand, regarding staff working on the shore to facilitate cargo handling operations, the equipment to be used is cranes to unload each vessel. For each crane, it is expected that one member of staff is required to operate it. For the handling of mother and daughter vessels up to two cranes could potentially be required (to allow for a reasonable turnaround time).

[3] http://www.unmanned-ship.org/munin/wp-content/uploads/2015/09/MUNIN-D8-8-Final-Report-Shore-Control-Centre-CTH-final.pdf

[4] https://products.damen.com/-/media/products/images/clusters-groups/shipping/container-feeder/cfe-800/deliveries/container-feeder-800-johanna-schepers/damen_container_feeder_800_568309_johanna_schepersr.pdf?la=en&rev=dc1bf3c027a940f79dc4ebcfaded8706

[5] https://www.salaryexpert.com/salary/job/seaman-able/norway#:~:text=The%20average%20seaman%20able%20gross,and%20anonymous%20employees%20in%20Norway.

[6] https://www.salaryexpert.com/salary/job/seaman-able/netherlands#:~:text=The%20average%20seaman%20able%20gross,and%20anonymous%20employees%20in%20Norway.

This would not require the hiring of additional staff (at least at the hub ports), but it can be expected that at the feeder services (smaller ports in Trondheimfjorden), some new jobs would be created for this purpose. Similarly, as the mother services would not replace existing services, jobs would not be lost. The feeder services would result in some reductions in road transport, which can cause some drivers to become unemployed. In particular, the required number of drivers in this scenario will be reduced. But it is possible that due to the volume of cargo that exists in that geographical area, there is practically no noticeable reduction in the workload of truck drivers.

Also, according to the data obtained from SINTEF Ocean, the breakdown amount of the rental price of terminal personnel on the ports owned by the Trondheim Port Authorities (TPA) in 2023 based on the Norwegian Krone currency is shown in Table 12.

Table 12: The breakdown of monthly salary in Norway for the crew[7].

	Price	Supplement	Unit	Minimum price
Ordinary hourly wage	695 NOK		per hour	1 hour
Overtime 50%	1043 NOK	348 NOK	per hour	2 hours
Overtime 100%	1390 NOK	695 NOK	per hour	2 hours
Consultant work	1115 NOK		per hour	1 hour
Overtime meals are charged NOK 285 per person per meal.				

Also, as one can see in Table 11, the yearly salary for heavy truck driver per person in Norway is 491,660 NOK (€ 44,780), which would be around € 3,750 per month[8].

In terms of cyber security, the vessels would require additional support to prevent cyber-attacks. However, this would be part of the responsibility of the control centre. In general, the staff working at the control centre would need to have a higher education level (as compared to an ordinary seafarer) and receive some training in order to monitor operations effectively.

Some words are necessary on how appropriate figures are computed for accidents and fatalities for the road scenarios. In order to estimate such figures for the road scenarios examined in use case A, and as higher traffic volumes would generally exhibit higher absolute numbers for both accidents and fatalities, it was decided to normalize these figures by dividing by an appropriate "exposure variable", that being the corresponding transport work expressed in tonne-km's.

As a purely hypothetical example, if country X has recorded 1,000 road accidents in a year with a total of 20 billion tonne-km of national transport work in a year, and we want to project road accidents in an AEGIS baseline road case that has 0.5 billion tonne-km in a year in that country, the equivalent number for AEGIS is 1,000*(0.5/20)= 25 road accidents in a year. A similar rationale applies for road fatalities.

In general, heavy goods vehicles (HGVs) are involved in 4.5 % of European police-reported road crashes and 14.2 % of fatal road crashes [14]. On the other hand, based on the statistics of EU Transport in

[7] https://trondheimhavn.no/wp-content/uploads/2023/02/prisliste-2023-versjon-30.pdf
[8] https://www.erieri.com/salary/job/heavy-truck-driver/norway#:~:text=The%20average%20pay%20for%20a,NOK%20355%2C896%20and%20NOK%20589%2C392.

figures- statistical pocketbook in 2022 [15], the annual number of accidents on Norwegian roads in 2020 was 3,500, and the number of fatalities was 93[9]. Also, based on that report, the annual transportation volume from the road in Norway in 2020 was around 21.4 billion tonne-km. The annual transport work associated with the UCA scenario is calculated as 0.21 billion tonne-km. Hence, the share of heavy vehicles in Norwegian road accidents and fatalities (on an annual basis) is estimated in equations 1 and 2, respectively.

$$\boldsymbol{Accidents}: 3{,}500 * \frac{0.21\ billion}{21.4\ billion} = 34.35 \tag{1}$$

$$\boldsymbol{Fatalities}: 93 * \frac{0.21\ billion}{21.4\ billion} * 0.045 = 0.04 \tag{2}$$

It should be noted that the fraction equations represent the share of transportation volume that UCA is involved in. These equations are the normalized rates of accidents and fatality, which are calculated by dividing the annual volume transported in tonne-km in UCA (daughter cases) by the annual volume transported in tonne-km in the whole of Norway that would transport by road.

A comment we want to make concerns eq. (2), the number of expected annual fatalities. One can see that this number is very low (even less than 1), perhaps as a result of stringent road regulations in Norway, or because of other factors, some of which may be due to chance. As this number is low and also highly random (a single serious accident may change this number significantly), it is difficult to draw concrete conclusions from it. By contrast, the number of accidents (see eq. (1)) provides a better KPI in terms of risk evaluation. Similar observations can be made for the other use cases.

4.3 Use Case B

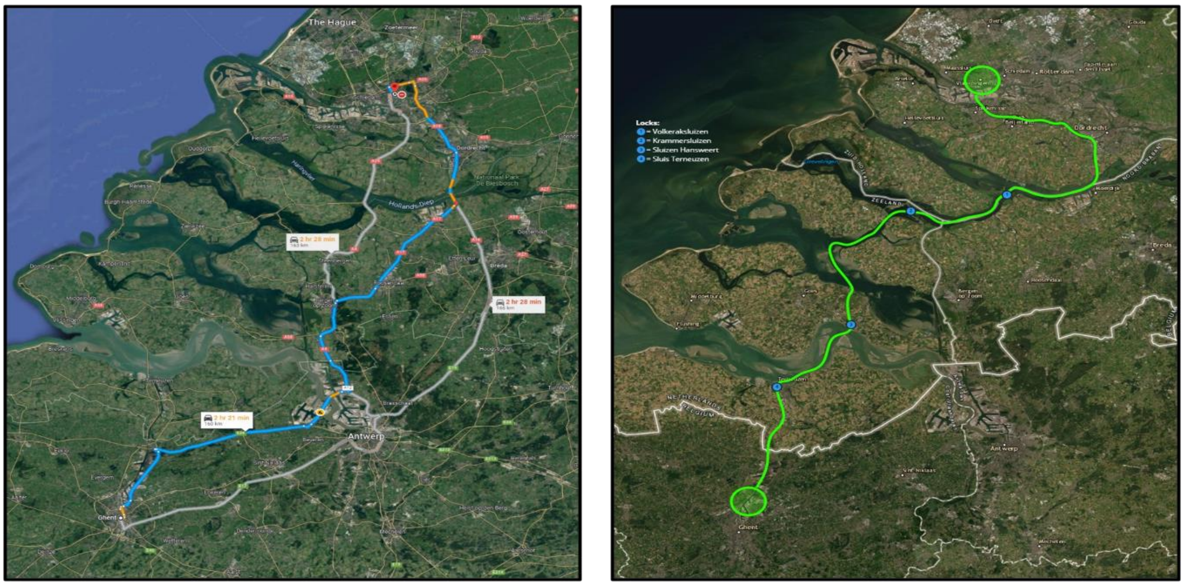
The final list of relevant and obtainable KPIs for the specific use case is presented in the following Table 13. This is the result of the Mapping of the KPIs in terms of use case relevance and context, as previously described in section 3.4.

Table 13: Social KPIs for Use Case B (adapted from Table 6 of deliverable D7.2 (Report on KPIs) [1]).

KPI Level	KPI Sublevel	KPI Name	KPI Measurement	KPI Description
Social	Security /Safety	Accidents	#	Number of unfortunate incidents resulting in damage or injury
Social	Security /Safety	Fatalities	#	Number of occurrences of death by accident
Social	Security /Safety	Fire incidents	#	Number of incidents involving smoke, heat and flames causing damage
Social	Work-life	Income	Monthly	Influence on earnings
Social	Work-life	Training	Time/worker	Time invested in teaching an employee a particular working skill

[9] https://www.statista.com/statistics/437961/number-of-road-deaths-in-norway/

In the following, according to the use case explained in section 2.2 and one can see more details for both scenarios (basic and AEGIS) in Figure 20, the results obtained and it is shown in Table 14.



a) Baseline (land-based system) b) AEGIS (sea transport)

Figure 20: Route details of two scenarios at UCB.

Table 14: Result of UCB.

KPI	KPI Name	KPI Measurement	Result		Description
			AEGIS	Baseline-Truck	
Security /Safety	***Accidents***	#	Inconclusive	(968;3356)	In the baseline scenario, the first one is relevant to the Netherlands and the second is to Belgium.
Security /Safety	***Fatalities***	#	Inconclusive	(0.23;1.89)	In the baseline scenario, the first one is relevant to the Netherlands and the second is to Belgium.
Security /Safety	***Fire incidents***	#	Inconclusive	Inconclusive	
Work-life	***Income-operator of control centre or driver***	Monthly- Euro	8400	4000	For one person in the control room and one driver

As explained in detail in section 2.2, the main concept of Use Case B revolves around the deployment of autonomous inland waterway vessels that will help move containers or trailers from and to the bigger ports (Ghent and Rotterdam) that partner DFDS currently calls at. For Use Case B, the vessels under consideration will be remotely controlled or monitored (high autonomy level 3 or 4). Their technical specs and associated information on the loading and unloading operations at the ports are shown in Table 5.

In any case, that would require the construction of a control room for the overall supervision of the shipping operations in these inland waterways and during mooring. The control centre can be located somewhere other than the Netherlands or Belgium, provided that it can effectively interact with the ships and exchange data and guidance during operations. Regarding job creation, at least six employees with a rotating schedule are necessary to operate that control room[10], and DFDS estimated that salary costs are estimated at around € 50,000 per month, which means it should be around € 8,400 per person per month. Thus, the employees for this control room would also have to have obtained a higher level of education to monitor these operations effectively. Also, as on can see in Table 14, the monthly salary of a heavy truck driver in the Netherlands and Belgium in a year is € 47,590[11] and € 48,297[12] per month, respectively. Which would be € 4000 per month in average.

The next component of this solution is how trailers will be handled, and primarily what equipment will be required and what would be the handling time. A port's turnaround time is critical for ship operators choosing where to call. It is natural that by moving to an autonomous solution, the turnaround time might also change. DFDS prefers to transport unaccompanied trailers along the IWW since DFDS will not manage road haulage after the inland navigation. One option is using an autonomous cargo handling solution, similar to the "Vera" autonomous vehicle designed by Volvo. Such vehicles are fully electric and autonomous that can carry trailers within short routes. Such tractors could, in theory, be onboard the Ro-Ro ship and handle the loading and unloading of the vessel at the port. This vehicle would also require some remote monitoring from the control room. This would also result in some changes in terms of jobs. Drivers would no longer need to onboard the ship to accompany their trailers or drive them via road. At the same time, at the port, there will be no need for stevedoring, as the only requirement at the port would be a ramp to allow the movement of the autonomous vehicle. As this would only be a pilot project, there would not be a loss in employment for stevedoring (other ships would still be calling and requiring these services).

Based on the statistics of EU Transport in figures- statistical pocketbook in 2022, the number of accidents on the Netherlands and Belgium roads in 2020 was 17,040 and 30,230, respectively. Also, the fatality rate in 2020 was 4 and 17 for heavy goods vehicles (HGVs) in the Netherlands and Belgium, respectively. In addition, based on that report, the annual transportation volume from the road in Netherlands and Belgium in 2020 was around 67.2 and 34.4 billion tonne-km, respectively. Hence, the share of heavy vehicles in these two countries' road accidents and fatalities (on an annual basis) is estimated in equations 3 - 6.

Netherlands:

$$\boldsymbol{Accidents}: 17040 * \frac{3.82\ billion}{67.2\ billion} = 968.45 \tag{3}$$

$$\boldsymbol{Fatalities}: 4 * \frac{3.82\ billion}{67.2\ billion} = 0.23 \tag{4}$$

[10] http://www.unmanned-ship.org/munin/wp-content/uploads/2015/09/MUNIN-D8-8-Final-Report-Shore-Control-Centre-CTH-final.pdf

[11] https://www.erieri.com/salary/job/heavy-truck-driver/netherlands#:~:text=Salary%20Recap-,The%20average%20pay%20for%20a%20Heavy%20Truck%20Driver%20is%20%E2%82%AC,%E2%82%AC34%2C451%20and%20%E2%82%AC57%2C054.

[12] https://www.erieri.com/salary/job/heavy-truck-driver/belgium#:~:text=The%20average%20pay%20for%20a,for%20a%20Heavy%20Truck%20Driver.

Belgium:

$$\textbf{\textit{Accidents}}: 30230 * \frac{3.82\ billion}{34.4\ billion} = 3356.27 \quad (5)$$

$$\textbf{\textit{Fatalities}}: 17 * \frac{3.82\ billion}{34.4\ billion} = 1.89 \quad (6)$$

It should be noted that the fraction equations represent the share of transportation volume that UCB is involved in both countries. These equations are the normalized rates of accidents and fatality, which are calculated by dividing the annual volume transported in tonne-km in UCB by the annual volume transported in tonne-km in both countries. The distance for UCB is 320 km for a round trip. Also, the annual volume that is carried in these cases can be extracted from deliverable D7.7 (Table 26). Based on that report, it would be 229,522 tonnes per week. Therefore, the desired volume would be estimated by multiplying by 52 for the annual calculation.

Regarding cyber security and associated recovery risks, the risk of cyberattacks is expected to be lower due to the nature of the use case with inland waterway sailing. The vessels would only transport minimal trailers (or containers). Due to the constrained passage and easy access from the shore (the banks of the river way), it would be easier to recover the vessel in case of an attack. However, there might be an increased risk of a potential accident and its impacts on the IWW itself, as, in theory, this could disrupt other vessels transiting the waterway.

4.4 Use Case C

The final list of relevant and obtainable KPIs for the specific UCC for the Aalborg and Vordingborg cases are presented in Table 15. This is the result of the Mapping of the KPIs in terms of use case relevance and context, as previsouly described in section 3.4.

Table 15: Social KPIs for Use Case C (adapted from Table 6 of deliverable D7.2 (Report on KPIs) [1]).

KPI Level	KPI Sublevel	KPI Name	KPI Measurement	KPI Description
Social	Security /Safety	Accidents	#	Number of unfortunate incidents resulting in damage or injury
Social	Security /Safety	Fatalities	#	Number of occurrences of death by accident
Social	Security /Safety	Fire incidents	#	Number of incidents involving smoke, heat and flames causing damage
Social	Work-life	Income	Monthly	Influence on earnings
Social	Work-life	Training	Time/worker	Time invested in teaching an employee a particular working skill

In the following, according to the use case explained in section 2.3, the results obtained in both scenarios (basic and AEGIS) for the Aalborg and Vordingborg are, respectively, in tables 16 to 17.

Table 16: Results of the Aalborg case in UCC.

KPI	KPI Name	KPI Measurement	Result			Description
			AEGIS		Baseline (Truck)	
			New Vessel	Truck		
Security /Safety	***Accidents***	#	Inconclusive	(101.28;510.97)	(262.01;142.4;718.48)	In AEGIS's truck side, the first element is for Denmark, and the second term is for Germany. In the baseline scenario, the first, second, and third elements are related to Sweden, Denmark, and Germany, respectively.
Security /Safety	***Fatalities***	#	Inconclusive	(0.08;0.11)	(0.06;0.11;0.16)	In AEGIS's truck side, the first element is for Denmark, and the second term is for Germany. In the baseline scenario, the first, second, and third elements are related to Sweden, Denmark, and Germany, respectively.
Security /Safety	***Fire incidents***	#	Inconclusive		Inconclusive	
Work-life	***Income-operator of control centre or driver***	Yearly- €	48,648	58,900	48,350	Per operator of control centre or driver
Work-life	***Training***	Time/worker		---	---	

Table 17: Results of the Vordingborg case in UCC.

KPI	KPI Name	KPI Measurement	Result			Description
			AEGIS	Baseline		
			New Vessel	Vessel	Truck	
Security /Safety	***Accidents***	#	Inconclusive	Inconclusive	18.11	
Security /Safety	***Fatalitiees***	#	Inconclusive	Inconclusive	0.02	
Security /Safety	***Fire incidents***	#	Inconclusive	Inconclusive	Inconclusive	
Work-life	***Income***	Monthly- €	8,400	4,600	1,400	Per operator of control centre (AEGIS scenario), crew or driver
Work-life	***Training***	Time/worker	No data	No data	No data	

This Use Case concerns establishing new maritime links that connect Gothenburg to Hamburg via Aalborg and Vordingborg to Elblag. Tables 6 and 7 provide information on the technical specifications of the vessels under consideration for use case C.

In the Aalborg case, as one can see in Table 18 (deliverable 10.3), we have different salaries for autonomous terminal worker and non- autonomous terminal worker (12 scenarios). Finally based on deliverable D10.3, we have assumed 2 tug masters, 2 weekly calls, and 5 min per trailer with a terminal worker and control centre worker.

Table 18: The worker yearly salary for the UCC-Aalborg case (€).

	Worker Type	2 weekly calls	3 weekly calls	4 weekly calls
4 tug masters, 5 min per trailer	At non- autonomous terminal	97,297	145,945	194,594
	At autonomous terminal	24,324	36,486	48,648
	Control Centre Worker	42,000	63,000	84,000
2 tug masters, 5 min per trailer	At non- autonomous terminal	48,648	72,972	97,297
	At autonomous terminal	24,324	36,486	48,648
	Control Centre Worker	42,000	63,000	84,000
3 tug masters, 4 min per trailer	At non- autonomous terminal	72,972	109,459	145,945
	At autonomous terminal	24,324	36,486	48,648
	Control Centre Worker	42,000	63,000	84,000
2 tug masters, 4 min per trailer	At non- autonomous terminal	48,648	72,972	97,297
	At autonomous terminal	24,324	36,486	48,648
	Control Centre Worker	42,000	63,000	84,000
3 tug masters, 3 min per trailer	At non- autonomous terminal	72,972	109,459	145,945
	At autonomous terminal	24,324	36,486	48,648
	Control Centre Worker	42,000	63,000	84,000

2 tug masters, 3 min per trailer	At non- autonomous terminal	48,648	72,972	97,297
	At autonomous terminal	24,324	36,486	48,648
	Control Centre Worker	42,000	63,000	84,000
4 tug masters, removing the backup terminal workers from the autonomous setup	At non- autonomous terminal	97,297	145,945	194,594
	At autonomous terminal	42,000	63,000	84,000
	Control Centre Worker	48,648	72,972	97,297
2 tug masters, removing the backup terminal workers from the autonomous setup	At non- autonomous terminal	42,000	63,000	84,000
	At autonomous terminal	97,297	145,945	194,594
	Control Centre Worker	48,648	72,972	97,297
4 tug masters, removing both backup terminal workers, as well as the control centre worker from the autonomous setup	At non- autonomous terminal	97,297	145,945	194,594
	At autonomous terminal	48,648	72,972	97,297
	Control Centre Worker	97,297	145,945	194,594
2 tug masters, removing both backup terminal workers, as well as the control centre worker from the autonomous setup	At non- autonomous terminal	24,324	36,486	48,648
	At autonomous terminal	42,000	63,000	84,000
	Control Centre Worker	48,648	72,972	97,297
4 tug masters, removing all the above, as well as removing the backup tug masters from both the autonomous and non-autonomous setup	At non- autonomous terminal	24,324	36,486	48,648
	At autonomous terminal	42,000	63,000	84,000
	Control Centre Worker	72,972	109,459	145,945
2 tug masters, removing all the above, as well as removing the backup tug masters from both the autonomous and non-autonomous setup	At non- autonomous terminal	24,324	36,486	48,648
	At autonomous terminal	42,000	63,000	84,000
	Control Centre Worker	48,648	72,972	97,297

Also, in this case, we have used the arithmetic average of Denmark[13] (which is DKK 438,430 that could be € 58,900) and Sweden[14] (which is SEK 419,352 or € 37,800) to calculate the drivers' salaries in the baseline scenario and just Denmark to calculate the drivers' wages in the AEGIS scenario.

In the Vordingborg case, for the AEGIS scenario, we need two people onboard the AEGIS ship (because of automation level 2) plus workers in the control centre room. The salary of the crew of the automation vessel, based on the data from Port of Vordingborg, is equivalent to € 945 (approximately € 1,000) per day. That is € 500 per person. On the other hand, at least six employees with a rotating schedule are necessary to operate that control room[15], and DFDS estimated that salary costs are estimated at around € 50,000 per month, which means it should be around € 8,400 per person per month.

We assumed the crew salary of the conventional ship at around DKK 411,050 (€ 55200) per year, which would be € 4600 per month. Also, the heavy truck driver salary in Poland is around PLN 81,070 (€17,200)[16], which would be € 1,400 per month.

In addition, based on the data that comes from the port of Vordingborg, the average salary on that port at each hour for each terminal worker is around DKK 500 which is equivalent to € 67.2. And, by considering 160 working hours in a month, the average salary of each worker in the terminal would be around € 10,752. In addition, according to the data obtained from Vordingborg port authorities, two

[13] https://www.erieri.com/salary/job/heavy-truck-driver/denmark
[14] https://www.erieri.com/salary/job/heavy-truck-driver/sweden#:~:text=Salary%20Recap,for%20a%20Heavy%20Truck%20Driver.
[15] http://www.unmanned-ship.org/munin/wp-content/uploads/2015/09/MUNIN-D8-8-Final-Report-Shore-Control-Centre-CTH-final.pdf
[16] https://www.erieri.com/salary/job/heavy-truck-driver/poland

workers, a crane, and a wheel loader are needed to load bulk cargo. On the other hand, two workers and a crane are needed to unload the bulk cargo.

Other people required on shore would include one port staff responsible for monitoring the safe mooring and unmooring of the autonomous vessel. However, it is expected that this would not lead to a new job creation, as the port already has some staff responsible. Merely this would add some work hours to cater to the needs of these two vessels. There would also be staff working on shore to monitor the vessels remotely during the voyage. These workers would require training to familiarize themselves with the AEGIS software system. These employees would need a higher education level (BSc/MSc minimum). The remaining social KPIs (recovery time after attacks, number of cyber-attacks, accident/fatality/incident rates) cannot be quantitatively estimated for the reasons stated earlier.

The countries of Sweden, Denmark, Germany, and Poland are involved in UCC in both cases, in terms of road traffic through these countries. Hence, based on the statistics of EU Transport in figures-statistical pocketbook in 2022, the number of accidents and fatalities in the above-mentioned countries is calculated in equations 7 to 18.

It should be noted that the fraction equations represent the share of transportation volume that UCC (both cases) is involved in in four countries. These equations are the normalized rates of accidents and fatality, which are calculated by dividing the annual volume transported in tonne-km in UCC by the annual volume transported in tonne-km in those countries. The distances for both cases are described in section 2.3. Also, the annual volume transfers in the Aalborg case can be extracted from deliverable D7.7 (Table 32).

No country-specific data was available for maritime modes, but in 2019 there was only one fatality in the North Sea with cargo vessels involved.

Sweden:

$$\boldsymbol{Accidents}: 13680 * \frac{0.83\ billion}{43.2\ billion} = 262.01 \quad (7)$$

$$\boldsymbol{Fatalities}: 3 * \frac{0.83\ billion}{43.2\ billion} = 0.06 \quad (8)$$

Denmark:

Non-AEGIS:

$$\boldsymbol{Accidents} - Aalborg\ Case: 2530 * \frac{0.83\ billion}{14.7\ billion} = 142.4 \quad (9)$$

$$\boldsymbol{Fatalities} - Aalborg\ Case: 2 * \frac{0.83\ billion}{14.7\ billion} = 0.11 \quad (10)$$

AEGIS:

$$\boldsymbol{Accidents} - Aalborg\ Case: 2530 * \frac{0.59\ billion}{14.7\ billion} = 101.28 \quad (11)$$

$$\boldsymbol{Fatalities} - Aalborg\ Case: 2 * \frac{0.59\ billion}{14.7\ billion} = 0.08 \quad (12)$$

Germany:

<u>Non-AEGIS:</u>

$$\textbf{Accidents}: 264500 * \frac{0.83\ billion}{304.6\ billion} = 718.48 \quad (13)$$

$$\textbf{Fatalities}: 61 * \frac{0.83\ billion}{304.6\ billion} = 0.17 \quad (14)$$

<u>AEGIS</u>:

$$\textbf{Accidents}: 264500 * \frac{0.59\ billion}{304.6\ billion} = 262.01 \quad (15)$$

$$\textbf{Fatalities}: 61 * \frac{0.59\ billion}{304.6\ billion} = 0.11 \quad (16)$$

Poland:

$$\textbf{Accidents}: 23540 * \frac{0.27\ billion}{354.9\ billion} = 18.1 \quad (17)$$

$$\textbf{Fatalities}: 31 * \frac{0.27\ billion}{354.9\ billion} = 0.02 \quad (18)$$

As in the other use cases, these results are considered very positive and in fact constitute a major social benefit that can be associated with the AEGIS solution.

5 Conclusions

This report set out to seek three main objectives below:

- Perform analyses of social effects of AEGIS solutions.
- Examine the general and specific parts of each use case in terms of social KPIs

It should be noted that although a maximum effort has been given to collect reliable data in this analysis, many related data proved impossible to acquire. In fact, the nature of the social analysis is such that much of the data for the analysis would become available only after the implementation of the AEGIS system. These indicatively include data on safety, security, resilience and recovery from cyber-attacks. In the absence of such data, many parts of the social analysis are by necessity inconclusive.

Despite these difficulties, in general we can conjecture that with the implementation of the AEGIS system, and mainly by moving some of the European road freight traffic to AEGIS vessels, we will see a reduction in road accidents and fatalities, for which we have attempted to make some quantitative estimates. This is, we believe, a significant social benefit that can be ascribed to AEGIS.

The results of the social analysis also show that the implementation of the AEGIS does not make a significant change in the unemployment of personnel. In fact, the AEGIS system is expected to create some higher paying jobs, for personnel tasked to be employed in the AEGIS control centre and in other positions. We have provided estimates of the wages of such personnel.

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Annex A. Data Template

This annex contains the data template circulated to the AEGIS partners.

Data	Units	ENTER INPUT HERE	COMMENT		Comparison with data
Vessel Name	Name				
Vessel Type	Name				
Route deployed in	Name				
Geometric Characteristics (LPP, LOA, B, T)	meters				
Main Engine Power (MCR)	kW				
Main Engine Type/Model					
Main Engine Fuel Type					
Main Engine Fuel Consumption at 75% MCR	tonnes/day				
Auxiliary Engine & Boiler Power (MCR)	kW				
Auxiliary Engine & Boiler Type/Model					
Auxiliary Engine & Boiler Fuel Type					
Auxiliary Engine & Boiler Fuel Consumption at 75% MCR	tonnes/day				
Design speed	knots				
Vessel capacity	TEU/lane meters				
Vessel cargo handling equipment (if any): name	Name				
Vessel cargo handling equipment; number	#				
Cargo handling rate (per cargo handling unit)	TEUs/hour, LM/hour				
CAPEX-Price New Vessel	€				
OPEX- crew	€/year				
OPEX-maintenance	€/year				
OPEX-other (no fuel)	€/year				
Crew size (non-hotel)	#				
Autonomy Level	Fully manual/Operator Controlled/Automatic/Partial Autonomy/ Constrained Autonomous/ Fully Autonomous				
Load factor	%				
Any other relevant info.					

Figure 21: The "Ship" worksheet

Data	Units	ENTER INPUT HERE	COMMENT
Route Length	NM		
Route description including transshipment nodes (ports, other)	Names		
Number of transshipment nodes	#		
Route Cargo Volume A to B	Lane meters/year or TEUs/year		
Route Cargo Volume B to A	Lane meters/year or TEUs/year		
Ship Speed (average)	Kn		
Total Sailing Time	hours		
Total Loading Time	hours		
Total Unloading Time	hours		
Total Terminal Cargo Residence Time	hours		
Other waiting time	hours		
Number of ships on route	#		
Punctuality	%		
Frequency of Service	shipments/week		
Bunkering Possibilities and Availabilities (LNG, Hydrogen, Battery…)	-		
Competing services on route and their shares			
Non-maritime leg of route- type of vehicle	name		
Non-maritime leg of route- total distance	km		
Non-maritime leg of route- total transit time	hours		
Non-maritime leg of route- total cost (last mile)	€		
Any other relevant info.			

Figure 22: The "Route" worksheet

Data	Units	ENTER INPUT HERE	COMMENT		CHECK WITH DATA
Volume of Cargo Moved (both loaded and unloaded) per Port Call and type of cargo	#TEUs/port call or #Lane meters/port call				
Type of cargo	name				
Average value of cargo	€/tonne				
Origin of cargo (if known)	name				
Destination of cargo (if known)	name				
Door to door transit time of cargo (if known)	name				
Door to door freight rate	€/tonne				
Any other relevant info.					

Figure 23: The "Cargo" worksheet

Data	Units	ENTER INPUT HERE	COMMENT
Name of port/terminal	Name		
Number of berths	#		
Storage capacity	TEUs, LMs		
Shore cargo handling equipment (if any): name	Name		
Shore cargo handling equipment; number	#		
Cargo handling rate (per cargo handling unit)	TEUs/hour, LM/hour		
People on shore needed to operate cargo handling equipment	#		
Other people on shore needed for operation	#		
Any other relevant info.			

Figure 24: The "Port" worksheet

Data	Data Measurement	ENTER INPUT HERE	COMMENT
Number of successful Cyber-Attacks per Year	#/year		
Number of intended Cyber-Attacks per Year	#/year		
Recovery Time due to Crime (cyber-attack…) from detection to recovery	hours		
Restored Level of Performance after a Cyber-Attack	% of Original Level of Performance		
Education Level Employees Needed	No Degree/BSc/MSc/PhD		
Maximum Noise Emitted Vessel + Port	dB		
Use of Renewable Energy Sources of the total Energy Required	%		
Accident Rate	#/year		
Fatality Rate	#/year		
Fire Incidents	#/year		
Crime (thefts, piracy…)	#/year		
Training time per worker	hours/worker		

Figure 25: The "Other" worksheet