Manual for the computer program

SHIP-DESMO Ro-Ro cargo

by

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Project no. 2014-122: Mitigating and reversing the side-effects of environmental legislation on Ro-Ro shipping in Northern Europe
Work Package 2.3, Report no. 08
July 2016

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User manual for the SHIP-DESMO program for Ro-Ro cargo ships

Introduction

This report is a user manual of the generic Ro-Ro ship model program SHIP-DESMO Ro-Ro cargo, primary intended for calculation of the energy demand (fuel consumption) and emissions for Ro-Ro cargo ships. Two separate programs have been developed, one for 1) Ro-Ro cargo ships, named "*SHIP-DESMO Ro-Ro cargo*" and one for 2) Ro-Ro passenger ships, named "*SHIP-DESMO Ro-Ro passenger*". The theoretical background for these two SHIP-DESMO models is described in six separate reports:

1. Report No. 1: *"Prediction of resistance and propulsion power of Ro-Ro ships"* by Hans Otto Kristensen

2. Report No. 2: *"Analysis of technical data of Ro-Ro ships"* by Hans Otto Kristensen

3. Report No. 3: *"Energy demand and exhaust gas emissions of marine engines*" by Hans Otto Kristensen

4. Report No. 4: "*Analysis of propulsion power data of Ro-Ro ships and analysis of the CEN standard 16258 for Ro-Ro ships"* by Hans Otto Kristensen*.*

5. Report No. 5: "*Energy and emission model for trucks"* by Hans Otto Kristensen*.*

6. Report No. 6: "*External cost calculator for the SHIP-DESMO model"* by Hans Otto Kristensen*.*

All six reports have been prepared as deliverables for the project no. 2014-122: Mitigating and reversing the side-effects of environmental legislation on Ro-Ro shipping in Northern Europe. Work Package 2.3 carried out for The Traffic Section of The Technical University of Denmark.

As this report is solely a user manual, the user is highly recommended to become familiar with the background of the SHIP-DESMO program package, as this will ensure the greatest benefit and understanding of using the programs. This will furthermore secure that the input values and the results are as realistic as possible, although the programs include several safeguards against wrong input and also include guidelines for the range of valid input values.

Definitions

L_{wl}	Length of waterline of ship
L_{pp}	Length between perpendiculars
B	Breadth, moulded of ship
T	Draught, moulded amidships (mean draught)
W_L	Lightship weight
D_w	Deadweight of ship
Δ	Displacement mass of ship ($\rho \cdot \nabla = W_L + D_W$)
∇	Displacement volume of ship
S	The wetted surface of immersed hull

A_M	Immersed midship section area
A_{wl}	Area of water plane at a given draught)
D_{prop}	Propeller diameter
g	gravitational constant (9.81 m/s^2)
Fn	Froude number ($\mathrm{Fn} = \frac{V}{\sqrt{g \cdot Lpp}}$)
C_B	Block coefficient ($C_B = \frac{\nabla}{Lpp \cdot B \cdot T}$)
C_M	Midship section coefficient ($C_M = \frac{A_M}{B \cdot T}$)
C_p	Prismatic coefficient ($C_P = \frac{C_B}{C_M}$)
C_w	Water plane area coefficient ($C_w = \frac{A_{wl}}{L \cdot B}$)
M	Length displacement ratio or slenderness ratio, $M = \frac{L}{\nabla^{1/3}}$
ρ	Mass density of water

General structure of the SHIP-DESMO program

The SHIP-DESMO program has been developed as Excel 2003 programs, which mean that they can be executed by all Excel versions from 2003 and up to the latest versions from Microsoft.

Folders: INPUT and SHIP DATA

Ship data			
Default ship (0) or ship alternative No. 1 or No. 2	0		
Deadweight density (1: Normal, 2: Low, 3: High)	1		
Cargo capacity (length of cargo lanes)	4000		
Payload/deadweight at design draught (%)	70		
Lanemeter capacity utilization (pct.)	80		
Deadweight per lanemeter (t/lm)	2.9		
Default max. deadweight per lanemeter (t/lm)	3.1		
Rolling cargo load per lanemeter	1.8		
Normal speed (knots)	21.2		
Speed change (pct.)	0.0		
Actual ship speed (knots)	21.2		
Suphur content of oil (%)	0.1		
NOx emissions (IMO TIER 1, 2 or 3)	2		
Slow speed (1) or medium speed main engine (2)	2		
Sailing percentage in harbour conditions	2	**Draft reserve (m) - shall be positive !**	**0.21**

Necessary input has to be specified in the two folders **INPUT** and **SHIP DATA**.

In INPUT are specified the more fundamental parameters which are following:

1. The deadweight or cargo density of the ship. 3 different dw densities can be specified 1) Normal, 2) Low and 3 High deadweight density
2. The maximum transport capacity (maximum lanemeters for Ro-Ro cargo ships)
3. The payload in pct. of the maximum deadweight
4. The actual utilization of the lanes in pct. of the maximum lanemeters.
5. The ship speed. The normal service speed corresponding to the actual capacity is given and the user can specify the actual speed by a percentage deviation from the proposed default speed
6. The Sulphur content in the oil fuel
7. The NOx Tier level of the engines (1 – 3)
8. Engine type, i.e. slow speed (2 stroke) or medium speed (4 stroke)
9. The percentage of the total sailing distance which is done in harbor area (city area)

After specification of the primary/main data in INPUT more detailed data can be specified in the folder SHIP DATA in the yellow cells below:

Ship data (Ro-Ro cargo ship)	Units	Default values Normal deadweight ship	Alternative No. 1 Normal deadweight ship	Alternative No. 2 Normal deadweight ship	Min. allowable value	Max. allowable value
Capacity of rolling cargo	lanemeter	4000	4000	4000	500	7000
Deadweight density (1: Normal, 2: Low, 3: High)	-	1	1	1		
Ship type (1: Single screw, 2: Conv. twin screw, 3: Twin-skeg)	-	2	2	2	1	2
Change of length in percent	%	0.0	0.0	0.0	-10	10
Length between pp	m	190.70	190.70	190.70		
Length in waterline incl. bulbous bow	m	197.37	197.37	197.37		
Length over all	m	204.57	204.57	204.57		
Breadth mld.	m	26.99	26.99	26.99	24.98	33.19
Depth to upper continous deck	m	18.30	18.30	18.30	16.47	20.13
Design draught	m	6.50	6.50	6.50		
Maximum draught	m	7.01	7.01	7.01	6.14	8.86
Maximum draught - design draught	m	0.51	0.51	0.51		
Design deadweight/Maximum deadweight	%	82	82	82		
Design deadweight	tons	10123	10123	10123		
Maximum deadweight	tons	12368	12368	12368		
Proposed maximum deadweight per lanemeter	tons/m	3.09	3.09	3.09	2.00	5.86
Maximum deadweight correction per lanemeter	tons/m	0.00	0.00	0.0	-1.09	2.76
Deadweight correction in per cent	%	0.0	0.0	0.0		
Final maximum deadweight per lanemeter	tons/m	3.09	3.09	3.09		
Proposed payload/deadweight at maximum draught	%	70	70	70		
Actual payload/deadweight at maximum draught	%	70	70	70	60	85
Lightweight coefficient	t/m^3	0.127	0.127	0.127		
Weight correction	tons	0	0	0	-2401	2401
Lightweight	tons	12005	12005	12005		
Displacement at design draught	tons	22128	22128	22128		
Displacement at maximum draught	tons	24373	24373	24373		
Gross tonnage	GT	33683	33683	33683		

Block coefficient (based on Lpp) at maximum draught	-	0.659	0.659	0.659	0.55	0.75
Block coefficient (based on Lwl) at maximum draught	-	0.637	0.637	0.637	0.55	0.75
Block coefficient (based on Lwl) at design draught		0.623	0.623	0.623	0.55	0.75
Lpp/Displ.vol.$^{1/3}$ at design draught	-	6.85	6.85	6.85	5.0	7.5
Lpp/Displ.vol.$^{1/3}$ at maximum draught	-	6.63	6.63	6.63	5.0	7.5
Midship section coefficient at design draught	-	0.969	0.969	0.969	0.90	0.99
Midship section coefficient at maximum draught	-	0.972	0.972	0.972	0.90	0.99
Prismatic coefficient at design draught based on Lwl	-	0.643	0.643	0.643	0.55	0.83
Prismatic coefficient at maximum draught based on Lwl	-	0.655	0.655	0.655	0.55	0.83
Waterplane area coefficient based on Lpp	-	0.841	0.841	0.841	0.7	0.9
Wetted surface at design draught	m^2	5837	5837	5837		
Wetted surface at maximum draught	m^2	6177	6177	6177		
Speed change in percent	%	0	0	0	-20	20
Service speed at design draught	knots	21.2	21.2	21.2	16.9	25.4
Froude Number at service speed	-	0.247	0.247	0.247		
Scantling trial speed at 100 % deadweight at 75 % MCR	knots	20.80	20.80	20.80		
Froude Number at 'reference speed'	-	0.247	0.247	0.247		
Service allowance on resistance	pct.	10	10	10		
Beaufort No.	-	8	8	8		
Calculated wind speed acc. to Beaufort No.	m/s	19.1	19.1	19.1		
Longitudinal wind resistance coefficient, Cx	-	0.80	0.8	0.8		
Wind speed to be used for separate wind resistance	m/s	0.0	0	0		
Wind resistance fraction of trial resistance	pct.	0	0	0		
Transmission efficiency	pct.	96	96	96		
General improved propeller efficiency	pct.	0.0	0.0	0.0	0	10
Main engine power (MCR)	kW	21776	21776	21776		
Auxiliary power at maximum draught at design speed	kW	794	794	794		
Power take off (P_{PTO})	kW	1059	1500	1500		
MIN(P_{PTO}, P_{AE}/0.75)	kW	1059	1059	1059		
MCR - P_{PTO}	kW	20717	20717	20717		
Propeller diameter	m	4.72	4.72	4.72	3.97	5.47
Propeller diameter if specified (if default diameter press - 1)	m	-1.00	-1.00	-1.00		
Propeller type (1 = conventional - 2 = ducted)	(-)	1	1	1	1	2
Propeller loading (MCR)	kW/m^2	623	623	623		

In the first column of SHIP DATA the default values, i.e. typical statistically based values, are shown for a Ro-Ro ship given by the general particulars specified in INPUT. In column 1 and 2 it is possible to specify alternative ship specific values in the yellow cells, other than the default values. However these alternative values have to be within the limits shown at the right side of the three columns. These limit values have been obtained from the comprehensive statistical analysis of many hundred Ro-Ro ships which are basis for the SHIP-DESMO models.

Engine technology

ENGINE TYPE & TECHNOLOGY				
Main engine type (slow speed = 1, medium speed = 2)	(-)	2	2	2
Main engine service rating (for non derated engine only)	pct. MCR	90	90	90
Fuel type (HFO = 1, MD/GO = 2, LNG = 3, Dual fuel = 4)	-	2	2	2
SFOC at 75 % MCR in normal ME mode (If default press 1)	g/kW/hour	1	1	1
If normal tuning press 1 - if low load tuning press 2 (2 stroke)	-	1	1	1
Sulphur content in heavy fuel (HFO)	pct.	0.1	0.1	0.1
Sulphur content in diesel oil or gas oil (DO/GO)	pct.	0.1	0.1	0.1
Derated 2 stroke main engine? (NO = 0, YES = 1)	-	1	1	1
Fuel optimised main engine? (NO = 0, YES = 1)	-	0	1	0
TIER 1, 2 or 3 engine? (1 - 3)	-	2	2	2
Specify NOx reduction technology: EGR (Exhaust Gas Recirculation) =1, SCR (Selective Catalyic Reduction) = 2 or other technology = 3	-	1	1	1
Use of scrubbers if oil is used (NO = 0, YES=1)	-	1	1	1

When data are specified in INPUT it is indirectly assumed that the ship is driven by diesel-engines. The blue cells in the above mentioned part of the SHIP DATA are transferred directly from INPUT

In the engine type and technology part of SHIP DATA it possible to select four different fuel types:

1. Heavy fuel oil (HFO)
2. Marine diesel oil (MDO)
3. Liquid natural gas in combination with a small amount of diesel oil, i.e. Dual Fuel
4. Purely Liquid Natural gas (LNG)

The normal maximum service engine loading has to be specified, and normally 90 pct. of the maximum engine power (max. continuous rating = MCR) is used except in the case where the main engine is specified as a de-rated engine, which means that the engine in normal service condition can run at 100 pct. of the maximum power (MCR).

More strict demands with respect to NOx emission has entered into force such that all new engines has to fulfill the so-called Tier 2 NOx demands from 2011. From 2016 ships sailing in so-called NOx emission control areas have to fulfill the NOx Tier 3 demands. In 2016 following areas are classified as NOx ECA´s: North America, Canadian coast, US Caribbean including Puerto Rico and the US Virgin Islands.
Different technologies can be used for NOx reduction and following possibilities can be specified in SHIP DATA:

1. EGR (Exhaust Gas Recirculation)
2. SCR (Selective Catalytic Reduction)
3. Other technology

Using a de-rated engine and some of the NOx reducing technologies changes the specific fuel oil consumption (SFOC) of the main engine. The SHIP-DESMO model automatically takes care of these changes such that the SFOC is updated according to the selected engine technology.

If the SFOC for the main engine and auxiliary engines are not known it is possible just to specify 1 as input in the appropriate cells and typical default values will be used corresponding to the engine type and fuel type. However if the actual SFOC is known the SFOC value at 75 % engine load can be specified separately.

Also different, still more stringent SOx demands, have to be fulfilled depending on the sailing area. In the Baltic Sea and the North Sea only 0.1 per cent Sulphur is allowed in the oil. Instead of using oil with a low Sulphur content, the exhaust gas can be cleaned using a scrubber system, which can remove the SOx in the exhaust gas, such that the SOx content in the gas corresponds to using oil with 0.1 per cent Sulphur. In SHIP DATA it is possible to specify whether a scrubber is used for SOx cleaning. The additional power demand needed for a scrubber system (3 %) is indirectly taken care of in the calculation procedures for the oil consumption.

Technically it is possible to introduce a shaft driven electrical generator in the shaft line from the main engine(s), if extra electrical power is needed (typical when bow thrusters are used during harbor manoeuvring), such that this can be generated by the main engine(s). If the SFOC for the main engine is lower than the SFOC for the auxiliary engines, the use and installation of a shaft generator will reduce the so-called Energy Efficiency Design Index (EEDI), which can be beneficial for Ro-Ro ships, which very likely will have problems to fulfill the coming demands to EEDI, especially after 2020.

Information of the technical issues of the different fuel types and engine technologies can be found in Report No. 3: "*Energy demand and exhaust gas emissions of marine engines*" by Hans Otto Kristensen. It is strongly advised to become familiar with the different engine technologies described in this report

Further additional changes can be made in SHIP DATA:

Propeller data

General improved propeller efficiency	pct.	0.0	0.0	0.0
Main engine power (MCR)	kW	20237	20237	19602
Auxiliary power - calculated acc. to IMO MEPC.212(63)	kW	756	756	740
Default propeller diameter	m	4.43	4.43	5.00
Prop. diameter (if different from default value - otherwise press -1)	m	-1.00	-1.00	5.00
Propeller type (1 = conventional - 2 = ducted)	(-)	1	1	1

The propeller diameter is automatically calculated on basis of the draught of the ship, which means, that if the draught is changed, the propeller diameter will also be changed. It is also possible to specify an individual propeller diameter completely independently of the draught. In general an increase of the propeller diameter will result in a higher propeller efficiency, such that 10 pct. larger propeller decreases the propulsion power by 2 – 3 pct.

If a special propeller with a higher efficiency than a normal propeller is assumed it is possible to specify the added propulsion efficiency in pct. As example the so-called Kappel propeller is reported to increase the efficiency by 4 - 5 pct.

For Ro-Ro ships so called open propellers are normally used, but it is possible to specify a ducted propeller, which is beneficial if the propeller loading is high, which most probably not will be actual for a Ro-Ro ship.

Hull type/hull form

Ship type (1: Single screw, 2: Conv. twin screw, 3: Twin-skeg)	-	2	2	2

Three different hull forms can be specified:

1. A single screw hull form
2. A normal twin screw hull form
3. A twin skeg hull form (with two propellers)

The wetted surface of ship depends on these hull forms, and it is automatically calculated according to the selected hull form. Also different propulsion characteristics are dependent on the hull form and will therefore automatically be calculated by the SHIP-DESMO model.

Length of the ship

The length of the ship can be changed without any change of the basic capacity and the maximum deadweight. The lightweight is automatically updated according to the changed length. A longer hull form will decrease the block coefficient, C_B, and increase the length displacement ratio, $\frac{L}{\nabla^{1/3}}$, which can be beneficial from a resistance point of view. The wetted surface increases when the length is increased, so the change of necessary propulsion power shall be checked before the final change of length is chosen, but normally a power reduction of 2 – 5 pct. can be obtained by 5 pct. length increase.

Change of breadth, draught and depth

Breadth mld.	m	26.99	26.99	26.99	24.98	33.19
Depth to upper continous deck	m	18.30	18.30	18.30	16.47	20.13
Design draught	m	6.50	6.50	6.50		
Maximum draught	m	7.01	7.01	7.01	6.14	8.86

It is also possible to change the maximum draught, the breadth and the depth of the ship, without changing the capacity, i.e. lanes, max. number of passengers and deadweight. The lightweight is automatically changed due to the changed dimensions, using an empirical lightweight formula.

Change of deadweight

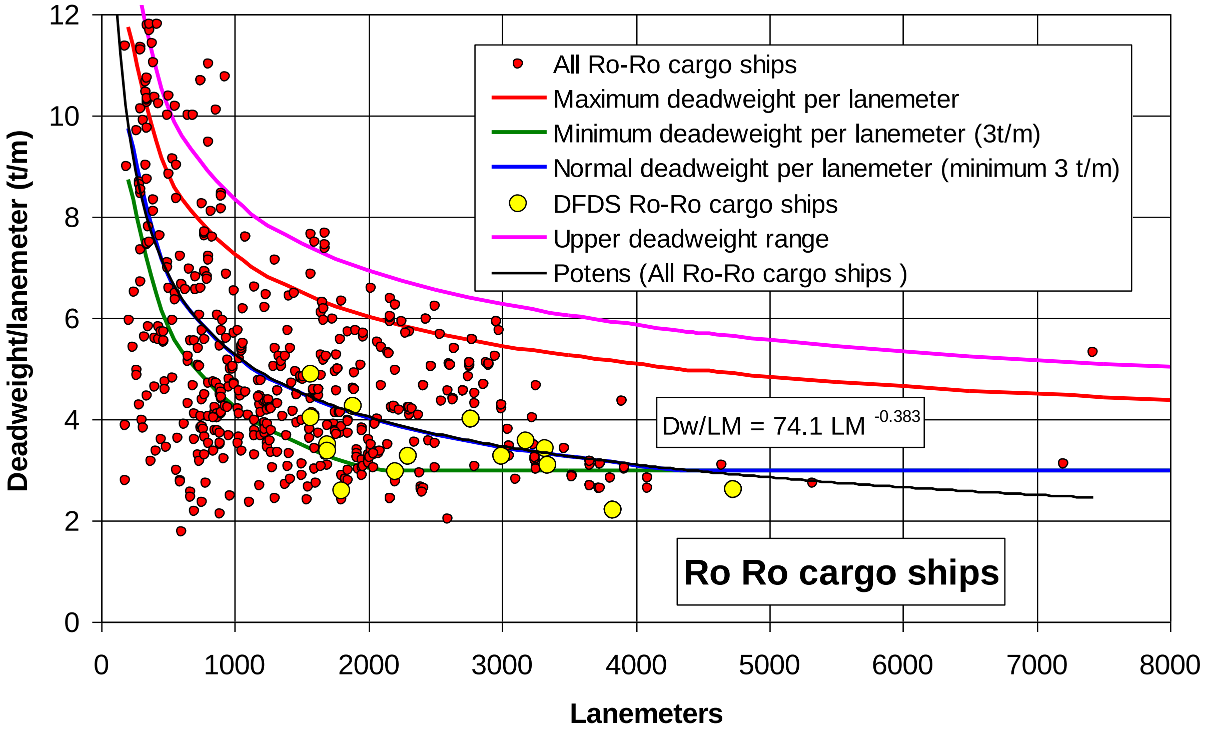
Maximum deadweight	tons	12368	12368	12368		
Proposed maximum deadweight per lanemeter	tons/m	3.09	3.09	3.09	2.00	5.86
Maximum deadweight correction per lanemeter	tons/m	0.00	0.00	0.0	-1.09	2.76
Deadweight correction in per cent	%	0.0	0.0	0.0		
Final maximum deadweight per lanemeter	tons/m	3.09	3.09	3.09		
Proposed payload/deadweight at maximum draught	%	70	70	70		
Actual payload/deadweight at maximum draught	%	70	70	70	60	85

The deadweight depends on the actual deadweight class for the ship type as follows:

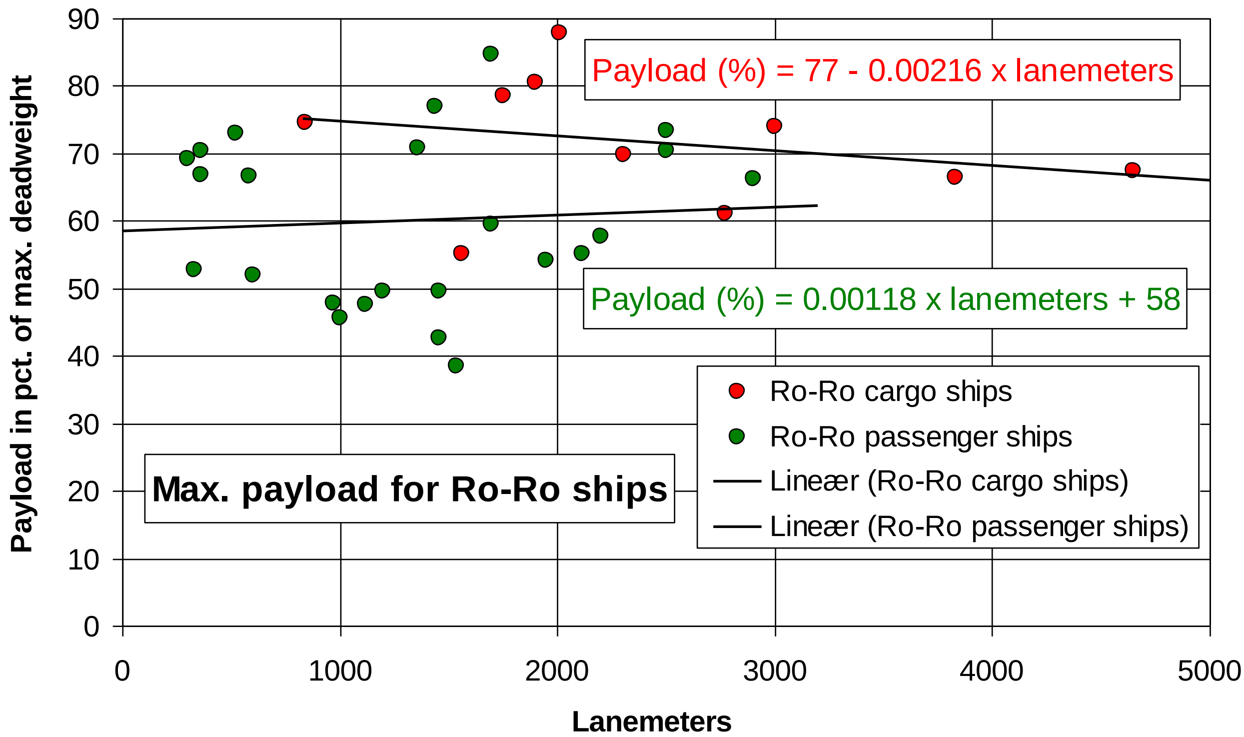
Ro-Ro cargo ships:

1. Normal deadweight density
2. Low deadweight density
3. High deadweight density

The three deadweight classes are shown in the following figure by the green, blue and red curves:



In addition to the deadweight class it is possible to change the maximum deadweight per lanemeter either in direct values or in percentage. Especially when the high deadweight type is choosen or when the dw/lanemeter is increased, it will be natural to change the ratio of payload in pct. of the deadweight from a default value of 70 pct. to 75 – 85 pct. according to following figure:



In relation to cargo weight, the user shall have in mind that the difference between the actual draught and the maximum draught shall be positive. A negative value means that the ship is loaded to a draught exceeding the maximum allowable draught. This draught indication is shown in the folder INPUT.

Emission calculations

As transport services carried out by Ro-Ro cargo ships fulfils only one transport need, namely transport of rolling cargo, such as trucks, trailers, mafis or project cargo, it will be most natural to express the energy demand and emissions in relation to lanemeter of cargo or per ton cargo.

The results of the emission calculations are found in two different folders:

1. Emissions per lanemeter
2. Emissions per ton cargo

All types of emissions (as defined and documented in the folder Emission factors) are presented in the emission folders, where the emissions are related to different parameters such as 1) per nautical mile, 2) per hour, 3) per passenger per nautical mile and finally 4) per lanemeter per nautical mile.

In two external cost folders are shown the external cost calculations, which are calculated according to the cost values defined and documented in the folder External cost factors.

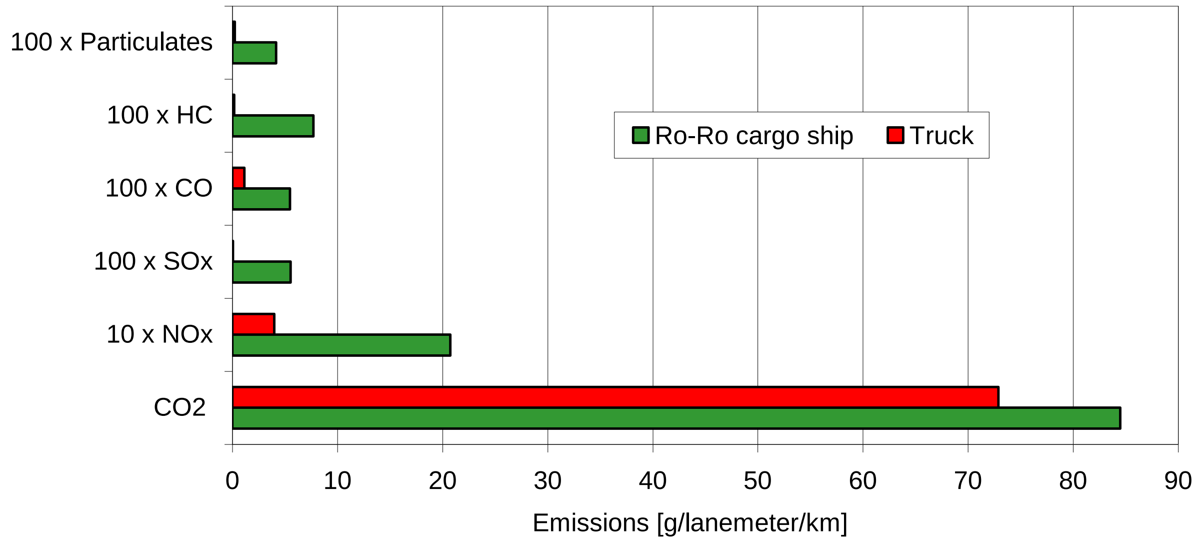
1. External costs per lanemeter
2. External costs per ton cargo

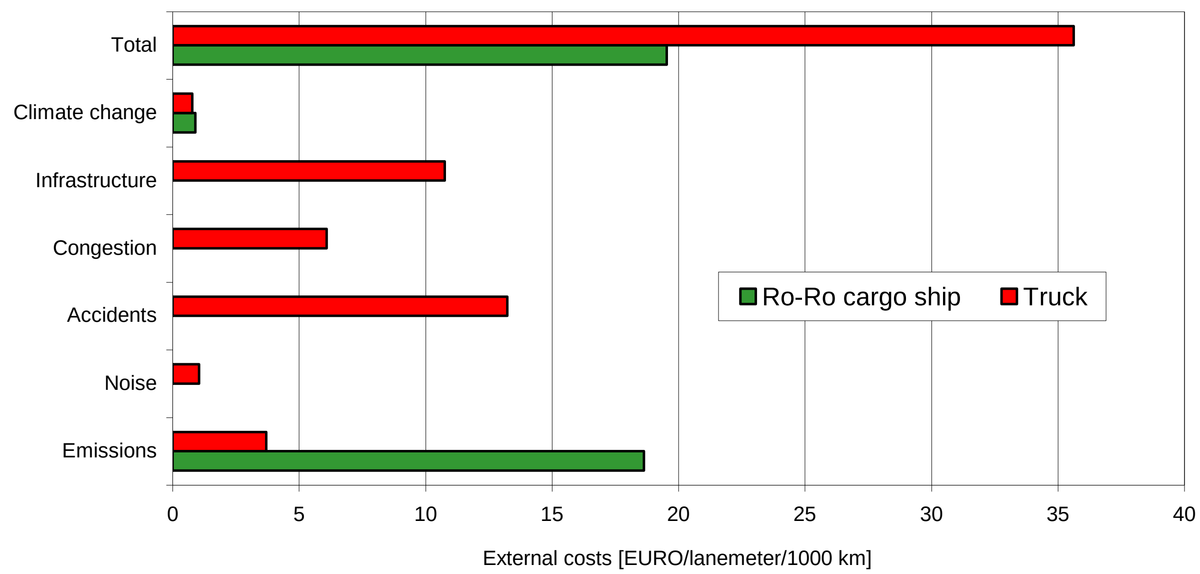
Comparison with other transport modes

In the folder INPUT it is possible to specify the transport of cargo by truck. The technical details of the truck transport forms are documented in the folder Truck data, where the energy and emission calculation procedures are given.

In the INPUT folder are presented emission and external cost values for the truck transport, such that it is possible to compare the emission performance and the external cost performance between land based transport by truck with the equivalent transport by the actual Ro-Ro cargo ship under the specified condition and with the specified technical main particulars.

Ship data		Truck data	
Default ship (0) or ship alternative No. 1 or No. 2	0	Truck weight (empty)	10.0
Deadweight density (1: Normal, 2: Low, 3: High)	1	Weight of truck cargo (t)	25.0
Cargo capacity (length of cargo lanes)	4000	Truck weight (loaded)	35.0
Payload/deadweight at design draught (%)	70	Length of truck - total (m)	14.0
Lanemeter capacity utilization (pct.)	80	EURO norm (2, 3, 4, 5 or 6)	4
Deadweight per lanemeter (t/lm)	2.9	Suphur content of oil (%)	0.001
Default max. deadweight per lanemeter (t/lm)	3.1	Driving distance (km)	400
Rolling cargo load per lanemeter	1.8	Driving percentage in city area	5
Normal speed (knots)	21.2	EURO/DKK exchange rate	7.50
Speed change (pct.)	0.0		
Actual ship speed (knots)	21.2		
Suphur content of oil (%)	0.1	**External cost level**	
NOx emissions (IMO TIER 1, 2 or 3)	2	1 = Low, 2 = Mean, 3 = High	2
Slow speed (1) or medium speed main engine (2)	1		
Sailing percentage in harbour conditions	2	**Draft reserve (m) - shall be positive !**	**0.21**





Emissions (g/lanemeter/km)

Ship		Truck	
CO_2	84.5	CO_2	72.9
10 x NOx	20.7	10 x NOx	3.98
100 x SOx	5.53	100 x SOx	0.05
100 x CO	5.49	100 x CO	1.14
100 x HC	7.71	100 x HC	0.17
100 x Particulates	4.15	100 x Particulates	0.23

External costs (EURO/lanemeter/1000 km)

Ship		Truck	
Emissions	18.64	Emissions	3.70
Noise	0	Noise	1.05
Accidents	0	Accidents	13.24
Congestion	0	Congestion	6.10
Infrastructure	0	Infrastructure	10.76
Climate change	0.90	Climate change	0.78
Total	**19.5**	**Total**	**35.6**

External costs (EURO/lanemeter/1000 km)

Ship		Truck	
CO_2	0.90	CO_2	0.78
NOx	14.65	NOx	2.81
SOx	1.55	SOx	0.013
CO	0.00007	CO	0.00001
HC	0.021	HC	0.00047
Particulates	1.52	Particulates	0.10
Total	**18.64**	**Total**	**3.70**

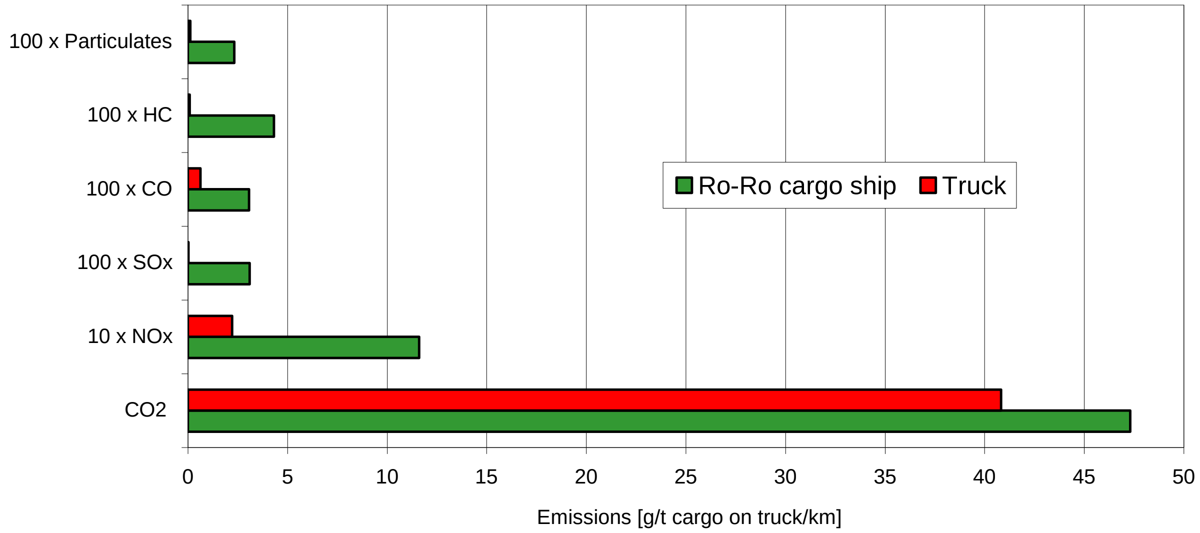
Service allowance on ship power (%)	10

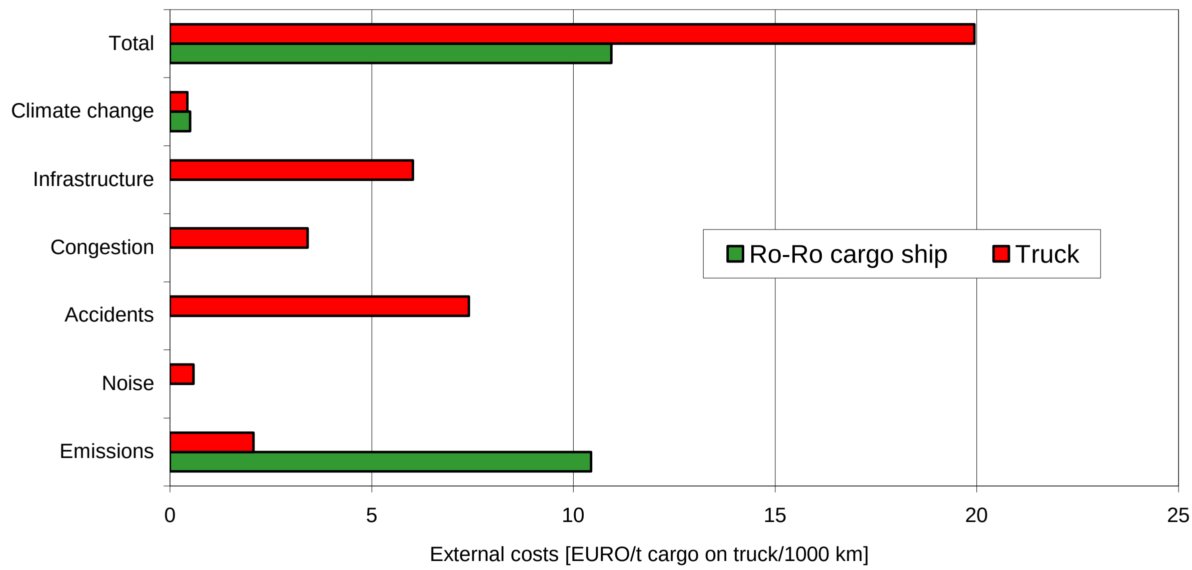
It is possible to scale the influence some of the external costs as follows:

Externality	Scaling (pct)
Noise	100
Accidents	100
Congestion	100
Infrastructure	100
Climate change	100

100 pct. means full implementation according to the quidelines by DTU/COWI

Ship data		Truck data	
Default ship (0) or ship alternative No. 1 or No. 2	0	Truck weight (empty)	10.0
Deadweight density (1: Normal, 2: Low, 3: High)	1	Weight of truck cargo (t)	28.0
Cargo capacity (length of cargo lanes)	4000	Truck weight (loaded)	38.0
Payload/deadweight at design draught (%)	70	Length of truck - total (m)	14.0
Lanemeter capacity utilization (pct.)	80	EURO norm (2, 3, 4, 5 or 6)	4
Deadweight per lanemeter (t/lm)	2.9	Suphur content of oil (%)	0.001
Default max. deadweight per lanemeter (t/lm)	3.1	Driving distance (km)	400
Rolling cargo load per lanemeter	1.8	Driving percentage in city area	5
Normal speed (knots)	21.2	EURO/DKK exchange rate	7.5
Speed change (pct.)	0.0		
Actual ship speed (knots)	21.2	**External cost level**	
Suphur content of oil (%)	0.1	1 = Low, 2 = Mean, 3 = High	2
NOx emissions (IMO TIER 1, 2 or 3)	2.0		
Slow speed (1) or medium speed main engine (2)	1.0		
Sailing percentage in harbour conditions	2.0	**Draft reserve (m) - shall be positive !**	**0.21**





Emissions (g/t cargo on truck/km)

Ship		Truck	
CO_2	47.3	CO_2	40.8
10 x NOx	11.61	10 x NOx	2.228
100 x SOx	3.10	100 x SOx	0.025
100 x CO	3.08	100 x CO	0.637
100 x HC	4.32	100 x HC	0.096
100 x Particulates	2.33	100 x Particulates	0.127

External costs (EURO/t cargo on truck/1000 km)

Ship		Truck	
Emissions	10.44	Emissions	2.07
Noise	0	Noise	0.59
Accidents	0	Accidents	7.41
Congestion	0	Congestion	3.41
Infrastructure	0	Infrastructure	6.03
Climate change	0.50	Climate change	0.44
Total	**10.94**	**Total**	**19.9**

External costs (EURO/t cargo on truck/1000 km)

Ship		Truck	
CO_2	0.50	CO_2	0.44
NOx	8.21	NOx	1.57
SOx	0.87	SOx	0.007
CO	0.00004	CO	0.00001
HC	0.012	HC	0.0003
Particulates	0.85	Particulates	0.05
Total	**10.44**	**Total**	**2.07**

Power prediction folders

Following folders are essential for the different types of power predictions needed to obtain the necessary propulsion power under different assumptions as follows:

PS1: Power prediction for service condition (i.e. including the prescribed service allowance, normally 15 pct.) at maximum draught according to default main dimensions

PT1: Power prediction for trial condition at maximum draught where the EEDI reference speed is calculated, i.e. the speed obtained at 75% MCR at maximum draught with NO service allowance. Valid for default main dimensions.

PAS1: Power prediction for actual service condition as specified in INPUT for default main dimensions

PS2: Power prediction for service condition (i.e. including the prescribed service allowance, normally 15 pct.) at maximum draught according to main dimensions for Alternative 1

PT2: Power prediction for trial condition at maximum draught where the EEDI reference speed is calculated, i.e. the speed obtained at 75% MCR at maximum draught with NO service allowance. Valid for Alternative 1.

PAS2: Power prediction for actual service condition as specified in INPUT for main dimensions for Alternative 1

PS3: Power prediction for service condition (i.e. including the prescribed service allowance, normally 15 pct.) at maximum draught according to main dimensions for Alternative 2

PT3: Power prediction for trial condition at maximum draught, where the EEDI reference speed is calculated, i.e. the speed obtained at 75% MCR at maximum draught with NO service allowance. Valid for alternative 2.

PAS3: Power prediction for actual service condition as specified in INPUT for main dimensions for Alternative 2.

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