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Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)

Méthodologie pour le calcul et la déclaration de la consommation d'énergie et des émissions de gaz à effet de serre (GES) des prestations de transport (passagers et fret)

Methode zur Berechnung und Deklaration des Energieverbrauchs und der Treibhausgasemissionen bei Transportdienstleistungen (Güter- und Personenverkehr)

This European Standard was approved by CEN on 8 September 2012.

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Foreword

This document (EN 16258:2012) has been prepared by Technical Committee CEN/TC 320 “Transport - Logistics and services”, the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2013, and conflicting national standards shall be withdrawn at the latest by May 2013.

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Introduction

This standard sets out the methodology and requirements for calculating and reporting energy consumption and greenhouse gas (GHG) emissions in transport services. This first edition of the standard is primarily focused on energy consumption and GHG emissions associated with vehicles (used on land, water and in the air) during the operational phase of the lifecycle. However, when calculating the energy consumption and emissions associated with vehicles, account is also taken of the energy consumption and emissions associated with energy processes for fuels and/or electricity used by vehicles (including for example production and distribution of transport fuels). This ensures the standard takes a "well-to-wheel" approach when undertaking calculations, and when making declarations to transport service users.

The philosophy, contents, and structure adopted in this standard seek to make it widely applicable across the transport sector (encompassing all modes impartially) and accessible to a very diverse user group. Within this sector, it is recognised that transport operations vary hugely, from multi-national organisations operating multiple transport modes to deliver transport services across the globe, through to a small local operator delivering a simple service to one user. In addition, the potential user group for this standard is similarly diverse, and the monitoring of transport energy and emissions within organisations can be at different levels of maturity and sophistication. Consequently, this first edition of the standard balances the desire for absolute precision and scientific rigour with a degree of pragmatism in order to achieve ease of use, accessibility and encourage widespread use.

Use of this standard will provide a common approach and frameworks for the calculation and declaration of energy consumption and emissions for transport services irrespective of the level of complexity (e.g. a simple transport service can provide one customer with a single journey, whereas a complex system can involve several legs, multiple vehicle types, different transport modes and several companies within the transport supply chain). The standard ensures declarations have greater consistency and transparency, and that the energy and emissions are fully allocated to a vehicle’s load (passengers and/or cargo).

It is anticipated that future editions of the standard will have broader quantification boundaries, to include additional aspects such as, transport terminals, transhipment activities, and other phases of the lifecycle. Users of the standard that would now like to use broader quantification boundaries, without waiting for a new edition of the standard are advised to communicate such results separately from the ones calculated according to this standard, and to give a transparent description of the methodology applied.

1 Scope

This European Standard establishes a common methodology for the calculation and declaration of energy consumption and greenhouse gas (GHG) emissions related to any transport service (of freight, passengers or both).

It specifies general principles, definitions, system boundaries, calculation methods, apportionment rules (allocation) and data recommendations, with the objective to promote standardised, accurate, credible and verifiable declarations, regarding energy consumption and GHG emissions related to any transport service quantified. It also includes examples on the application of the principles.

Potential users of this standard are any person or organisation who needs to refer to a standardised methodology when communicating the results of the quantification of energy consumption and GHG emissions related to a transport service, especially:

— transport service operators (freight or passengers carriers);

— transport service organisers (carriers subcontracting transport operations, freight forwarders and travel agencies);

— transport service users (shippers and passengers).

2 Terms, definitions and abbreviations

For the purposes of this document, the following terms and definitions apply.

2.1 General terms

2.1.1
carbon dioxide equivalent
CO_2e
unit for comparing the radiative forcing of a GHG to carbon dioxide

Note 1 to entry: The carbon dioxide equivalent is calculated using the mass of a given GHG multiplied by its global warming potential

[SOURCE: ISO 14064-1:2006]

2.1.2
carbon offsetting
mechanism for compensating for carbon emissions of a process through the prevention of the release of, reduction in, or removal of, an equivalent amount of GHG emissions outside the boundary of that process, provided such prevention, removal or reduction are quantified, permanent and additional to a business-as-usual scenario

[SOURCE: adapted from ISO 14021:2010]

2.1.3
cargo
collection / quantity of goods (carried on a means of transport) transported from one place to another

Note 1 to entry: Cargo can consist of either liquid or solid materials or substances, without any packaging (e.g. bulk cargo), or of loose items of unpacked goods, packages, unitised goods (on pallets or in containers) or goods loaded on transport units and carried on active means of transport.

[SOURCE: EN 14943:2005]

2.1.4
energy
electricity, fuels, steam, heat, compressed air and other like media

[SOURCE: EN ISO 50001:2011 modified]

2.1.5
energy carrier
substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes

[SOURCE: ISO 13600:1997]

2.1.6
energy consumption
quantity of energy applied

[SOURCE: EN ISO 50001:2011]

2.1.7
energy factor
factor relating activity data to energy consumption

2.1.8
energy use
manner or kind of application of energy

EXAMPLE Vehicle propulsion, cooling, heating.

[SOURCE: EN ISO 50001:2011 modified]

2.1.9
freight
goods being transported from one location to another

[SOURCE: EN 14943:2005]

2.1.10
fuel consumption
quantity of energy carrier used by the means of transport

Note 1 to entry: For reasons of simplification, this definition includes all energy carriers, such as electricity.

Note 2 to entry: For rail transport using electric traction, the fuel consumption is the total quantity of energy collected from the contact line minus any energy returned to the contact line by the vehicle. Energy is returned (to the contact line) when electric traction has regenerative braking and the energy generated during braking is made available to other consumers connected to the contact line.

2.1.11
global warming potential
GWP
factor describing the radiative forcing impact of one mass-based unit of a given green house gas relative to an equivalent unit of carbon dioxide over a period of one hundred years

[SOURCE: ISO 14064-1:2006 modified]

2.1.12
greenhouse gas
GHG
gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, the atmosphere, and clouds

Note 1 to entry: In this standard, GHGs are limited to, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). There are the six gases listed in Annex A of the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

[SOURCE: ISO 14064-1:2006 modified]

2.1.13
greenhouse gas emission factor
GHG emission factor
factor relating activity data to GHG emissions

2.1.14
means of transport
particular vessel, vehicle, or other mobile device used for the transport of passenger and/or freight

[SOURCE: EN 14943:2005 modified]

2.1.15
passenger
pax
person carried in a vehicle, without participating in its operation

Note 1 to entry: The term and its abbreviation are also used as a unit for quantity of passengers.

2.1.16
route
path (to be) taken to get from one point to another point

[SOURCE: EN 14943:2005 modified]

2.1.17
transport
assisted movement of passenger and/or freight

Note 1 to entry: The term "transport" in general is used for movement supported by means.

[SOURCE: EN 14943:2005 modified]

2.1.18
Twenty-Foot Equivalent Unit
TEU
standard unit (6,10 m) used to express a number of containers of various lengths and for describing the capacities of container ships or terminals

Note 1 to entry: One standard forty-foot ISO Series container equals 2 TEUs.

[SOURCE: EN 14943:2005 modified]

2.1.19
vehicle
any means of transport

Note 1 to entry: Within this standard, this definition includes vessels (watercraft and aircraft like ships, boats, and planes), for reasons of simplification only.

2.2 Specific terms

2.2.1
default value
external value which is not determined by the transport service operator

Note 1 to entry: Guidelines related to the use of this concept are given in 5.4 of this standard.

2.2.2
empty trip
section of the route of a vehicle during which no cargo or passenger is transported

EXAMPLE Positioning trips are empty trips.

2.2.3
energy process
operational process taking place upstream of the level of the vehicle, needed for all energy carrier used by the vehicle

2.2.4
fleet
set of vehicles operated by one transport service operator

2.2.5
Great Circle Distance
theoretical shortest distance between any two points on the surface of the planet measured along a path on the surface of the sphere (as opposed to going through the sphere's interior)

2.2.6
load
quantity or nature of whatever is being carried by a vehicle

[SOURCE: EN 14943:2005 modified]

2.2.7
leg (of a transport service)
for a transport service of a cargo or a passenger, section of the route taken or to be taken within which the cargo or the passenger is carried by the vehicle

2.2.8
load factor
ratio of the actual load and the maximum authorised load of one means of transport

Note 1 to entry: Different dimensions are used for the measurement of the capacity, such as mass and volume.

[SOURCE: EN 14943:2005 modified]

2.2.9
marginal accounting
Method of allocation consisting in differentiation of entities on the basis of non-physical criteria

EXAMPLE For a flight, most of the fuel consumption is allocated to passengers, and belly freight is allocated only of the extra fuel consumption corresponding to the extra weight of the plane.

2.2.10
process
activity using energy and/or emitting GHG

2.2.11
specific measured value
value measured for a specific aspect of the calculation being performed

2.2.12
shortest feasible distance
distance actually achievable by the shortest route, with the vehicle considered

2.2.13
tank-to-wheels assessment
assessment related to the vehicle processes

2.2.14
transport activity
quantity of passenger, cargo or vehicles movements

EXAMPLE Two thousand passenger kilometres, one thousand five hundred tonne kilometres, one hundred pallets carried, five hundred vehicle kilometres.

2.2.15
transport operator fleet value
value established by the transport service operator on the basis of measurements of the transport activity of a fleet that includes the type of vehicle for which the calculation is being performed

2.2.16
transport operator specific value
value established by the transport service operator on the basis of measurements, specifically for the type of vehicle or the type of route for which the calculation is being performed

2.2.17
transport service
service provided to a beneficiary for the transport of a cargo or a passenger from a departure point to a destination point

Note 1 to entry: The beneficiary is named “transport service user”; see definition 2.2.20

2.2.18
transport service organiser
entity that provides transport services which are subcontracted to another entity (transport service operator) which operates them

Note 1 to entry: A transport service organiser can be a freight forwarder, an entity organising trips/travel (e.g.: travel agency, tour operator), a local authority responsible of public passenger transport

2.2.19
transport service operator
entity that carries out transport services

Note 1 to entry: A transport service operator can be a passenger's carrier (acting directly for passengers or as sub-contractor of a transport service organiser), a freight carrier (acting directly for shippers or as sub-contractor of a transport service organiser).

2.2.20
transport service user
entity that buys and/or uses a transport service

Note 1 to entry: A transport service user can be a passenger, a shipper, or a transport service organiser (for the transport services sub contracted to transport service operators).

2.2.21
vehicle operation
deployment of a vehicle to fully or partially provide a transport service for one or more transport service users

2.2.22
vehicle operation system
VOS
set of vehicle operations

Note 1 to entry: Guidelines and examples related to the use of this concept are given in Clause 7 and Annexes C, E and F of this standard

2.2.23
vehicle process
process taking place at the level of a vehicle, corresponding to operation of engines on board

2.2.24
well-to-tank assessment
assessment related to the energy processes

2.2.25
well-to-wheels assessment
assessment related to both vehicle and energy processes

3 Units and symbols

3.1 Energy

Quantities of energy shall be expressed in joule (J) or multiple thereof such as megajoule (MJ) or gigajoule (GJ).

3.2 GHG emissions

Quantities of GHG emissions shall be expressed in gram (g) of carbon dioxide equivalent (CO_2e) or multiples thereof such as kilogram (kg) or tonne (t) of CO_2e.

4 Quantification boundaries

4.1 General

The processes in the following subclauses relate to the transport service being assessed and are not limited by organisational boundaries.

4.2 Processes included

The assessment of energy consumption and GHG emissions of a transport service shall include both vehicle operational processes and energy operational processes that occur during the operational phase of the lifecycle.

The vehicle operational processes shall include operation of all on-board vehicle systems including propulsion and ancillary services.

EXAMPLES Main engines, ancillary equipment used to maintain the temperature of the cargo space, handling or transhipment devices on board are on-board vehicle systems which operation is included.

The energy operational processes shall include:

— for fuels: extraction or cultivation of primary energy, refining, transformation, transport and distribution of energy at all steps of the production of the fuel used;

— for electricity: extraction and transport of primary energy, transformation, power generation, losses in electricity grids.

NOTE 1 Details of excluded processes and examples are given in 4.3.

NOTE 2 Careful use of European Directives on fuels and electricity such as Directive 2009/30/EC on Fuel Quality and Directive 2009/72/EC on internal market in electricity can assist in quantifying energy processes in the context of this standard. However, it has to be pointed out that calculations done in accordance with Directive 2009/72/EC could include only CO_2 and only the upstream processes from power plants to the customer, and so not all operational energy processes and all gases required by this CEN standard.

4.3 Processes not included

The assessment of energy consumption and GHG emissions of a transport service shall not include, in particular:

— direct emissions of GHG resulting from leakage (of refrigerant gas or natural gas for example) at the vehicle level;

— additional impacts of combustion of aviation fuel in high atmosphere, like contrails, cirrus, etc.;

— processes consisting of short-term assistance to the vehicle for security or movement reasons, with other devices like tugboats for towing vessels in harbours, aircraft tractors for planes in airports, etc;

— processes implemented by external handling or transhipment devices (for freight), or by external movement devices (for passengers, like elevators and moving walkways), for the movement or transhipments of freight or the movement of passengers. In express delivery services and other transport services organised in networks, handling operations that take place inside platforms, and consisting of loading and unloading of parcels or pallets, belong to this category of processes;

— processes at the administrative (overhead) level of the organisations involved in the transport services. These processes can be operation of buildings, staff commuting and business trips, computer systems, etc;

— processes for the construction, maintenance, and scrapping of vehicles;

— processes of construction, service, maintenance, and dismantling of transport infrastructures used by vehicles;

— non operational energy processes, like the production or construction of extraction equipments, of transport and distribution systems, of refinery systems, of enrichment systems, of power production plants, etc. so as their reuse, recycle and scrap.

4.4 Greenhouse gases

Calculation of GHG emissions shall include all the following six gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Any other gas shall be excluded.

4.5 Carbon offsetting and emissions trading

Outcomes from carbon offsetting actions or emissions trading (whether or not under the EU ETS) shall not be taken into account for calculation and declaration of energy consumption and GHG emissions in transport services.

5 Principles of calculation of energy consumption and GHG emissions in transport services

5.1 General objectives

Calculation shall take into account:

— all vehicles used to perform the transport service, including those operated by subcontractors;

— all fuel consumption from each energy carrier used by each vehicle;

— all loaded and empty trips made by each vehicle.

EXAMPLE For the following vehicles using two different energy carriers, both energy carriers are taken into account for the calculation: road vehicle using LPG and gasoline, road vehicle using electricity and gasoline (plug in), ship using HFO (heavy fuel oil) and MDO (marine diesel oil).

Calculation shall produce the four following results:

— well-to-wheels energy consumption (E_w);

— well-to-wheels GHG emissions (G_w);

— tank-to-wheels energy consumption (E_t);

— tank-to-wheels GHG emissions (G_t).

5.2 Steps of the calculation of energy consumption and GHG emissions of one transport service

Calculation for one given transport service shall be implemented through the following three main steps:

— step 1: Identification of the different legs of this transport service (see Clause 6);

— step 2: Calculation of energy consumption and GHG emissions of each leg (see corresponding sub steps in 5.3);

— step 3: Sum of the results for each leg (see Clause 9).

5.3 Sub steps for the calculation of energy consumption and GHG emissions of one leg of one transport service

Calculation for one leg of one transport service shall be implemented through the following four main sub steps:

— sub step 2.1: Establishing the vehicle operation system (VOS) related to this leg;

— sub step 2.2: Quantification of the total fuel consumption for this VOS;

— sub step 2.3: Calculation of total energy consumption and GHG emissions for this VOS;

— sub step 2.4: Allocation to the leg of a share of each of the four results of sub step 2.3.

Sub steps 2.1, 2.2 and 2.3 shall be undertaken according to Clause 7.

Sub step 2.4 shall be undertaken according to Clause 8.

5.4 Categories of values used for the calculation

5.4.1 General

Calculations explained further on in this standard require using data related to the operational characteristics of the transport service and the vehicles used to achieve the legs. These characteristics can be, for example:

— fuel consumption;

— distance;

— fuel consumption per distance;

— load;

— load factor;

— vehicle capacity;

— empty distance.

NOTE Energy and GHG emission factors are not operational characteristics and so are not concerned by this subclause.

The values selected for these operational characteristics shall be determined in accordance with this standard and shall belong to the following categories of values, given by order of preference:

- specific measured values;
- transport operator specific values;
- transport operator fleet values;
- default values.

For the use of default values, 5.4.2 shall be followed.

NOTE 1 A mix of these values categories can be used.

NOTE 2 Examples of calculations with the use of the different categories of values are given in Annexes E, F and G.

5.4.2 Use of default values

Default values should be taken from a published documentation. The last available version should be used.

Default values should be relevant to the operation for which the calculation is being performed.

6 Principles of identification of the different legs of a transport service

The transport service to be quantified shall be analysed in regards to the different vehicles that carry the cargo and / or the passenger successively.

Step 1 as described in 5.2 shall be implemented by associating each section of the route using the same vehicle to a leg of the transport service.

EXAMPLE If a passenger firstly takes a bus, then a metro and finally a second bus, with the same ticket, the corresponding transport service is composed of three legs.

7 Principles of the calculation at the vehicle operation system (VOS) level

7.1 General

Clause 7 provides principles for the first three sub steps (2.1, 2.2 and 2.3) of the calculation for one leg. These three sub steps correspond to the calculation at the VOS level.

7.2 Sub step 2.1: Establishing the VOS related to the leg

The calculation of any leg of a transport service shall start with the selection of a VOS related to this leg.

As a minimum requirement, this VOS shall be a consistent set of vehicle operations relevant to the leg being calculated.

When establishing the VOS, consideration should be given to factors which affect the scale and composition of the VOS such as:

- number and type of vehicles to be included;
- period of time of activity of these vehicles.

The VOS may be chosen according to the criteria chosen by the user of this standard.

In all cases, the VOS shall include the empty trips related to the vehicle operations.

NOTE Annex C gives examples showing the inclusion of empty trips into a VOS.

EXAMPLE 1 The whole activity of the fleet of a transport operator over one year can be the VOS for all legs performed by this fleet.

EXAMPLE 2 If the leg is a part of a container ship line, the VOS related to this leg can be the whole ship line.

EXAMPLE 3 If the leg is included in a collection and/or delivery round trip, the VOS related to this leg can be this collection/delivery round trip.

EXAMPLE 4 If the leg is a trip of a passenger in a public transport bus, the VOS related to this leg can be the whole bus line from starting point to the ending point. It is also possible to choose the whole bus network.

7.3 Sub step 2.2: Quantification of the total fuel consumption for the VOS

Quantification of the total fuel consumption for the VOS shall be undertaken using the categories of values listed in 5.4.

In the cases for which the vehicles use different energy carriers, total fuel consumptions shall be quantified separately for each energy carrier used.

7.4 Sub step 2.3: Calculation of total energy consumption and GHG emissions for the VOS

Conversion from total fuel consumption for the VOS into quantities of energy consumption and GHG emissions shall be made using following formulas:

— for well-to-wheels energy consumption of the VOS:

$$E_w(VOS) = F(VOS) \times e_w \tag{1}$$

— for well-to-wheels GHG emissions of the VOS:

$$G_w(VOS) = F(VOS) \times g_w \tag{2}$$

— for tank-to-wheels energy consumption of the VOS:

$$E_t(VOS) = F(VOS) \times e_t \tag{3}$$

— for tank-to-wheels GHG emissions of the VOS:

$$G_t(VOS) = F(VOS) \times g_t \tag{4}$$

where

F(VOS) is the total fuel consumption used for the VOS (examples: F(VOS) equals five thousand litres of diesel; or F(VOS) equals thirty thousand kilowatt hours);

e_w is the well-to-wheels energy factor for the fuel used (example: for diesel, e_w = 42,7 MJ/l);

g_w is the well-to-wheels GHG emission factor for the fuel used (example: for diesel, g_w = 3,24 $kgCO_2e/l$);

e_t is the tank-to-wheels energy factor for the fuel used (example: for diesel, e_t = 35,9 MJ/l);

g_t is the tank-to-wheels GHG emission factor for the fuel used (example: for diesel, g_t = 2,67 $kgCO_2e/l$).

Values for energy and GHG emission factors shall be selected in accordance with Annex A.

If the vehicles use different energy carriers within the VOS, the several fuel consumptions quantified in sub step 2.2 shall be separately converted into energy consumption and GHG emissions, and then added together.

8 Principles of allocation to cargo and/or passengers

8.1 General

This clause sets out requirements for the fourth sub step (2.4) for the calculation for one leg.

After sub steps 2.1, 2.2 and 2.3 are done, the leg of the transport service shall be allocated a share of $E_w(VOS)$, $G_w(VOS)$, $E_t(VOS)$, $G_t(VOS)$, corresponding to its relative share of the transport activity performed within the VOS.

Corresponding formulas are:

$$S(\text{leg}) = T(\text{leg}) \div T(\text{VOS}) \quad (5)$$

$$E_w(\text{leg}) = E_w(\text{VOS}) \times S(\text{leg}) \quad (6)$$

$$G_w(\text{leg}) = G_w(\text{VOS}) \times S(\text{leg}) \quad (7)$$

$$E_t(\text{leg}) = E_t(\text{VOS}) \times S(\text{leg}) \quad (8)$$

$$G_t(\text{leg}) = G_t(\text{VOS}) \times S(\text{leg}) \quad (9)$$

where

S(leg) is the factor used to calculate the share of the VOS's energy and emissions which is allocated to a transport service for the leg. This share is based on relative proportions of transport activity for the leg and for the associated VOS;

T(leg) is the transport service's transport activity for the leg ;

T(VOS) is the transport activity of the VOS which is related to the leg (see 7.2);

T(leg) and T(VOS) shall have the same allocations parameters and units, and are to be determined according to 8.3.

NOTE As Clause 8 presents different possibilities of apportionment, Clause 10 specifies that choices made by the user regarding allocation methods will be declared and justified.

8.2 Basic principles

All energy consumption and GHG emissions of the vehicle operation shall be allocated to the corresponding cargo and/or passengers carried.

No marginal accounting shall be carried out for any cargo or passenger carried.

The allocation parameters and units used shall remain consistent over time, as appropriate.

Only one allocation method shall be used for all the cargo and/or passengers within the same VOS.

8.3 Allocation parameters and units

8.3.1 General

The allocation parameter shall be the transport activity.

8.3.2 Allocation for passengers

8.3.2.1 General

The transport activity should be quantified by multiplying the quantity of passengers by the distance travelled.

The quantity of passengers should be the number of passengers.

The distance travelled should be the real distance travelled.

If distance is used in aviation, it shall be the Great Circle Distance plus 95 kilometres.

Therefore, the allocation parameter should be the product of the number of passengers by the real distance travelled.

The corresponding allocation unit is passenger kilometre (pax.km)

8.3.2.2 Other parameters and units

Other allocation parameters may be the transport activity measured with the number of passengers or number of trips.

8.3.3 Allocation for freight

8.3.3.1 General

The transport activity should be quantified by multiplying the quantity of freight by the distance travelled.

The quantity of freight shall be characterised by the cargo being carried, including any packaging, container, and means of handling or transport except those that are not part of the shipment.

EXAMPLE 1 For a cargo carried on pallets, the quantity of freight includes the pallets.

EXAMPLE 2 For a cargo carried on a truck that uses a Roll-On Roll-Off maritime transport service, the quantity of freight corresponds to the truck and its cargo and not just to the cargo inside the truck.

EXAMPLE 3 For a cargo carried on a train in a swap body in combined rail road transport, the quantity of freight corresponds to the swap body and its cargo.

EXAMPLE 4 For a cargo carried on pallets on a train, the quantity of freight corresponds to the cargo including the pallets.

EXAMPLE 5 For a cargo that is bundled by the transport service organiser or transport service operator to allow for easy handling (e.g. on a pallet or in a container), the quantity of freight does not include the cargo carrier.

The unit for quantity of freight should be the mass.

The distance travelled should be the real distance travelled, except for collection and distribution round trips (as specified in 8.3.3.3).

If distance is used in aviation, it shall be the Great Circle Distance plus 95 kilometres.

Therefore, the allocation parameter should be the product of the mass by the real distance travelled.

Corresponding allocation unit is tonne kilometre (t.km).

8.3.3.2 Other parameters and units

As the parameter for quantity of freight, mass may be replaced by another unit, especially if it is more relevant to the vehicle's capacity limit, like volume, pallet, parcel, Twenty-foot Equivalent Unit (TEU), lane meter, etc.

Other allocation parameters may also be the transport activity expressed in:

— either quantity of freight only, represented by mass or other parameter like volume, etc; corresponding units are tonne, cubic metre (m^3), etc.;

— or quantity of distance only, represented by real distance travelled or, for round trips, Great Circle Distance or shortest feasible distance; corresponding unit is kilometre (km).

8.3.3.3 Collection and distribution round trips

Concerning the distance travelled, one of the two following options should be taken:

— use of the Great Circle Distance;

— use of the shortest feasible distance.

8.3.4 Combined transport of passengers and freight

8.3.4.1 Air transport

The transport activity shall be quantified by multiplying the mass of passengers and freight by the distance travelled.

The total mass shall be the sum of:

a) mass of freight;

b) mass of passengers calculated with, by order of preference:

1) first option: the mass for passengers and checked baggage contained in the mass and balance documentation[1)] for the flight;

2) second option: a default value of 0,1 tonne for each passenger including their checked baggage.

Distance shall be the Great Circle Distance plus 95 kilometres.

Corresponding allocation unit is tonne kilometre (t.km).

NOTE 1 If the VOS consists of flights between the same origins and destinations, then the allocation parameter becomes mass only, as distances are the same for all cargo and passengers.

NOTE 2 This specific recommendation conforms to European Commission Decision 2009/339/EC regarding the inclusion of monitoring and reporting guidelines for emissions and tonne-kilometre data from aviation activities.

8.3.4.2 Maritime transport (ferries)

One of the two allocation methods, detailed in Annex B, shall be used:

— mass allocation method;

— area allocation method.

8.3.4.3 Any other combined transport of passengers and freight

In the case of any other combined transport of passengers and freight not covered by 8.4.4.1 and 8.4.4.2, a specific method for measurement of the transport activity may be adapted and used. Then a description of this method and justification for its use shall be given in the declaration.

8.4 Data collecting

Quantities of cargo, passengers and distances used for allocation formulas shall be obtained according to 5.4.

9 Principles of summing the results for each leg

The values of E_w, G_w, E_t and G_t for the complete transport service shall be calculated (step 3) by adding together the corresponding values (calculated according to 8.1 to 8.4) for all legs of the transport service.

NOTE The total results for the transport service can be obtained from a mix of categories of values (specific measured values; transport operator vehicle-type or route-type specific values; transport operator fleet values; default values), especially if the transport service is composed of several legs

10 Declaration

10.1 General

Declarations on energy consumption and GHG emissions of a transport service shall include:

a) four results, calculated according to previous clauses, which are:

---

1) According to European Commission Decision 2009/339/EC, "mass and balance documentation" means the documentation as specified in international or national implementation of the Standards and Recommended Practices (SARPs);

1) well-to-wheels GHG emissions (G_w) of the transport service;

2) tank-to-wheels GHG emissions (G_t) of the transport service;

3) well-to-wheels energy consumption (E_w) of the transport service;

4) tank-to-wheels energy consumption (E_t) of the transport service;

b) supporting information specified in 10.3.

The units and corresponding symbols to be used in the declaration are set out in Clause 3.

For the declaration to the beneficiary, the user of the standard may use any medium which gives the clearest results and associated basis for calculations, such as pages on web sites.

10.2 Possibility to make a short declaration

A declaration may be made in two separate parts provided that:

a) the first part contains:

1) well-to-wheels GHG emissions (G_w) of the transport service;

2) the following statement: "This is one of the four results calculated according to standard EN 16258:2012. Please consult [XXXX] to obtain the remaining results and supporting information;"

NOTE In the above text, [XXXX] is replaced by text giving details (e.g. a web address) of where the other three results and the supporting information can be obtained.

b) the second part contains the three other results and the supporting information, and is available to the receiver of the declaration during a reasonable period of time.

10.3 Supporting information

10.3.1 General statement

The following statement shall be communicated:

"These four results have been established according to the standard EN 16258:2012. Please consult this standard to get further information about processes not taken into account, guidelines and general principles. If you wish to make comparisons between these results and other results calculated in accordance with this standard, please take particular care to review the detailed methods used, especially allocation methods and data sources."

10.3.2 Transparent description of the method

The user of the standard shall make available to the receiver of the results a transparent description of the method used.

This description shall include:

a) categories of (each) value(s) used for the calculation (cf. 5.4);

b) if an energy or a GHG emission factor different than the one provided in Annex A has been used, justifications for the factor used;

c) if a default value has been used:

1) the default value used;

2) each corresponding source, identified precisely;

3) justifications for the choice of this source;

4) justifications for the use of default values instead of specific measured or transport operator's values;

d) if electricity is used, justifications for energy and GHG emission factor used for electricity;

e) if a fuel used is a blend of bio fuel and conventional fuel, share of bio fuel included in the blend;

f) the allocation methods applied, including parameters and units selected, with justifications;

g) the list of recommendations of the standard that have not been implemented, with justifications;

NOTE Annex D gives a template for declaration of categories of values used for the calculation.

In addition, the description may include, in particular:

h) a basic description of the transport service (starting point, point of destination, load);

i) an explicit description of the operational implementation of the transport service;

j) the VOS selected for each leg;

k) if transport operator fleet values are used, additional information about system boundaries (e.g. size of fleet, vehicle classes);

l) information on the ratio between the four results and the transport activity, for example expressed in kilogramme of CO_2e per tonne kilometre, or kilogramme of CO_2e per passenger kilometre;

m) any other general information necessary for the understanding of the method.

Annex A
(normative)

Energy and GHG emission factors

A.1 Transport fuels

A.1.1 General

Any energy and GHG emission factor of transport fuels used for the implementation of this standard shall be, by order of preference:

a) the value specified by the fuel supplier according to European Commission Directive 2009/30/EC and any amendments to this directive;

b) the value established on the basis of following Table A.1 and A.1.3, A.1.4 and A.1.5;

c) any other value provided that:

   1) the declaration is completed with this value, the corresponding source, and justification for its use;

   2) the value selected includes all upstream operational processes according to the objectives of this standard as required in Clause 4;

   3) if biofuels are used, the methodology is consistent with Directive 2009/30/EC and any amendments to this directive.

A.1.2 Consistency between sources

If a value is taken from one source for a tank-to-wheels energy or GHG emission factor of a transport fuel, then the corresponding value for the well-to-wheels factor should be obtained either directly from the same source, or by addition of the value of the well-to-tank factor from another source. This well-to-wheels factor should not be taken directly from another source.

A.1.3 Table of energy and GHG emission factors

Following table A.1 provides the factors for the main transport fuels.

Sources used and calculations done for the establishment of this table A.1 are detailed in Annex H.

Table A.1 — Transport fuels: density, energy factor and GHG emission factor

	Density (d)	Energy factor				GHG emission factor					
		Tank-to-wheels (e_t)		Well-to-wheels (e_w)		Tank-to-wheels (g_t)			Well-to-wheels (g_w)		
Fuel type description	kg/l	MJ/kg	MJ/l	MJ/kg	MJ/l	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$
Gasoline	0,745	43,2	32,2	50,5	37,7	75,2	3,25	2,42	89,4	3,86	2,88
Ethanol	0,794	26,8	21,3	65,7	52,1	0	0	0	58,1	1,56	1,24
Gasoline/Ethanol blend 95/5	0,747	42,4	31,7	51,4	38,4	72,6	3,08	2,30	88,4	3,74	2,80
Diesel	0,832	43,1	35,9	51,3	42,7	74,5	3,21	2,67	90,4	3,90	3,24
Bio-diesel	0,890	36,8	32,8	76,9	68,5	0	0	0	58,8	2,16	1,92
Diesel/bio-diesel blend 95/5	0,835	42,8	35,7	52,7	44,0	71,0	3,04	2,54	88,8	3,80	3,17
Liquefied Petroleum Gas (LPG)	0,550	46,0	25,3	51,5	28,3	67,3	3,10	1,70	75,3	3,46	1,90
Compressed Natural Gas (CNG)		45,1		50,5		59,4	2,68		68,1	3,07	
Aviation Gasoline (AvGas)	0,800	44,3	35,4	51,8	41,5	70,6	3,13	2,50	84,8	3,76	3,01
Jet Gasoline (Jet B)	0,800	44,3	35,4	51,8	41,5	70,6	3,13	2,50	84,8	3,76	3,01
Jet Kerosene (Jet A1 and Jet A)	0,800	44,1	35,3	52,5	42,0	72,1	3,18	2,54	88,0	3,88	3,10
Heavy Fuel Oil (HFO)	0,970	40,5	39,3	44,1	42,7	77,7	3,15	3,05	84,3	3,41	3,31
Marine Diesel Oil (MDO)	0,900	43,0	38,7	51,2	46,1	75,3	3,24	2,92	91,2	3,92	3,53
Marine Gas Oil (MGO)	0,890	43,0	38,3	51,2	45,5	75,3	3,24	2,88	91,2	3,92	3,49

A.1.4 Biofuel Blends

Energy and GHG emission factors for biofuel blends shall be calculated using the factors of the fuels blended, taking into account their relative share in the blend based on fuel volume or fuel energy content.

Following Tables A.2, A.3, A.4 and A.5 give the values for different percentage of biofuel in the blend, on the basis of the factors given in Table A.1.

Table A.2 — Gasoline/Ethanol blend factors, % biofuel (share by volume)

Gasoline/Ethanol blend	Density (d)	Energy factor				GHG emission factor					
% of ethanol in volume		Tank-to-wheels (e_t)		Well-to-wheels (e_w)		Tank-to-wheels (g_t)			Well-to-wheels (g_w)		
	kg/l	MJ/kg	MJ/l	MJ/kg	MJ/l	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$
1 %	0,74549	43,0	32,1	50,8	37,8	74,7	3,21	2,40	89,23	3,84	2,86
2 %	0,74598	42,9	32,0	50,9	38,0	74,2	3,18	2,37	89,03	3,82	2,85
3 %	0,74647	42,7	31,9	51,1	38,1	73,6	3,14	2,35	88,81	3,79	2,83
4 %	0,74696	42,5	31,8	51,2	38,3	73,1	3,11	2,32	88,60	3,77	2,81
5 %	0,74745	42,4	31,7	51,4	38,4	72,6	3,08	2,30	88,39	3,74	2,80
6 %	0,74794	42,2	31,5	51,6	38,6	72,1	3,04	2,27	88,18	3,72	2,78
7 %	0,74843	42,0	31,4	51,7	38,7	71,6	3,01	2,25	87,96	3,69	2,77
8 %	0,74892	41,8	31,3	51,9	38,9	71,1	2,97	2,23	87,74	3,67	2,75
9 %	0,74941	41,7	31,2	52,0	39,0	70,5	2,94	2,20	87,52	3,65	2,73
10 %	0,74990	41,5	31,1	52,2	39,1	70,0	2,90	2,18	87,30	3,62	2,72
15 %	0,75235	40,6	30,6	53,0	39,9	67,3	2,73	2,06	86,18	3,50	2,63
20 %	0,75480	39,8	30,0	53,8	40,6	64,5	2,56	1,94	85,01	3,38	2,55
30 %	0,75970	38,1	28,9	55,3	42,0	58,6	2,23	1,69	82,54	3,14	2,39

Table A.3 — Gasoline/Ethanol blend factors, % biofuel (share by energy)

Gasoline/Ethanol blend	Density (d)	Energy factor				GHG emission factor					
% of ethanol in energy		Tank-to-wheels (e_t)		Well-to-wheels (e_w)		Tank-to-wheels (g_t)			Well-to-wheels (g_w)		
	kg/l	MJ/kg	MJ/l	MJ/kg	MJ/l	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$
1 %	0,74579	42,9	32,0	50,7	37,8	74,5	3,20	2,38	89,04	3,82	2,85
2 %	0,74656	42,7	31,9	51,0	38,1	73,7	3,15	2,35	88,73	3,79	2,83
3 %	0,74733	42,4	31,7	51,2	38,3	73,0	3,10	2,31	88,42	3,75	2,80
4 %	0,74808	42,2	31,5	51,5	38,5	72,2	3,05	2,28	88,11	3,72	2,78
5 %	0,74883	41,9	31,4	51,7	38,7	71,5	3,00	2,24	87,79	3,68	2,76
6 %	0,74957	41,7	31,2	51,9	38,9	70,7	2,95	2,21	87,48	3,65	2,73
7 %	0,75030	41,4	31,1	52,1	39,1	70,0	2,90	2,17	87,17	3,61	2,71
8 %	0,75102	41,2	30,9	52,4	39,3	69,2	2,85	2,14	86,86	3,58	2,69
9 %	0,75174	40,9	30,8	52,6	39,5	68,5	2,80	2,11	86,55	3,54	2,66
10 %	0,75244	40,7	30,6	52,8	39,7	67,7	2,76	2,07	86,24	3,51	2,64
15 %	0,75585	39,6	29,9	53,9	40,7	63,9	2,53	1,91	84,68	3,35	2,53
20 %	0,75907	38,5	29,2	54,9	41,6	60,2	2,32	1,76	83,12	3,20	2,43

Table A.4 — Diesel/bio-diesel blend factors, % biofuel (share by volume)

Diesel/Bio-diesel blend	Density (d)	Energy factor				GHG emission factor					
% of bio-diesel in volume		Tank-to-wheels (e_t)		Well-to-wheels (e_w)		Tank-to-wheels (g_t)			Well-to-wheels (g_w)		
	kg/l	MJ/kg	MJ/l	MJ/kg	MJ/l	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$
1 %	0,83258	43,1	35,9	51,6	43,0	73,7	3,17	2,64	89,96	3,88	3,23
2 %	0,83316	43,0	35,8	51,9	43,2	73,0	3,14	2,62	89,67	3,86	3,21
3 %	0,83374	42,9	35,8	52,1	43,5	72,3	3,11	2,59	89,38	3,84	3,20
4 %	0,83432	42,9	35,8	52,4	43,7	71,6	3,07	2,56	89,09	3,82	3,19
5 %	0,83490	42,8	35,7	52,7	44,0	71,0	3,04	2,54	88,80	3,80	3,17
6 %	0,83548	42,7	35,7	53,0	44,2	70,3	3,00	2,51	88,50	3,78	3,16
7 %	0,83606	42,7	35,7	53,2	44,5	69,6	2,97	2,48	88,21	3,76	3,15
8 %	0,83664	42,6	35,7	53,5	44,8	68,9	2,94	2,46	87,92	3,75	3,13
9 %	0,83722	42,5	35,6	53,8	45,0	68,2	2,90	2,43	87,62	3,73	3,12
10 %	0,83780	42,5	35,6	54,0	45,3	67,5	2,87	2,40	87,33	3,71	3,11
15 %	0,84070	42,1	35,4	55,4	46,6	64,0	2,70	2,27	85,85	3,62	3,04
20 %	0,84360	41,8	35,3	56,7	47,9	60,5	2,53	2,14	84,35	3,53	2,98
50 %	0,86100	39,9	34,4	64,6	55,6	38,9	1,55	1,34	75,11	3,00	2,58
85 %	0,88130	37,7	33,3	73,3	64,6	12,0	0,45	0,40	63,67	2,40	2,12

Table A.5 — Diesel/bio-diesel blend factors, % biofuel (share by energy)

Diesel/Bio-diesel blend	Density (d)	Energy factor				GHG emission factor					
% of bio-diesel in energy		Tank-to-wheels (e_t)		Well-to-wheels (e_w)		Tank-to-wheels (g_t)			Well-to-wheels (g_w)		
	kg/l	MJ/kg	MJ/l	MJ/kg	MJ/l	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$
1 %	0,83268	43,0	35,8	51,6	43,0	73,8	3,17	2,64	90,09	3,88	3,23
2 %	0,83335	43,0	35,8	51,9	43,2	73,0	3,14	2,61	89,78	3,86	3,21
3 %	0,83403	42,9	35,8	52,2	43,5	72,3	3,10	2,58	89,46	3,84	3,20
4 %	0,83470	42,8	35,7	52,5	43,8	71,5	3,06	2,56	89,14	3,82	3,19
5 %	0,83537	42,7	35,7	52,8	44,1	70,8	3,02	2,53	88,83	3,80	3,17
6 %	0,83603	42,7	35,7	53,1	44,4	70,0	2,99	2,50	88,51	3,78	3,16
7 %	0,83670	42,6	35,6	53,4	44,7	69,3	2,95	2,47	88,19	3,76	3,14
8 %	0,83736	42,5	35,6	53,7	44,9	68,5	2,91	2,44	87,88	3,74	3,13
9 %	0,83802	42,4	35,6	53,9	45,2	67,8	2,88	2,41	87,56	3,72	3,11
10 %	0,83868	42,4	35,5	54,2	45,5	67,1	2,84	2,38	87,25	3,70	3,10
15 %	0,84193	42,0	35,4	55,7	46,9	63,3	2,66	2,24	85,66	3,60	3,03
20 %	0,84514	41,7	35,2	57,1	48,3	59,6	2,48	2,10	84,08	3,50	2,96

A.1.5 Specified fuels

The greenhouse gas emission saving from the use of specified biofuels and bioliquids shall be calculated in accordance with Article 19(1) of Directive 2009/28/EC.

A.2 Electricity

A.2.1 Well-to-wheels energy factors

A well-to-wheels energy factor (e_w) used for the implementation of this standard for electricity shall be one of the following data, provided that data selected include all upstream operational processes according to the objectives of this standard as required in Clause 4, or are corrected in order to take into account contribution of missing processes and gases. This list is given by order of preference:

— value specified by the electricity supplier for the production-certified electricity bought;

— value for the electricity bought, specified by the electricity supplier for its production in the relevant electricity grid within which the transport operation is performed;

— as a last resort, average value for electricity supplied to consumers in the relevant electricity grid within which the transport operation is performed.

In order to avoid double counting, production certified electricity sold should be excluded in remaining average mix of electricity sold by the electricity supplier.

The relevant electricity grid can be either the national grid, or one of several unconnected grids within the country, or the grid shared by several countries. The identification of the relevant electricity grids (over Europe at least) should be specified by the relevant entity.

A.2.2 Well-to-wheels emission factors

A well-to-wheels emission factor (g_w) used for the implementation of this standard for electricity shall be one of the following data, provided that data selected include all upstream operational processes according to the objectives of this standard as required in Clause 4, or are corrected in order to take into account contribution of missing processes and gases. This list is given by order of preference:

— value specified by the electricity supplier for the production-certified electricity bought;

— value for the electricity bought, specified by the electricity supplier for its production in the relevant electricity grid within which the transport operation is performed;

— as a last resort, average value for electricity supplied to consumers in the relevant electricity grid within which the transport operation is performed.

In order to avoid double counting, production certified electricity sold should be excluded in remaining average mix of electricity sold by the electricity supplier.

The relevant electricity grid can be either the national grid, or one of several unconnected grids within the country, or the grid shared by several countries. The identification of the relevant electricity grids (over Europe at least) should be specified by the relevant entity.

Directive 2009/72/EC mentions that Member States shall ensure that electricity suppliers specify in or with the bills and in promotional materials made available to final customers: (a) the contribution of each energy source to the overall fuel mix of the supplier over the preceding year in a comprehensible and, at a national level, clearly comparable manner; (b) at least the reference to existing reference sources, such as web pages, where information on the environmental impact, in terms of at least CO_2 emissions and the radioactive waste resulting from the electricity produced by the overall fuel mix of the supplier over the preceding year is publicly available; (c) information concerning their rights as regards the means of dispute settlement available to them in the event of a dispute.

Careful use should be made of values specified by suppliers that may not correspond to the GHGs and boundaries of upstream processes required by of this CEN standard. For example, calculations done in accordance with Directive 2009/72/EC could include only CO_2 and only the upstream processes from power plants to the customer.

A.2.3 Tank-to-wheels energy factor

The tank-to-wheels energy factor (e_t) for electricity equals to 3,6 MJ/kWh.

A.2.4 Tank-to-wheels emission factor

The tank-to-wheels emission factor (g_t) for electricity equals to zero.

Annex B
(normative)

Allocation methods for ferries (maritime transport)

B.1 General

Transport services carried out by combined passenger and cargo ferries fulfils in principle two separate transport needs served by one vessel. The total energy consumption and GHG emissions from combined ferry transport operations needs to be allocated between the passenger and freight beneficiaries. As ferry line operations are based on different dominating main business models i.e. passenger transport or freight transport, this has a major influence on ship design i.e. the general ship performance. Allocation principles have a huge impact on the results of the calculation of energy consumption and GHG emissions for freight and passengers.

In order to present performance data that are reasonably fair for different ferry lines system, two separate allocation methods may be used.

The allocation method used shall be the mass method (B.2) or the area method (B.3) and shall remain consistent over time and per line. Allocation method may be changed for one given ship if it is converted to another type of ship, or if it is put into another line.

These allocation methods are only valid for combined passenger and cargo vessels.

Unaccompanied vehicles are considered as cargo in both allocation methods.

B.2 Mass method

The mass method is based on operational transport statistics on total cargo gross mass (vehicles + cargo) and total passenger mass (passenger, luggage and accompanied vehicles).

Included transported entities shall be clearly specified per ship/fleet or route(s).

Calculation of the mass shall be based on:

- number of passengers;
- number of accompanied cars;
- number of accompanied caravans/mobile homes etc;
- number of accompanied buses;
- total mass of cargo being carried, including any packaging, container, and means of handling or means of transport like trailers and vehicles.

B.3 Area method

The area method is based on 100 % accessible area capacity according to valid general arrangement plan (GA-plan).

Included areas are:

- accessible vehicle decks area, including hanging decks (if available and operational);
- accessible passenger decks area.

Areas not in use for passenger and cargo, such as bridge, engine area, crew area, galley and other service areas, are excluded.

Whole passenger deck area shall be allocated to passengers. Vehicle deck area shall be allocated according to the ratio between passenger vehicles and freight vehicles including their cargo. This ratio shall be based on their real or default mass or length.

B.4 Default values

Default values for mass, length, and width presented in Table B.1 may be used for both methods.

Mass of vehicles in Table B.1 does not include mass of the transported passengers and/or cargo.

For freight, mass of the cargo shall be added to the values in Table B.1, when using mass for allocation.

NOTE These values are based on statistics from ferry lines.

Table B.1 — Default values for mass and lengths

	Mass (kg)	Length (m)	Width (m)
Passenger and luggage	100	*not applicable*	*not applicable*
Passenger car	1 500	6	3,1
Bus	15 000	12	3,1
Caravan (small)	1 000	3	3,1
Caravan (medium)	2 000	6	3,1
Caravan (large)	2 500	10	3,1
Mobile home	3 500	8	3,1
Motorcycle	200	1,5	3,1
Unaccompanied trailer	8 000	14	3,1
Accompanied / articulated trailer (Semi / mega trailer plus tractor unit)	16 000	17	3,1
Road Train Continent	18 500	19	3,1
Road Train Scandinavia	20 000	24,5	3,1

Annex C
(informative)

Inclusion of empty trips into a VOS

C.1 General

This Annex gives two examples on how to include empty trips into a VOS.

Reminder: as specified in 7.2, the VOS shall be is a consistent set of vehicle operations relevant to the leg being calculated; and the VOS shall include the empty trips related to the vehicle operations.

C.2 Example for a simple case

We consider a leg of a transport service consisting in carrying a cargo from a point A to a point B, performed by a vehicle V that is loaded only with this single cargo from A to B, and then returns empty to A.

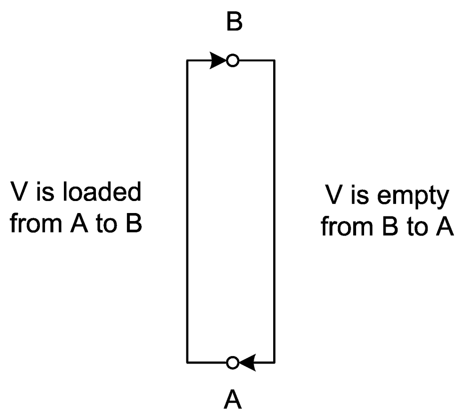

Figure C.1 — Example of a simple case of empty trip

The VOS in this example consists of the vehicle operation from A to A via B in order to include the empty trip (cf. 7.2).

The same applies if the empty trip is done first (from A to B), before the loaded trip.

As a consequence, the total fuel consumption of the VOS will include the consumption for the empty trip, and finally, the quantification of energy consumption and GHG emissions for this leg will correspond to the one of the whole round trip.

C.3 Example of a VOS for a distribution or collection round trip.

We consider a leg of a transport service TS consisting in carrying a cargo from a point A to a point E, performed by a vehicle V that achieves a collection and distribution round trip starting in A and going through B, C, D, E, F, G, H, I and back to A. V runs empty from E to F, and from I to A; for the rest of the trip, V is loaded with various cargo loaded during the different stops (excepted E and I).

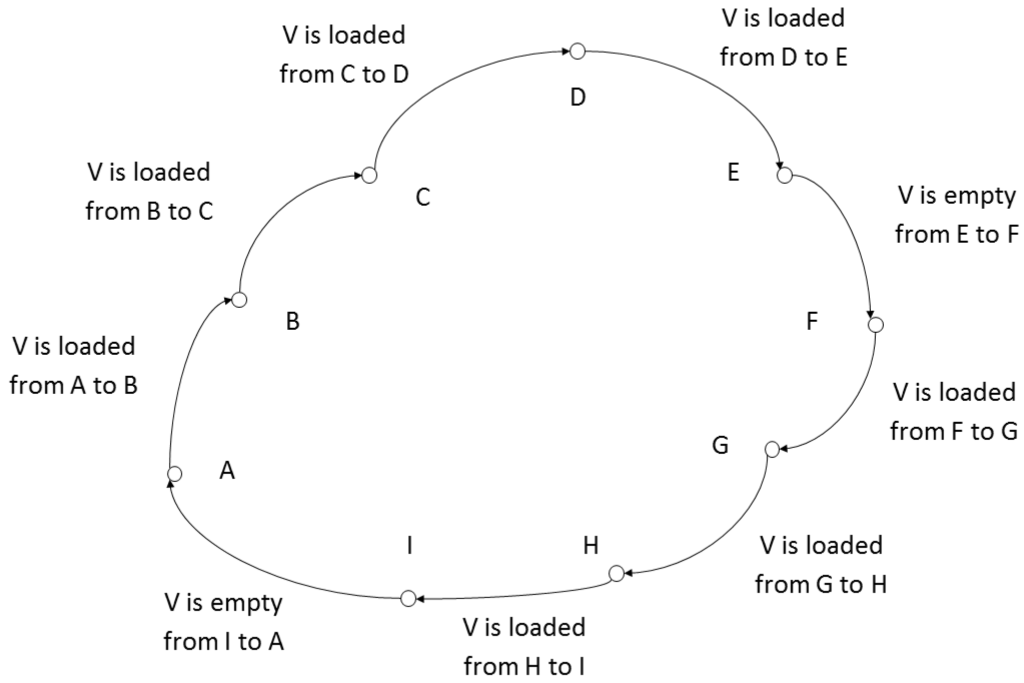

Figure C.2 — Example of a distribution and collection round trip

The VOS related to the leg [AE] of transport service TS should be the operation of V on the whole round trip (from A to A via E). Therefore, the VOS includes the two empty trips achieved during the round trip.

Annex D
(informative)

Template for declaration of categories of values used

Table D.1 gives a template for declaration of categories of values used for the calculation of one transport service.

This template can be used for communicating the part of the supporting information requested in 10.3 concerning the categories of values used for the calculation.

The cells are meant to be filled in with crosses or – provided that multiple namings were necessary – to contain proportional distribution of the used values on the respective category.

Table D.1 — Template for declaration of categories of values used

Categories of values used per leg of the transport service	Default value			Transport operator fleet value			Transport operator specific value			Specific measured value		
Leg	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Fuel consumption												
Distance												
Fuel consumption per distance												
Load												
Load factor												
Vehicle capacity												
Empty trip												
Other												

Annex E
(informative)

Example for passengers: transport service by bus

E.1 Description of the example

We consider one transport service, named "TS", of one passenger who uses a portion of a bus line. As represented in Figure E.1, this bus line starts at stop S_0 and ends at stop S_{10}, and the passenger gets into the bus at stop S_2 and gets off the bus at stop S_5.

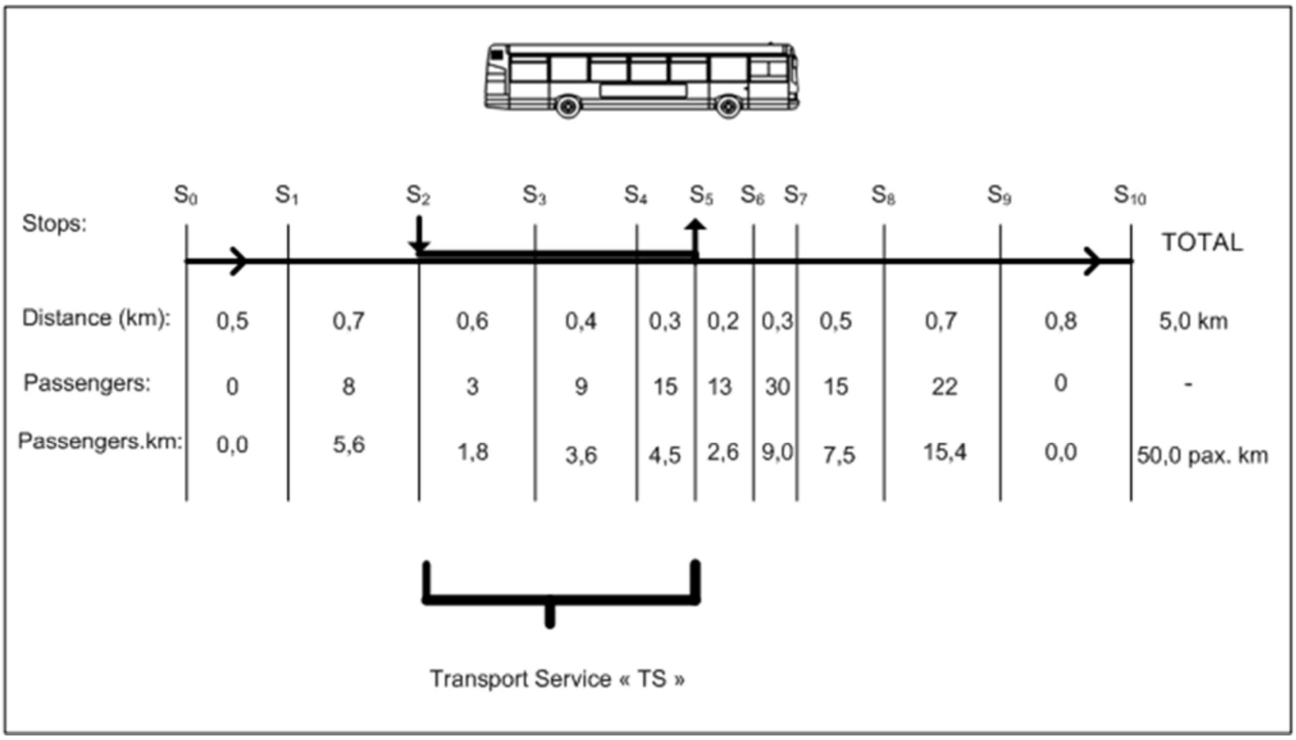

Figure E.1 — Example of transport service by bus

E.2 Example with use of specific measured values

Table E.1 presents assumptions, calculations and results related to this example.

This example is theoretical but it shows how a calculation specific to the transport of one passenger could be done. It gives also a basis for comparison with the outcomes of the other categories of values (cf. the following subclauses).

Table E.1 — Assumptions, calculations and results

ASSUMPTIONS	The fuel consumption of the bus between S_0 and S_{10} is measured and equals two litres of pure diesel.
	Energy and GHG emission factors for pure diesel are taken from Table A.1 (Annex A).
	Transport activity of the bus between S_0 to S_{10} is 50,0 pax.km (cf. Figure E.1).
	Transport activity of the passenger between S_2 to S_5 is 1,3 pax.km (cf. Figure E.1).
STEP 1	This transport service is composed of only one leg that is the route taken by the passenger from S_2 to S_5.
STEP 2.1	The VOS chosen is the whole line from S_0 to S_{10} for the bus that carries the passenger.
STEP 2.2	$F(VOS) = 2{,}0\ l$
STEP 2.3	$E_w(VOS) = F(VOS) \times e_w = 2{,}0 \times 42{,}7 = 85{,}4\ MJ$
	$G_w(VOS) = F(VOS) \times g_w = 2{,}0 \times 3{,}24 = 6{,}48\ kgCO_2e$
	$E_t(VOS) = F(VOS) \times e_t = 2{,}0 \times 35{,}9 = 71{,}8\ MJ$
	$G_t(VOS) = F(VOS) \times g_t = 2{,}0 \times 2{,}67 = 5{,}34\ kgCO_2e$
STEP 2.4	$S(leg) = T(leg) \div T(VOS) = 1{,}3 \div 50{,}0 = 2{,}6 \times 10^{-2}$
	$E_w(leg) = E_w(VOS) \times S(leg) = 85{,}4 \times 2{,}6 \times 10^{-2} = 2{,}220\ MJ$
	$G_w(leg) = G_w(VOS) \times S(leg) = 6{,}48 \times 2{,}6 \times 10^{-2} = 0{,}168\ kgCO_2e$
	$E_t(leg) = E_t(VOS) \times S(leg) = 71{,}8 \times 2{,}6 \times 10^{-2} = 1{,}867\ MJ$
	$G_t(leg) = G_t(VOS) \times S(leg) = 5{,}34 \times 2{,}6 \times 10^{-2} = 0{,}139\ kgCO_2e$
STEP 3	$E_w(TS) = E_w(leg) = 2{,}220\ MJ$
	$G_w(TS) = G_w(leg) = 0{,}168\ kgCO_2e$
	$E_t(TS) = E_t(leg) = 1{,}867\ MJ$
	$G_t(TS) = G_t(leg) = 0{,}139\ kgCO_2e$

E.3 Example with use of transport operator fleet values

Table E.2 presents assumptions, calculations and results for this example.

Table E.2 — Assumptions, calculations and results

ASSUMPTIONS	The fuel consumption of the whole fleet (i.e. all the buses operating this public network) is measured and equals 490 560 litres of pure diesel during the previous year.
	Energy and GHG emission factors for pure diesel are taken from Table A.1 (Annex A).
	Transport activity for the whole fleet was 10 512 000 pax.km during the previous year.
	The average distance travelled by a passenger was 2,5 km per trip during the previous year, established through a survey over this public network.
STEP 1	This transport service is composed of only one leg that is the route of 2,5 km taken by the passenger on this public network.
STEP 2.1	The VOS chosen is the set of buses operations on the whole network of public transport, over one year.
STEP 2.2	$F(VOS) = 490\ 560\ l$
STEP 2.3	$E_w(VOS) = F(VOS) \times ew = 490\ 560 \times 42{,}7 = 20\ 946\ 912\ MJ$
	$G_w(VOS) = F(VOS) \times g_w = 490\ 560 \times 3{,}24 = 1\ 589\ 414\ kgCO_2e$
	$E_t(VOS) = F(VOS) \times e_t = 490\ 560 \times 35{,}9 = 17\ 611\ 104\ MJ$
	$G_t(VOS) = F(VOS) \times g_t = 490\ 560 \times 2{,}67 = 1\ 309\ 795\ kgCO_2e$
STEP 2.4	$S(leg) = T(leg) \div T(VOS) = 2{,}5 \div 10\ 512\ 000 = 2{,}378 \times 10^{-7}$
	$E_w(leg) = E_w(VOS) \times S(leg) = 20\ 946\ 912 \times 2{,}378 \times 10^{-7} = 4{,}981\ MJ$
	$G_w(leg) = G_w(VOS) \times S(leg) = 1\ 589\ 414 \times 2{,}378 \times 10^{-7} = 0{,}378\ kgCO_2e$
	$E_t(leg) = E_t(VOS) \times S(leg) = 17\ 611\ 104 \times 2{,}378 \times 10^{-7} = 4{,}188\ MJ$
	$G_t(leg) = G_t(VOS) \times S(leg) = 1\ 309\ 795 \times 2{,}378 \times 10^{-7} = 0{,}311\ kgCO_2e$
STEP 3	$E_w(TS) = E_w(leg) = 4{,}981\ MJ$
	$G_w(TS) = G_w(leg) = 0{,}378\ kgCO_2e$
	$E_t(TS) = E_t(leg) = 4{,}188\ MJ$
	$G_t(TS) = Gt(leg) = 0{,}311\ kgCO_2e$

E.4 Example with use of default values

Table E.3 presents assumptions, calculations and results for this example.

Table E.3 — Assumptions, calculations and results

ASSUMPTIONS	A modelling tool gives the average consumption of a similar bus in similar conditions as being forty five litres of pure diesel per one hundred kilometres.
	Energy and GHG emission factors for pure diesel are taken from Table A.1 (Annex A).
	A national statistic on public transport gives an average load of 11 passengers per bus in similar buses and conditions.
	A national statistic on public transport gives an average distance of 3,1 km in similar public networks.
STEP 1	This transport service is composed of only one leg that is the average route of 3,1 km taken by the passenger.
STEP 2.1	The VOS chosen is the operation of the bus on this average route of 3,1 km.
STEP 2.2	$F(VOS) = 45 \div 100 \times 3{,}1 = 1{,}395\ l$
STEP 2.3	$E_w(VOS) = F(VOS) \times e_w = 1{,}395 \times 42{,}7 = 59{,}57\ MJ$
	$G_w(VOS) = F(VOS) \times g_w = 1{,}395 \times 3{,}24 = 4{,}52\ kgCO_2e$
	$E_t(VOS) = F(VOS) \times e_t = 1{,}395 \times 35{,}9 = 50{,}08\ MJ$
	$G_t(VOS) = F(VOS) \times g_t = 1{,}395 \times 2{,}67 = 3{,}72\ kgCO_2e$
STEP 2.4	$S(leg) = T(leg) \div T(VOS) = (1 \times 3{,}1) \div (11 \times 3{,}1) = 9{,}091 \times 10^{-2}$
	$E_w(leg) = E_w(VOS) \times S(leg) = 59{,}57 \times 9{,}091 \times 10^{-2} = 5{,}415\ MJ$
	$G_w(leg) = G_w(VOS) \times S(leg) = 4{,}52 \times 9{,}091 \times 10^{-2} = 0{,}411\ kgCO_2e$
	$E_t(leg) = E_t(VOS) \times S(leg) = 50{,}08 \times 9{,}091 \times 10^{-2} = 4{,}553\ MJ$
	$G_t(leg) = G_t(VOS) \times S(leg) = 3{,}72 \times 9{,}091 \times 10^{-2} = 0{,}339\ kgCO_2e$
STEP 3	$E_w(TS) = E_w(leg) = 5{,}415\ MJ$
	$G_w(TS) = G_w(leg) = 0{,}411\ kgCO_2e$
	$E_t(TS) = E_t(leg) = 4{,}553\ MJ$
	$G_t(TS) = G_t(leg) = 0{,}339\ kgCO_2e$

E.5 Example with use of transport operator specific values

This example is not developed. The VOS chosen could have been the set of buses operation on this bus line, on both directions, over one year.

E.6 Overview of the results

Table E.4 gives an overview of the results for the transport service considered in this example.

This illustrates the potential significant differences linked to the categories of values used.

Table E.4 — Results of example for transport service by bus

	Specific measured values	Transport operator specific values	Transport operator fleet values	Default values
E_w	2,220 MJ	Not developed	4,981 MJ	5,415 MJ
G_w	0,168 kgCO_2e	Not developed	0,378 kgCO_2e	0,411 kgCO_2e
E_t	1,867 MJ	Not developed	4,188 MJ	4,553 MJ
G_t	0,139 kgCO_2e	Not developed	0,311 kgCO_2e	0,339 kgCO_2e

Annex F
(informative)

Examples for freight

F.1 Transport service of freight transport by train

F.1.1 Description of the example

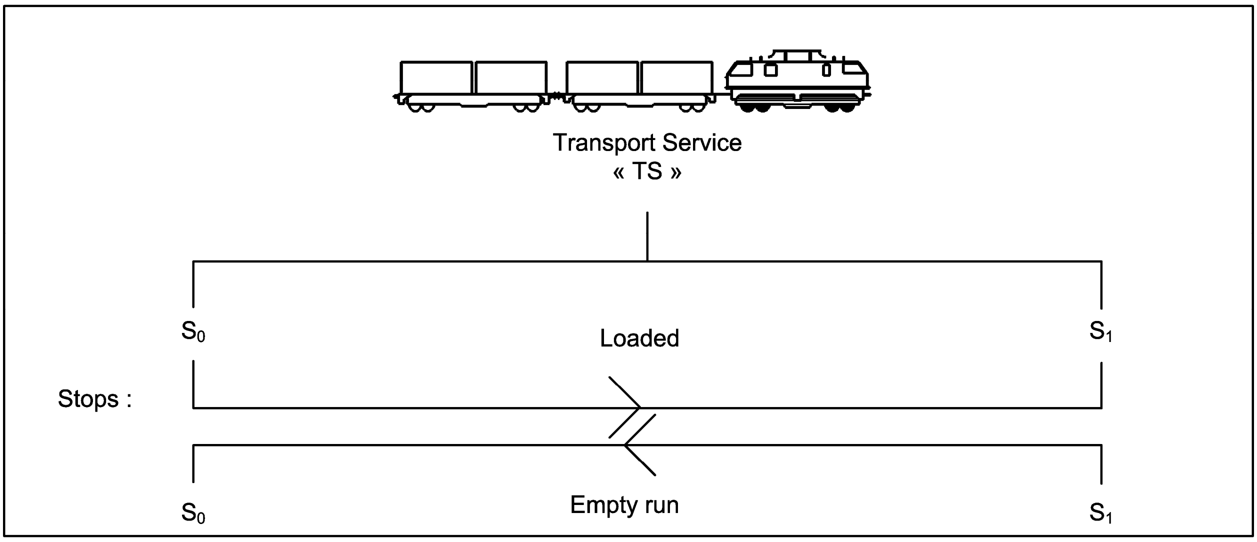

Figure F.1 — Example of freight transport service by train

We consider one transport service, named "TS", of a whole load 2 394 t of gravel that is transported from starting point S_0 to final destination S_1 by train. The gravel is completely unloaded in S_1. The empty train drives back to S_0. The energy carrier (diesel or electric) is specified differently according to the following cases.

F.1.2 Example with use of specific measured values

Table F.1 presents assumptions, calculations and results related to this example.

Table F.1 — Assumptions, calculations and results

ASSUMPTIONS	This is a diesel train, and the fuel consumption of the complete round trip of the train from S_0 via S_1 to S_0 is 6 025 litres of pure diesel (not blended with bio fuel).
	Energy and GHG emission factors for pure diesel are taken from Table A.1 (Annex A).
STEP 1	This transport service is composed of only one leg that starts in S_0 and ended in S_1.
STEP 2.1	The VOS chosen is the whole round trip from S_0 to S_0 via S_1, including therefore the empty trip from S_1 to S_0.
STEP 2.2	$F(VOS) = 6\,025$
STEP 2.3	$E_w(VOS) = F(VOS) \times e_w = 6\,025 \times 42{,}7 = 257\,268\ MJ$
	$G_w(VOS) = F(VOS) \times g_w = 6\,025 \times 3{,}24 = 19\,521\ kgCO_2e$
	$E_t(VOS) = F(VOS) \times e_t = 6\,025 \times 35{,}9 = 216\,298\ MJ$
	$G_t(VOS) = F(VOS) \times g_t = 6\,025 \times 2{,}67 = 16\,087\ kgCO_2e$
STEP 2.4	The transport activity of the leg represents the whole transport activity of the VOS. $S(leg) = T(leg) \div T(VOS) = 1$
	$E_w(leg) = E_w(VOS) \times S(leg) = 257\,268 \times 1 = 257\,268\ MJ$
	$G_w(leg) = G_w(VOS) \times S(leg) = 19\,521 \times 1 = 19\,521\ kgCO_2e$
	$E_t(leg) = E_t(VOS) \times S(leg) = 216\,298 \times 1 = 216\,298\ MJ$
	$G_t(leg) = G_t(VOS) \times S(leg) = 16\,087 \times 1 = 16\,087\ kgCO_2e$
STEP 3	$E_w(TS) = E_w(leg) = 257\,268\ MJ$
	$G_w(TS) = G_w(leg) = 19\,521\ kgCO_2e$
	$E_t(TS) = E_t(leg) = 216\,298\ MJ$
	$G_t(TS) = G_t(leg) = 16\,087\ kgCO_2e$

F.1.3 Example with use of transport operator specific values

Table F.2 presents assumptions, calculations and results related to this example.

Table F.2 — Assumptions, calculations and results

ASSUMPTIONS	This is a diesel train, and the fuel consumption of the all trains operating on this route (round trip) over the previous year is measured and equals 127 223 litres of pure diesel.
	Energy and GHG emission factors for pure diesel are taken from Table A.1 (Annex A).
	The transport activity for all these trains over the previous year, expressed in tonne kilometre, is measured and equals 25 239 323 t.km.
	Real distance from S_0 to S_1 is 518 km.
STEP 1	This transport service is composed of only one leg that starts in S_0 and ended in S_1.
STEP 2.1	The VOS chosen is all trips of trains which transported gravel between S_0 and S_1, including the empty runs between S_1 and S_0, over the previous year.
STEP 2.2	$F(VOS) = 127\,233\text{ l}$
STEP 2.3	$E_w(VOS) = F(VOS) \times e_w = 127\,233 \times 42{,}7 = 5\,432\,849\text{ MJ}$
	$G_w(VOS) = F(VOS) \times g_w = 127\,233 \times 3{,}24 = 412\,235\text{ kgCO}_2\text{e}$
	$E_t(VOS) = F(VOS) \times e_t = 127\,233 \times 35{,}9 = 4\,567\,665\text{ MJ}$
	$G_t(VOS) = F(VOS) \times g_t = 127\,233 \times 2{,}67 = 339\,712\text{ kgCO}_2\text{e}$
STEP 2.4	$S(leg) = T(leg) \div T(VOS) = (2\,394 \times 518) \div 25\,239\,323 = 4\,913 \times 10^{-2}$
	$E_w(leg) = E_w(VOS) \times S(leg) = 5\,432\,849 \times 4{,}913 \times 10^{-2} = 26\,6916\text{ MJ}$
	$G_w(leg) = G_w(VOS) \times S(leg) = 412\,235 \times 4{,}913 \times 10^{-2} = 20\,253\text{ kgCO}_2\text{e}$
	$E_t(leg) = E_t(VOS) \times S(leg) = 4\,567\,665 \times 4{,}913 \times 10^{-2} = 224\,409\text{ MJ}$
	$G_t(leg) = G_t(VOS) \times S(leg) = 339\,712 \times 4{,}913 \times 10^{-2} = 16\,690\text{ kgCO}_2\text{e}$
STEP 3	$E_w(TS) = E_w(leg) = 266\,916\text{ MJ}$
	$G_w(TS) = G_w(leg) = 20\,253\text{ kgCO}_2\text{e}$
	$E_t(TS) = E_t(leg) = 224\,409\text{ MJ}$
	$G_t(TS) = G_t(leg) = 16\,690\text{ kgCO}_2\text{e}$

F.1.4 Examples with use of default values

F.1.4.1 First example : case of a diesel train

Table F.3 presents assumptions, calculations and results related to this example.

Table F.3 — Assumptions, calculations and results

ASSUMPTIONS	This is a diesel train. The fuel consumption of the train, with a payload of 2 394 t, is 708 l of diesel per 100 km. The fuel consumption of the empty train is 431 l of pure diesel per 100 km (mass of the wagons is 886 t). These values are taken from a default value source.
	Energy and GHG emission factors for pure diesel are taken from Table A.1 (Annex A).
	Length of the line between S_o and S_1 is 518 km (taken from a default value source).
STEP 1	This transport service is composed of only one leg that starts in S_0 and ended in S_1.
STEP 2.1	The VOS chosen is the full-loaded trip from S_0 to S_1 (2 394 t of gravel) and the empty trip from S_1 to S_0.
STEP 2.2	$F(VOS) = 708 \div 100 \times 518 + 431 \div 100 \times 518 = 5\,900\ l$
STEP 2.3	$E_w(SOV) = F(VOS) \times e_w = 5\,900 \times 42{,}7 = 251\,930\ MJ$
	$G_w(VOS) = F(VOS) \times g_w = 5\,900 \times 3{,}24 = 19\,116\ kgCO_2e$
	$E_t(VOS) = F(VOS) \times e_t = 5\,900 \times 35{,}9 = 211\,810\ MJ$
	$G_t(VOS) = F(VOS) \times g_t = 5\,900 \times 2{,}67 = 15\,753\ kgCO_2e$
STEP 2.4	The transport activity of the leg represents the whole transport activity of the VOS. $S(leg) = T(leg) \div T(VOS) = 1$
	$E_w(segment) = E_w(PT) \times S(leg) = 251\,930\ MJ \times 1 = 251\,930\ MJ$
	$G_w(leg) = G_w(VOS) \times S(leg) = 19\,116 \times 1 = 19\,116\ kgCO_2e$
	$E_t(leg) = E_t(VOS) \times S(leg) = 211\,810 \times 1 = 211\,810\ MJ$
	$G_t(leg) = G_t(VOS) \times S(leg) = 15\,753 \times 1 = 15\,753\ kgCO_2e$
STEP 3	$E_w(TS) = E_w(leg) = 251\,930\ MJ$
	$G_w(TS) = G_w(leg) = 19\,116\ kgCO_2e$
	$E_t(TS) = E_t(leg) = 211\,810\ MJ$
	$G_t(TS) = G_t(leg) = 15\,753\ kgCO_2e$

F.1.4.2 Second example : case of an electric train

Table F.4 presents assumptions, calculations and results related to this example.

Table F.4 — Assumptions, calculations and results

ASSUMPTIONS	The transport is operated by an electric train, and is located in Germany. The average electricity consumption of a train with a payload of 2 394 t is 26,3 kWh/km. The electricity consumption of the empty train is 16,4 kWh/km (mass of the wagons: 886 t). Energy efficiency of the electricity supply for railway transport is 32 % in Germany. The well-to-wheels emission factor of the electricity supply for railway transport is 574 gCO_2e/kWh. These values are taken from a default value source.
	Length of the line between S_o and S_1 is 518 km (taken from a default value source).
STEP 1	This transport service is composed of only one leg that starts in S_0 and ended in S_1.
STEP 2.1	The VOS chosen is the full-loaded trip from S_0 to S_1 and the empty trip from S_1 to $S_{0.}$
STEP 2.2	$F(VOS) = 26{,}3 \times 518 + 16{,}4 \times 518 = 22\,119$ kWh
STEP 2.3	$E_w(VOS) = F(VOS) \times e_w = 22\,119 \times (3{,}6 \div 32\%) = 248\,838$ MJ
	$G_w(VOS) = F(VOS) \times g_w = 22\,119 \times 0{,}574 = 12\,696$ $kgCO_2e$
	$E_t(VOS) = F(VOS) \times e_t = 22\,119 \times 3{,}6 = 79\,628$ MJ
	$G_t(VOS) = F(VOS) \times g_t = 22\,119 \times 0 = 0$ $kgCO_2e$
STEP 2.4	The transport activity of the leg represents the whole transport activity of the VOS. $S(leg) = T(leg) \div T(VOS) = 1$
	$E_w(leg) = E_w(VOS) \times S(leg) = 248\,838 \times 1 = 248\,838$ MJ
	$G_w(leg) = G_w(VOS) \times S(leg) = 12\,696 \times 1 = 12\,696$ $kgCO_2e$
	$E_t(leg) = E_t(VOS) \times S(leg) = 79\,628 \times 1 = 79\,628$ MJ
	$G_t(leg) = G_t(VOS) \times S(leg) = 0 \times 1 = 0$ $kgCO_2e$
STEP 3	$E_w(TS) = E_w(leg) = 248\,838$ MJ
	$G_w(TS) = G_w(leg) = 12\,696$ $kgCO_2e$
	$E_t(TS) = E_t(leg) = 79\,628$ MJ
	$G_t(TS) = G_t(leg) = 0$ $kgCO_2e$

F.1.5 Overview of the results

Table F.5 gives an overview of the results for the transport service considered in this example.

Table F.5 — Results of example for freight transport service by train

	Specific measured values	Transport operator specific values	Transport operator fleet values	Default value: diesel train	Default value: electric train
E_w	257 268 MJ	266 916 MJ	*Not considered*	251 930 MJ	248 838 MJ
G_w	19 521 $kgCO_2e$	20 253 $kgCO_2e$	*Not considered*	19 116 $kgCO_2e$	12 696 $kgCO_2e$
E_t	216 298 MJ	224 409 MJ	*Not considered*	211 811 MJ	79 628 MJ
G_t	16 087 $kgCO_2e$	16 690 $kgCO_2e$	*Not considered*	15 753 $kgCO_2e$	0 $kgCO_2e$

These results correspond to the transport service described in F.2.1, so to a cargo of 2394 t. In addition to the declaration to be made according to Clause 10 of this standard, it might be useful to communicate a result per tonne. For this purpose, the results of Table F.5 should be simply divided per 2394 t.

F.2 Transport service of freight transport by container ship

F.2.1 Description of the example

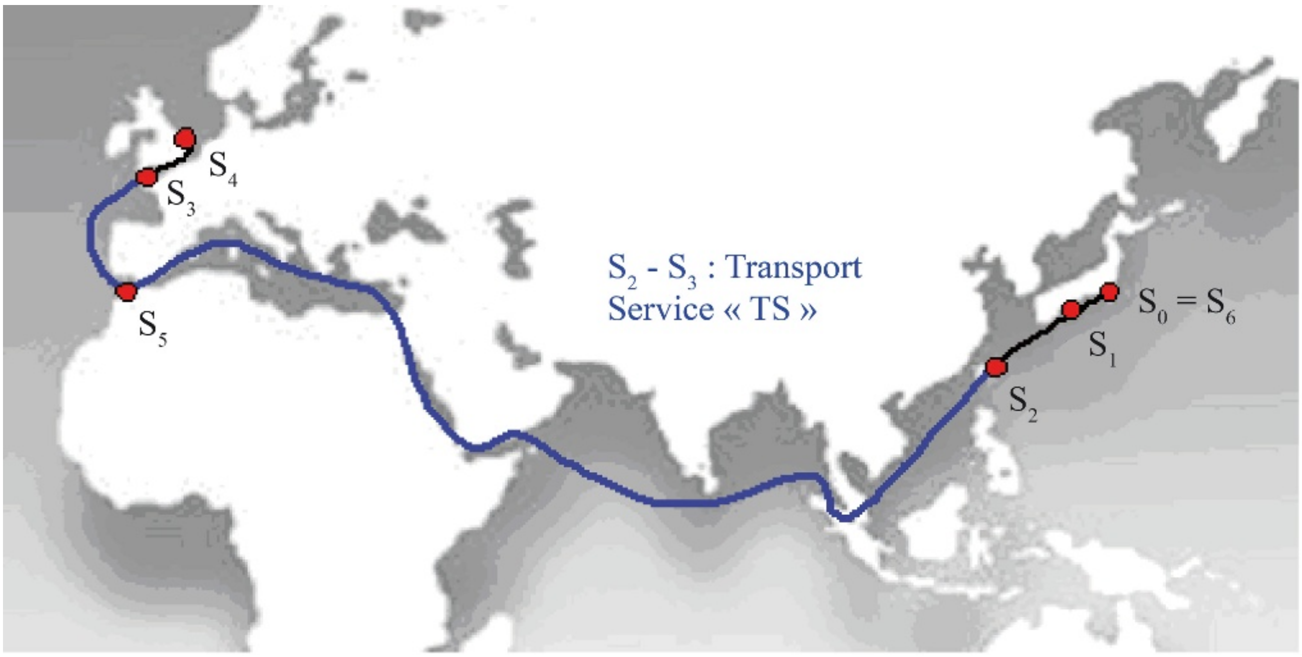

Figure F.2 — Example of freight transport by container ship

This example shows the calculation of energy consumption and GHG emissions of the transport of 1,5 t of clothes from the harbour in Keelung (S_2) to the harbour in Le Havre (S_3) by a container ship.

F.2.2 Example with use of specific measured values

Table F.6 presents assumptions, calculations and results related to this example.

Table F.6 — Assumptions, calculations and results

<table>
<tr><td rowspan="4">ASSUMPTIONS</td><td>The fuel consumption of the container ship line from Kobe (S_0) via Yokohama (S_1), Keelung (S_2), Le Havre (S_3), Felixstowe (S_4) and Tangier (S_5) to Kobe (S_6) is 10 940 t of Heavy Fuel Oil (HFO).</td></tr>
<tr><td>The number of containers and distances between each port are measured for this container ship line; results are given below:
<table>
<tr><th>From</th><th>To</th><th>Load (TEU)</th><th>Distance (km)</th><th>Transport activity (TEU.km)</th></tr>
<tr><td>Kobe (S_0)</td><td>Yokohama (S_1)</td><td>2 500</td><td>644</td><td>1 610 407</td></tr>
<tr><td>Yokohama (S_1)</td><td>Keelung (S_2)</td><td>4 800</td><td>2 140</td><td>10 273 355</td></tr>
<tr><td>Keelung (S_2)</td><td>Le Havre (S_3)</td><td>7 900</td><td>18 641</td><td>147 264 269</td></tr>
<tr><td>Le Havre (S_3)</td><td>Felixstowe (S_4)</td><td>4 800</td><td>314</td><td>1 505 187</td></tr>
<tr><td>Felixstowe (S_4)</td><td>Tangier (S_5)</td><td>2 900</td><td>2 418</td><td>7 012 116</td></tr>
<tr><td>Tangier (S_5)</td><td>Kobe (S_6)</td><td>4 200</td><td>18 216</td><td>76 507 253</td></tr>
<tr><td colspan="2">Total</td><td>27 100</td><td>42 373</td><td>244 172 588</td></tr>
</table></td></tr>
<tr><td>The 1,5 t of clothes are loaded in a twenty-foot container which total load is 10,5 t.</td></tr>
<tr><td>Energy and GHG emission factors for HFO are taken from Table A.1 (Annex A).</td></tr>
<tr><td>STEP 1</td><td>This transport service is composed of only one leg that starts in S_2 and ended in S_3.</td></tr>
<tr><td>STEP 2.1</td><td>The VOS chosen is the container ship line which goes from the harbour of Kobe (S_0) via the harbours of Yokohama (S_1), Keelung (S_2), Le Havre (S_3), Felixstowe (S_4) and Tangier (S_5) back to the harbour of Kobe (S_6).</td></tr>
<tr><td>STEP 2.2</td><td>$F(VOS) = 10\,940\,000 \text{ kg}$</td></tr>
<tr><td rowspan="4">STEP 2.3</td><td>$E_w(VOS) = F(VOS) \times e_w = 10\,940\,000 \times 44{,}1 = 482\,454\,000 \text{ MJ}$</td></tr>
<tr><td>$G_w(VOS) = F(VOS) \times g_w = 10\,940\,000 \times 3{,}41 = 37\,305\,400 \text{ kgCO}_2\text{e}$</td></tr>
<tr><td>$E_t(VOS) = F(VOS) \times e_t = 10\,940\,000 \times 40{,}5 = 443\,070\,000 \text{ MJ}$</td></tr>
<tr><td>$G_t(VOS) = F(VOS) \times g_t = 10\,940\,000 \times 3{,}15 = 34\,461\,000 \text{ kgCO}_2\text{e}$</td></tr>
<tr><td rowspan="5">STEP 2.4</td><td>The transport activity is expressed in TEU.km.
$S(leg) = T(leg) \div T(VOS) = [(1{,}5 \div 10{,}5) \times 18\,641] \div 244\,172\,588 = 1{,}09062 \times 10^{-5}$</td></tr>
<tr><td>$E_w(leg) = E_w(VOS) \times S(leg) = 482\,454\,000 \times 1{,}09062 \times 10^{-5} = 5\,262 \text{ MJ}$</td></tr>
<tr><td>$G_w(leg) = G_w(VOS) \times S(leg) = 37\,305\,400 \times 1{,}09062 \times 10^{-5} = 407 \text{ kgCO}_2\text{e}$</td></tr>
<tr><td>$E_t(leg) = E_t(VOS) \times S(leg) = 443\,070\,000 \times 1{,}09062 \times 10^{-5} = 4\,832 \text{ MJ}$</td></tr>
<tr><td>$G_t(leg) = G_t(VOS) \times S(leg) = 34\,461\,000 \times 1{,}09062 \times 10^{-5} = 376 \text{ kgCO}_2\text{e}$</td></tr>
<tr><td rowspan="4">STEP 3</td><td>$E_w(TS) = E_w(leg) = 5\,262 \text{ MJ}$</td></tr>
<tr><td>$G_w(TS) = G_w(leg) = 407 \text{ kgCO}_2\text{e}$</td></tr>
<tr><td>$E_t(TS) = E_t(leg) = 4\,832 \text{ MJ}$</td></tr>
<tr><td>$G_t(TS) = G_t(leg) = 376 \text{ kgCO}_2\text{e}$</td></tr>
</table>

F.2.3 Example with use of default values

Table F.7 presents assumptions, calculations and results related to this example.

Table F.7 — Assumptions, calculations and results

ASSUMPTIONS	The fuel consumption of a container ship between Asia and Europe is 217 kg of Heavy Fuel Oil (HFO) per kilometre (taken from a default value source).
	The distance from S_2 to S_3 is 18 432 km (taken from a default value source).
	The average maximum load of the container ship is 6 580 TEU and the average load factor is 70 % (average value over the whole container ship line). Data taken from default value sources.
	Energy and GHG emission factors for HFO are taken from Table A.1 (Annex A).
STEP 1	This transport service is composed of only one leg that starts in S_2 and ended in S_3.
STEP 2.1	The VOS chosen is the operation of the container ship between S_2 and S_3. Such a limitation to this restricted section of the ship line is consistent with this standard only if the average load factor of the whole container ship line is considered in sub step 2.4 (for allocation). It would have been preferable to consider, as in Figure F.2, the whole line from S_0 and S_6.
STEP 2.2	$F(VOS) = 217 \times 18\,432 = 3\,999\,744\text{ kg}$
STEP 2.3	$E_w(VOS) = F(VOS) \times e_w = 3\,999\,744 \times 44{,}1 = 176\,388\,710\text{ MJ}$
	$G_w(VOS) = F(VOS) \times g_w = 3\,999\,744 \times 3{,}41 = 13\,639\,127\text{ kgCO}_2\text{e}$
	$E_t(VOS) = F(VOS) \times e_t = 3\,999\,744 \times 40{,}5 = 161\,989\,632\text{ MJ}$
	$G_t(VOS) = F(VOS) \times g_t = 3\,999\,744 \times 3{,}15 = 12\,599\,194\text{ kgCO}_2\text{e}$
STEP 2.4	The transport activity is expressed in TEU.km. $S(leg) = T(leg) \div T(VOS) = [(1{,}5 \div 10{,}5) \times 18\,432] \div (6\,580 \times 70\% \times 18\,432) = 3{,}1015 \times 10^{-5}$
	$E_w(leg) = E_w(VOS) \times S(leg) = 176\,388\,710 \times 3{,}1015 \times 10^{-5} = 5\,471\text{ MJ}$
	$G_w(leg) = G_w(VOS) \times S(leg) = 13\,639\,127 \times 3{,}1015 \times 10^{-5} = 423\text{ kgCO}_2\text{e}$
	$E_t(leg) = E_t(VOS) \times S(leg) = 161\,989\,632 \times 3{,}1015 \times 10^{-5} = 5\,024\text{ MJ}$
	$G_t(leg) = G_t(VOS) \times S(leg) = 12\,599\,194 \times 3{,}1015 \times 10^{-5} = 391\text{ kgCO}_2\text{e}$
STEP 3	$E_w(TS) = E_w(leg) = 5\,471\text{ MJ}$
	$G_w(TS) = G_w(leg) = 423\text{ kgCO}_2\text{e}$
	$E_t(TS) = E_t(leg) = 5\,024\text{ MJ}$
	$G_t(TS) = G_t(leg) = 391\text{ kgCO}_2\text{e}$

F.2.4 Overview of the results

Table F.8 gives an overview of the results for the transport service considered in this example.

Table F.8 — Results of example for freight transport service by container ship

	Specific measured values	Transport operator specific values	Transport operator fleet values	Default values
E_w	5 262 MJ	*Not considered*	*Not considered*	5 471 MJ
G_w	407 $kgCO_2e$	*Not considered*	*Not considered*	423 $kgCO_2e$
E_t	4 832 MJ	*Not considered*	*Not considered*	5 024 MJ
G_t	376 $kgCO_2e$	*Not considered*	*Not considered*	391 $kgCO_2e$

Annex G
(informative)

Example for combined passenger and freight transport: ferry lines

G.1 Description of the example

This example serves as an illustration of the impact of the two allocation methods specified in Annex B on one real ferry transport system.

The areas in the example are based on 100 % accessible area capacity according to valid general arrangement plan (GA-plan). The transport statistics used are one year real data i.e. this example presents an example of annual average allocation values. The values per entity used are the default values presented in Annex B, Table B1.

Table G.1 — Data for this example

	Annual activity data			Value per entity			
Entity	**Quantity**	**Mass (t)**	**Area (m²)**	**Mass (kg)**	**Area (m²)**	**Length (m)**	**Width (m)**
Pax deck area					7 550		
Vehicles deck area					5 770		
Passenger and luggage	478 500	47 850		100			
Passenger car	90 000	135 000	1 674 000	1 500	18,6	6	3,1
Bus	1 000	15 000	37 200	15 000	37,2	12	3,1
Caravan (small)	500	500	4 650	1 000	9,3	3	3,1
Caravan (medium)	500	1 000	9 300	2 000	18,6	6	3,1
Caravan (large)	500	1 250	15 500	2 500	31,0	10	3,1
Mobile home	-	-	-	3 500	24,8	8	3,1
Motorcycle	1 000	200	4 650	200	4,7	1,5	3,1
Unaccompanied trailer							
Empty trailer				8 000	43,4	14	3,1
Average load per trailer				19 000			
Total	4 000	108 000	173 600	27 000	43,4	14	3,1
Accompanied trailer							
Empty trailer				16 000	52,7	17	3,1
Average load per trailer				19 000			
Total	34 000	1 190 000	1 791 800	35 000	52,7	17	3,1

G.2 Results and comparison of the two allocation methods

In the mass allocation method, the weight of vehicles (including their loads for freight) and weight of passengers are based on annual activity data and values per entity presented in Table G.1. Table G.2 gives the corresponding results.

Table G.2 — Results with use of Mass allocation method

Mass allocation method	mass	%
Freight	1 298 000	87 %
Passengers	200 800	13 %
Total	1 498 800	100 %

In the area allocation method the relation between areas used by freight and passenger serves as the allocation ratio. Whole passenger deck area is allocated to passengers. Vehicle deck area is allocated according to the ratio between freight vehicles and passenger vehicles according to activity data and values per entity presented in Table G1. Table G.3 gives the corresponding results.

Table G.3 — Results with use of Area allocation method

Area allocation method	area	%
Freight	3 056	23 %
Passengers	10 264	77 %
Total	13 320	100 %

In conclusion, by using one allocation method or the other for the same combined passenger and cargo ferry, the distribution of energy consumption and GHG emissions gives completely different results. Hence, if the emission and energy data includes ferry vessel operation and the receiver of the data wishes to compare results, particular attention should be paid to the consistency in allocation methodology. As stated in Annex B.1, the ferry allocation method shall be consistent over time and per ferry line unless the ship is converted or allocated to a different line. Information about the allocation method used for a particular transport service will be available to the receiver of the data, and can be found in the supporting information which accompanies the declaration of results (see 10.3.2).

Annex H
(informative)

Detailed sources used and calculations done for establishment of Table A.1

Fuel type description		Sources and explanations of the calculations
Gasoline	d kg/l	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "Density kg/m^3", "Gasoline 2010"
	e_t MJ/kg	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "LHV MJ/kg", "Gasoline 2010"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to gasoline", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,17 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,17 (=1+0,17)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "CO_2 emissions", "Gasoline 2010": 73,38 g/MJ; - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.2.2 "Motor Gasoline - Low Mileage Light Duty Vehicle Vintage 1995 or Later", "Default": 3,8 kg/TJ (CH_4) and 5,7 kg/TJ (N_2O); - values for CO_2, CH_4 and N_2O are finally added
	g_t kgCO_2e/kg	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t kgCO_2e/l	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to gasoline", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 14,2 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w kgCO_2e/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w kgCO_2e/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Ethanol	d kg/l	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "Density kg/m^3", "Ethanol"
	e_t MJ/kg	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "LHV MJ/kg", "Ethanol"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 19 of 68: "WTET1a", "Ethanol from Wheat, Conv NG boiler, DDGS as animal feed", "energy expended (MJx/MJf)", "Total primary", "Best est." : 1,66; "WTET1b", "Ethanol from Wheat, Conv NG boiler, DDGS as fuel", "energy expended (MJx/MJf)", "Total primary", "Best est." : 1,24; - the value selected is the average of the two, so 1,45; - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 2,45 (=1+1,45)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	convention
	g_t $kgCO_2e$/kg	convention
	g_t $kgCO_2e$/l	convention
	g_w gCO_2e/MJ	calculated: - Directive 2009/30/EC page L 140/96 "The greenhouse gas emission saving from the use of biofuels (…) shall be at least 35 %" - this saving is applied to the well-to-wheels (g_w) emission factor of gasoline, expressed in gCO_2e/MJ
	g_w $kgCO_2e$/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e$/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Gasoline/Ethanol blend 95/5	d kg/l	calculated from values of gasoline (95 % in volume) and ethanol (5 % in volume)
	e_t MJ/kg	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/l is divided by density (d) in kg/l
	e_t MJ/l	calculated from values of gasoline (95 % in volume) and ethanol (5 % in volume)
	e_w MJ/kg	calculated: well-to-wheels energy factor (e_w) expressed in MJ/l is divided by density (d) in kg/l
	e_w MJ/l	calculated from values of gasoline (95 % in volume) and ethanol (5 % in volume)
	g_t gCO_2e/MJ	calculated: tank-to-wheels emission factor (g_t) expressed in $kgCO_2e/l$ is multiplied by 1000 then divided by tank-to-wheels energy factor (e_t) expressed in MJ/l
	g_t $kgCO_2e/kg$	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/l is divided by density (d) in kg/l
	g_t $kgCO_2e/l$	calculated from values of gasoline (95 % in volume) and ethanol (5 % in volume)
	g_w gCO_2e/MJ	calculated: well-to-wheels emission factor (g_w) expressed in $kgCO_2e/l$ is multiplied by 1000 then divided by well-to-wheels energy factor (e_t) expressed in MJ/l
	g_w $kgCO_2e/kg$	calculated: well-to-wheels emission factor (g_w) expressed in $kgCO_2e/l$ is divided by density (d) in kg/l
	g_w $kgCO_2e/l$	calculated from values of gasoline (95 % in volume) and ethanol (5 % in volume)

Fuel type description		Sources and explanations of the calculations
Diesel	d kg/l	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "Density kg/m^3", "Diesel 2010"
	e_t MJ/kg	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "LHV MJ/kg", "Diesel 2010"
	e_tMJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COD1", "Crude oil to diesel", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,19 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,19 (=1+0,19)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "CO_2 emissions", "Diesel 2010": 73,25 g/MJ; - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.2.2 "Gas / Diesel Oil", "Default": 3,9 kg/TJ (CH_4) and 3,9 kg/TJ (N_2O); - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e$/kg	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e$/l	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to diesel", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 15,9 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e$/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e$/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Bio-diesel	d kg/l	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "Density kg/m^3", "Bio-diesel"
	e_t MJ/kg	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "LHV MJ/kg", "Bio-diesel"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 22 of 68: "ROFA1", "RME, glycerine as chemical, meal as animal feed": 1,09 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 2,09 (=1+1,09)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	convention
	g_t $kgCO_2e/kg$	convention
	g_t $kgCO_2e/l$	convention
	g_w gCO_2e/MJ	calculated: - Directive 2009/30/EC page L 140/96 "The greenhouse gas emission saving from the use of biofuels (…) shall be at least 35 %" - this saving is applied to the well-to-wheels (g_w) emission factor of diesel, expressed in gCO_2e/MJ
	g_w $kgCO_2e/kg$	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e/l$	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Diesel/bio-diesel blend 95/5	d kg/l	calculated from values of diesel (95 % in volume) and bio-diesel (5 % in volume)
	e_t MJ/kg	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/l is divided by density (d) in kg/l
	e_t MJ/l	calculated from values of diesel (95 % in volume) and bio-diesel (5 % in volume)
	e_w MJ/kg	calculated: well-to-wheels energy factor (e_w) expressed in MJ/l is divided by density (d) in kg/l
	e_w MJ/l	calculated from values of diesel (95 % in volume) and bio-diesel (5 % in volume)
	g_t gCO_2e/MJ	calculated: tank-to-wheels emission factor (g_t) expressed in $kgCO_2e/l$ is multiplied by 1000 then divided by tank-to-wheels energy factor (e_t) expressed in MJ/l
	g_t $kgCO_2e/kg$	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/l is divided by density (d) in kg/l
	g_t $kgCO_2e/l$	calculated from values of diesel (95 % in volume) and bio-diesel (5 % in volume)
	g_w gCO_2e/MJ	calculated: well-to-wheels emission factor (g_w) expressed in $kgCO_2e/l$ is multiplied by 1000 then divided by well-to-wheels energy factor (e_t) expressed in MJ/l
	g_w $kgCO_2e/kg$	calculated: well-to-wheels emission factor (g_w) expressed in $kgCO_2e/l$ is divided by density (d) in kg/l
	g_w $kgCO_2e/l$	calculated from values of diesel (95 % in volume) and bio-diesel (5 % in volume)

Fuel type description		Sources and explanations of the calculations
Liquefied Petroleum Gas (LPG)	d kg/l	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "Density kg/m^3", "LPG"
	e_t MJ/kg	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "LHV MJ/kg", "LPG"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 16 of 68: "LRLP1", "LPG from gas field (remote)", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,12 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,12 (=1+0,12)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "CO_2 emissions", "LPG": 65,68 g/MJ; - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.2.2 "Liquified petroleum gas", "Default": 62 kg/TJ (CH_4) and 0,2 kg/TJ (N_2O); - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e$/kg	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e$/l	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 16 of 68: "LRLP1", "LPD from gas field (remote)", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 8,0 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e$/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e$/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Compressed Natural Gas (CNG)	d kg/l	no value proposed
	e_t MJ/kg	JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "LHV MJ/kg", "CNG/CBG"
	e_t MJ/l	no value proposed
	e_w MJ/kg	- calculated from JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 13 of 68: "GMCG1", "NG current EU-mix (1000 km)", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,12 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,12 (=1+0,12)
	e_w MJ/l	no value proposed
	g_t gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - TTW Report v3c July 2011, page 8 of 46 - "CO_2 emissions", "CNG/CBG": 56,24 g/MJ; - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.2.2 "Natural Gas", "Default": 92 kg/TJ (CH_4) and 3 kg/TJ (N_2O); - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e/kg$	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e/l$	no value proposed
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 13 of 68: "GMCG1", "NG current EU-mix (1000 km)", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 8,7 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e/kg$	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e/l$	no value proposed

Fuel type description		Sources and explanations of the calculations
Aviation Gasoline (AvGas)	d kg/l	Decision 2009/339/EC - page L 103/21, 2.2.3 Fuel Density
	e_t MJ/kg	Decision 2009/339/EC - page L 103/18, Net Calorific Value (TJ/Gg), "Aviation gasoline (AvGas)"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to gasoline", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,17 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,17 (=1+0,17)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - Decision 2009/339/EC - page L 103/18, Emission factor, "Aviation gasoline (AvGas)": 70,0 tCO_2/TJ; - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.6.5 "All fuels", "CH_4 Default": 0,5 kg/TJ;"N_2O Default": 2 kg/TJ; - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e/kg$	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e/l$	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to gasoline", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 14,2 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e/kg$	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e/l$	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Jet Gasoline (Jet B)	d kg/l	Decision 2009/339/EC - page L 103/21, 2.2.3 Fuel Density
	e_t MJ/kg	Decision 2009/339/EC - page L 103/18, Net Calorific Value (TJ/Gg), "Jet gasoline (Jet B)"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to gasoline", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,17 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,17 (=1+0,17)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - Decision 2009/339/EC - page L 103/18, Emission factor, "Jet gasoline (Jet B)": 70,0 tCO_2/TJ; - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.6.5 "All fuels", "CH_4 Default": 0,5 kg/TJ;"N_2O Default": 2 kg/TJ; - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e$/kg	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e$/l	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to gasoline", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 14,2 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e$/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e$/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Jet Kerosene (Jet A1 and Jet A)	d kg/l	Decision 2009/339/EC - page L 103/21, 2.2.3 Fuel Density
	e_t MJ/kg	Decision 2009/339/EC - page L 103/18, Net Calorific Value (TJ/Gg), "Jet kerosene (jet A1 or jet A)"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COD1", "Crude oil to diesel", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,19 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,19 (=1+0,19)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - Decision 2009/339/EC - page L 103/18, Emission factor, "Jet kerosene (jet A1 or jet A)": 71,5 tCO_2/TJ; - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.6.5 "All fuels", "CH_4 Default": 0,5 kg/TJ;"N_2O Default": 2 kg/TJ; - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e/kg$	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e/l$	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to diesel", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 15,9 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e/kg$	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e/l$	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Heavy Fuel Oil (HFO)	d kg/l	JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 1, page 16 of 108 - "Density kg/m^3", "HFO"
	e_t MJ/kg	JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 1, page 16 of 108 - "LHV MJ/kg", "HFO"
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 1, page 19 of 108: "HFO production", "Mjex/MJ": 0,0880 - tank-to-wheels energy factor (et) expressed in MJ/kg is multiplied by 1,088 (=1+0,088)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - International Maritime Organization (IMO), Marine Environment Protection Committee (MEPC), Circular 681, 17 August 2009 - Annex page 2, table of conversion factors, "Heavy Fuel Oil (HFO): 3,114400 t CO_2 per ton of fuel; - this value of 3,1144 is multiplied per 1000 and then divided by the tank-to-wheels (e_t) energy factor; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.5.3 "Ocean-going Ships": 7 kg/TJ (CH_4) and 2 kg/TJ (N_2O); - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e$/kg	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e$/l	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 1, page 19 of 108: "HFO production", "gCO_2/MJ": 6,65 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e$/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e$/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Marine Diesel Oil (MDO)	d kg/l	ISO 8217:2010 Fuels (class F) Specifications of marine fuels - Table 1, "Density at 15°C", "DMB": 900,0 kg/m^3
	e_t MJ/kg	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2 "Gas/Diesel Oil", "Net Calorific value": 43,0 TJ/Gg;
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COD1", "Crude oil to diesel", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,19 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,19 (=1+0,19)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - International Maritime Organization (IMO), Marine Environment Protection Committee (MEPC), Circular 681, 17 August 2009 - Annex page 2, table of conversion factors, "Diesel/Gas Oil): 3,206000 t CO_2 per ton of fuel; - this value of 3,206 is multiplied per 1000 and then divided by the tank-to-wheels (e_t) energy factor; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.5.3 "Ocean-going Ships": 7 kg/TJ (CH_4) and 2 kg/TJ (N_2O); - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e$/kg	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e$/l	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to diesel", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 15,9 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e$/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e$/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Fuel type description		Sources and explanations of the calculations
Marine Gas Oil (MGO)	d kg/l	ISO 8217:2010 Fuels (class F) Specifications of marine fuels - Table 1, "Density at 15°C", "DMA": 890,0 kg/m^3
	e_t MJ/kg	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2 "Gas/Diesel Oil", "Net Calorific value": 43,0 TJ/Gg;
	e_t MJ/l	calculated: tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by density (d) in kg/l
	e_w MJ/kg	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COD1", "Crude oil to diesel", "energy expended (MJx/MJf)", "Total primary", "Best est." : 0,19 - tank-to-wheels energy factor (e_t) expressed in MJ/kg is multiplied by 1,19 (=1+0,19)
	e_w MJ/l	calculated: well-to-wheels energy factor (e_w) expressed in MJ/kg is multiplied by density (d) in kg/l
	g_t gCO_2e/MJ	calculated: - International Maritime Organization (IMO), Marine Environment Protection Committee (MEPC), Circular 681, 17 August 2009 - Annex page 2, table of conversion factors, "Diesel/Gas Oil): 3,206000 t CO_2 per ton of fuel; - this value of 3,206 is multiplied per 1000 and then divided by the tank-to-wheels (e_t) energy factor; - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 3 Mobile Combustion, Table 3.5.3 "Ocean-going Ships": 7 kg/TJ (CH_4) and 2 kg/TJ (N_2O); - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 - Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing", table 2.14: Global Warming Potential for 100 years is 25 for CH_4 and 298 for N_2O; - values for CO_2, CH_4 and N_2O are finally added
	g_t $kgCO_2e$/kg	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_t $kgCO_2e$/l	calculated: tank-to-wheels emission factor (g_t) expressed in gCO_2e/kg is multiplied by density (d) in kg/l
	g_w gCO_2e/MJ	calculated: - JEC Well-to-Wheels Analysis, version 3c 2011 - WTT Report v3c July 2011, Appendix 2, page 11 of 68: "COG1", "Crude oil to diesel", "Net GHG emitted (gCO_2eq/MJf)", "Best est.": 15,9 - this value is added to the tank-to-wheels (g_t) emission factor expressed in gCO_2e/MJ
	g_w $kgCO_2e$/kg	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/MJ is multiplied by tank-to-wheels energy factor (e_t) expressed in MJ/kg, then divided by 1000
	g_w $kgCO_2e$/l	calculated: well-to-wheels emission factor (g_w) expressed in gCO_2e/kg is multiplied by density (d) in kg/l

Annex I
(informative)

Example of available sources of default values

a) ADEME: Base Carbone®;

b) Connekt e.a. : Lijst emissiefactoren;

c) Department for Environment Food and Rural Affairs (Defra, United Kingdom); Defra / DECC's GHG Conversion Factors for Company Reporting;

d) EcoPassenger;

e) EcoTransIT World (Ecological Transport Information Tool);

f) European Commission – JRC (Joint Research Centre):

   1) European Reference Life Cycle Database (ELCD);

   2) Well-to-Wheels Analyses;

g) Federal Environment Agency (Umwelt Bundes Amt, Germany): PROBAS (Prozessorientierte Basisdaten für Umweltmanagement-Instrumente);

h) IEA (International Energy Agency);

i) INFRAS (mandated by the responsible authorities of Germany, Austria, Switzerland, Sweden, France and Norway): HBEFA (Handbook Emission Factors for Road Transport);

j) International Maritime Organization (IMO): EEOI (Energy Efficiency Operational Indicator);

k) International Union of Railways (UCI):

l) NTM, Network for Transport and Environment (NTMCalc Goods & NTMCalc Travel);

m) Oeko-Institut (Germany): GEMIS (Global Emission Model for Integrated Systems);

n) SÅ Miljöcalc;

o) Ecoinvent Centre (Swiss Centre for Life Cycle Inventories): Ecoinvent Life Cycle Inventory;

p) Technical Research Centre of Finland (VTT, Finland): LIPASTO ;

q) WRI/WBCSD: GHG Protocol (Greenhouse Gas Protocol);

NOTE Default values presented by any of the sources included in this list may or may not have been calculated in full accordance with this standard.

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[16] ISO/DIS 14067:2012, *Carbon footprint of products — Requirements and guidelines for quantification and communication*

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[21] WRI/WBCSD: GHG Protocol (Greenhouse Gas Protocol)

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