Carbon Footprint Calculation Tool
Manual

Table of Contents

Introduction

Welcome to the user manual of EVISA's carbon footprint calculation tool! The manual aims to provide an easy-to-follow guide for members of a port authority willing to create a greenhouse gas emission inventory for their port.

New EU regulations and frameworks will most likely soon require ports to follow a clear path towards a greener and more sustainable future. To support the ports in this endeavour, the EVISA project assessed means and approaches for small and medium-sized ports on how to undertake an energy-wise transformation. As part of the Strategic Energy Management Planning Tool, the carbon footprint of a port needs to be calculated to identify the most emission-intensive structures inside the harbour area. Knowledge of the current situation will

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help the port authority identify the most appropriate ways to move forward and help lower the port's impact on the environment.

In addition to this written manual, explanations in video format are available as well and can be used as guidance when attempting to calculate the port's carbon footprint. The tool's excel file itself also includes a couple of highlighted short instructions.

All EVISA tools were developed specifically for small and medium-sized ports in Finland. However, except for some special (energy-related) emission factors, it is entirely possible to utilise the carbon footprint calculation tool also for ports located in different countries.

Scopes of emissions

The greenhouse gas inventory for ports is divided into three scopes with several subcategories. Figure 1 provides an overview.
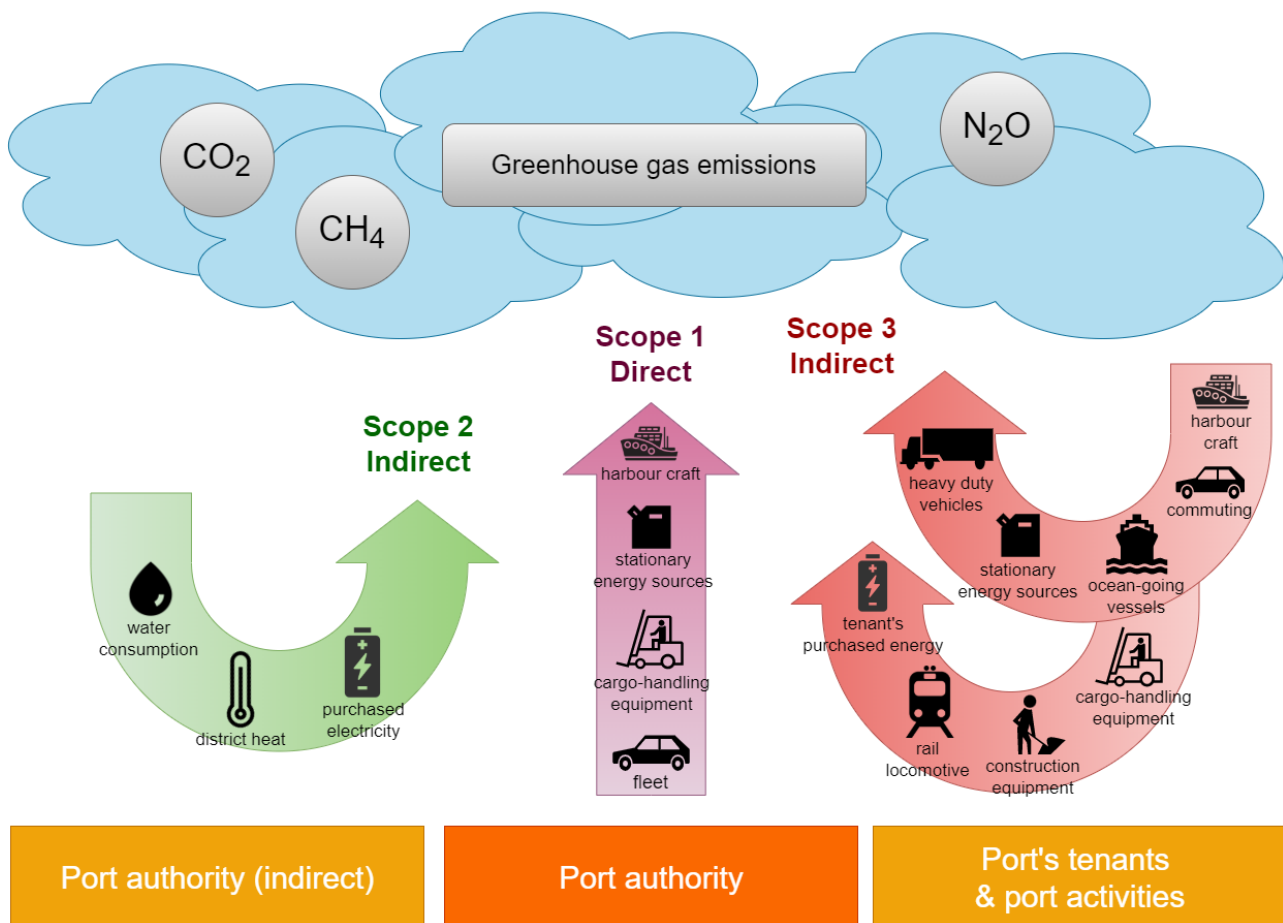

Figure 1. Scopes of emissions for a port's carbon footprint.

Scope 1 represents the direct emissions. All operations inside the harbour area that are under the direct control of the port authority are allocated to this scope. That includes harbour crafts and cargo-handling equipment owned or rented by the port, the port's own car fleet, as well as any stationary energy sources utilised by the port authority.

The second scope combines indirect, energy-related emissions, meaning emissions caused during the production phase of energy sources outside the port area. But because the final consumption occurs inside the harbour, the emissions are added to the port's carbon footprint. Purchased electricity, the usage of district heating and the water consumption that are controlled by the port authority belong to this category.

Lastly, all greenhouse gas emissions allocated to activities of port tenants or the port's visitors and customers are represented in scope 3. The analysed activities are mainly limited to inside the port's barriers on land- and waterside. Included are harbour crafts, stationary energy sources and cargo-handling equipment operated by the port's tenants, as well as their energy consumption. In addition, visiting ocean-going vessels, rail transport and heavy-duty vehicles entering the harbour area, construction equipment and the commuting of employees are assessed in scope 3 as well.

Structure of the tool

The process of mapping a port's greenhouse gas inventory consists of different steps, making sure that every scope and category of emissions are included in the final results. The tool can be completed in any order that is the most convenient. However, it might be the most beneficial approach to start with the direct emissions in scope 1 and the energy-related emissions allocated to scope 2. Those categories most often contain data that is the easiest to obtain as they are under the direct control of the port authority. While scope 3 emissions might be more challenging to gather, they usually represent a considerable part of the carbon footprint and should therefore not be neglected and mapped diligently.

In the end, the tool delivers the final carbon footprint of the port and lists all emissions allocated to the different scopes and categories. To enable a certain degree of comparability between ports, the emissions are also reported in relation to the port's capacity factors. Furthermore, a visual representation of the results is offered in form of different pie charts.

Besides the carbon footprint assessment, the EVISA tool includes also other parts that represent important steps on the way to creating a strategic energy management plan. In case the port considers completing also other parts in addition to the carbon footprint calculation, information already gathered in the "Energy Mapping Survey" can be used for this tool as well.

Starting the calculation

The self-assessment tool is divided into several sheets, each dedicated to an individual category.

Cells with a **white** background are cells that represent results or additional information and should not be changed. Data is only to be filled in cells with a **grey** background.

The first page of the calculation tool is the 'SUMMARY' sheet with the navigation panel and the table displaying the final results. All information in the results table is filled in automatically and it is not recommended to make any changes to the cells.

At first, the name of the port should be added to **cell B2** and the year for which the calculation is carried out needs to be defined (**cell D2**). The latter is important because in some scopes of emissions the applied emission factors depend on the chosen year. In addition, the port's capacity factors need to be supplied to the tool (**cells O11 to O14**), including cargo tonnage, number of visiting vessels, container volume and annual revenue.
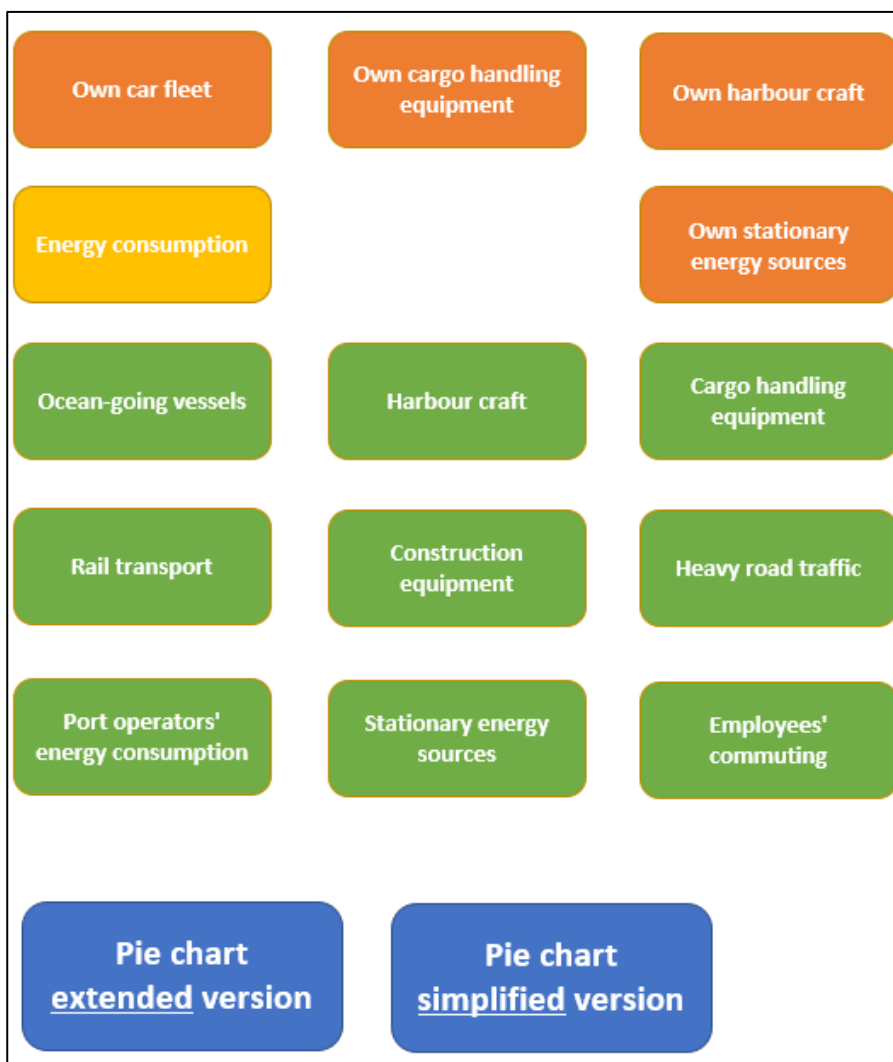

Figure 2. The navigation panel on the Summary sheet.

To navigate between the different sheets dedicated to the various scopes and categories of emissions, the 'SUMMARY' sheet has a '**NAVIGATION PANEL**' (see Figure 2). Clicking on the buttons will switch the view to the relevant sheet.

Besides the navigation panel on the summary page, every other sheet has a button that allows a quick return to the summary page (see Figure 3). The button is located in the frozen top rows of each sheet.
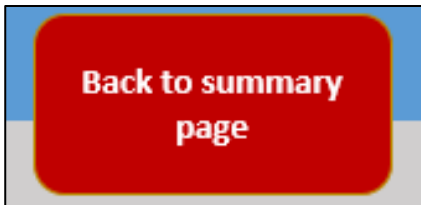

Figure 3. 'Back to summary page'-button

Energy consumption

To calculate the energy-related emissions of the port, it is necessary to collect data on the consumption of electricity, water and, if applicable, district heat. Similar information is required during EVISA's energy mapping survey. In case your port has undertaken that assessment as well, it is possible to use it as a reference and copy the data to the fitting categories in this carbon footprint tool.

The 'Energy' sheet can be reached from the 'SUMMARY' page by clicking the yellow 'Energy consumption'-button in the navigation panel, as well as the green 'Port tenant's energy consumption'-button. It is divided into two parts: Scope 2 – Port authority's energy-related, indirect emissions, and Scope 3 – Port tenants' energy-related, indirect emissions. For both scopes, it is possible to add data on electricity, water, and district heat consumption separately. The mechanism for providing the information follows the same rules regardless of the scope. The following instructions can therefore be used as an explanation for all tables in the worksheet.

Electricity

1. Enter the name of the consumer or the measurement point (see Figure 4).
2. Add the electricity consumption in kWh.
3. Choose the type of electricity from the cell's drop-down menu. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow (see Figure 4). You can either choose 'Finnish average', '100% renewable energy' or 'carbon-neutral electricity'.
   Selecting '100% renewable energy' or 'carbon-neutral energy' will result in an emission factor of zero. If 'Finnish average' was chosen, the tool will automatically

choose the appropriate emission factor depending on the year, which must be provided on the 'SUMMARY' page in cell D2.

Emission factors for electricity consumed in Finland are available for the years 2018, 2019, 2020 and 2021 (as reported by Fingrid[1]). By default, all other years are assigned the same value as 2021. However, it is also possible to provide a new value by changing the hidden formula sheet. A more detailed explanation of how to make those changes and access the hidden sheets can be found in the advanced manual part.

SCOPE 2 - Port authority's energy-related, indirect emissions			
Electricity			
Consumer/Measuring point	**Electricity consumption (kWh)**	**Type of electricity**	
Office building	10000	Finnish average	
Harbour master building	3000	Finnish average	▼

Figure 4. Table to be filled in the 'Energy'-sheet of the calculation tool.

District heat

1. Enter the name of the consumer or the measurement point.
2. Add the consumption of district heat in kWh.
3. Choose the type of district heat from the drop-down menu. You can either choose 'Finnish average', '100% renewable energy' or 'carbon-neutral energy'. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.

> Selecting '100% renewable energy' or 'carbon-neutral energy' will result in an emission factor of zero. If 'Finnish average' was chosen, the tool will automatically choose the appropriate emission factor depending on the year, which must be provided on the 'SUMMARY' page.
>
> Emission factors for district heat consumed in Finland are available for the years 2017, 2018, 2019 and 2020 (as reported by Statistics Finland[2]). By default, all other years are assigned the same value as 2020. However, it is also possible to provide a new value by changing the hidden formula sheet. A more detailed

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[1] Fingrid Oyj, 2020 (https://www.fingrid.fi/en/electricity-market/electricity-market-information/real-time-co2-emissions-estimate/).

[2] Statistics Finland, 2020, Table 12.3.2.2 Moving averages of specific carbon dioxide emissions in electricity and heat production (energy method, g CO2 / kWh) (https://pxhopea2.stat.fi/sahkoiset_julkaisut/energia2020/html/engl0011.htm).

explanation of how to make those changes and access the hidden sheets can be found in the advanced manual part.

In case your port is utilising **district cooling**, the energy consumption can be added under the district heating section. Follow the instructions above but choose as type of energy 'district cooling'. Due to the local variability of available district cooling systems, the emission factor has to be added manually. Further instructions can be found in the advance part of this manual.

Water

1. Enter the name of the consumer or the measurement point.
2. Choose the type of water from the drop-down menu, which will appear after selecting the cell and clicking on the button with the downward pointing arrow. You can choose between 'clean water' and 'wastewater'. In case only clean water consumption data is available for the port, the wastewater consumption should at least be estimated based on the clean water consumption.
3. Add the consumption of water in m^3.

The results of the calculation can be found on the 'SUMMARY' sheet. The red 'Back to summary page' button at the top of the sheet will take you back there.

Ocean-going vessels (OGV)

The 'OGV' sheet can be reached from the 'SUMMARY' page by clicking the green 'Ocean-going vessels'-button in the navigation panel.

First, please choose one of the following approaches by clicking on the appropriate button (see Figure 5):

a) Port is using Satamatieto & Portensys

If the port is using this management tool, the emissions caused by the vessels should already be known or it will be possible to collect this data from the system. In that case, there is no need to calculate the emissions from ocean-going vessels again with this tool. The same results can be used.

b) Port is using other software (for example, WD.net)

If the port is utilising a different management system than Portensys, it is likely that the emissions are so far unknown, but that a list of ship calls and details about the ships are available. In that case, that information will be used by the EVISA tool to calculate the emissions of the visiting vessels to the port.

Clicking on the appropriate button will lead to a new sheet where the necessary information for each approach can be filled in. Make sure that you only fill in data for *one* of the options. Otherwise, the emissions might end up being counted double in the 'SUMMARY' sheet.

Figure 5. Worksheet concerning the calculation of emission caused by ocean-going vessels - the buttons will lead to the appropriate tables to fill in the date.

A) Satamatieto and Portensys in use

If the port uses a system that already provides information about the emissions caused by visiting vessels, then it is possible to simply add that data to this sheet. To ensure a better understanding later on or the possibility to follow up on the calculation, please fill in also additional information and not only the emissions.

Area, Pier/Quay, as well as the type of ship, are information to be provided in the table. The greenhouse gas emissions divided into CO_2, CH_4 and N_2O are to be added in tonnes. In case the emissions are already converted and available in CO_2-equivalents (based on the global warming potential of the greenhouse gases), the value should only be put into the CO_2-column. Otherwise, the CH_4- and N_2O-emissions are automatically converted to CO_2 equivalents by the tool.

Lastly, the number of vessel calls per type of ship and/or area should be added to the last column. The provided emissions will be summed up automatically and added to the 'SUMMARY' page. You can go back there by choosing the red 'Back to summary page'-button at the top of the excel sheet.

B) Other software in use (for example WD.net)

If the port is utilising a management system for visiting vessels that does not provide information on caused emissions, this approach will calculate them based on more detailed information about the ships. The most important information to be added to the worksheet is the time of arrival and departure, type of vessel, length, deadweight tonnage and main engine power. The maximum number of visits that can be added to the tool is 700. If more vessels

need to be added, the calculation sheet needs to be adapted (see instructions in the advanced part of the manual).

The safest way to add the data is to copy and paste each column individually from the port's management system to the tool, so that differences in formatting won't influence the calculation.

Time of arrival and departure

First, add the time of arrival and the time of departure. The time must be given in the format 09.01.2020 22:00:00. If the port is using WD.net, then this is the format the data is already provided in. The cell will only show the date, but the time will still play a role in the calculation. The two columns are formatted as "Date". Please do not change this formatting.

Additional visit information

Information about the pier/quay, the part of the harbour, as well as the visit ID, Lloyds number and the name of the vessel are secondary information and not strictly required for carrying out the calculation. However, having a complete inventory list might help with follow-up or analysing tasks. Please add the data via copy and paste to the tool.

Type of vessel

The type of vessel is very important information and needs to be filled in. Please be aware of the types of vessels that are recognised by the calculation tool. As the tool relies on the type of vessel for all consecutive calculations, only the names displayed in Table 1 should be used when filling in the information. Otherwise, types that cannot be identified by the tool are automatically allocated to the category "Other vessel", which will decrease the accuracy of the calculation.

Table 1. Types of vessels usable in the calculation tool.

English name	Finnish name	Type of vessel in tool
Other dry cargo	Muu kuivalasti, Muu kuivalastialus	General cargo
Dry bulk	Kuiva Bulk	Dry bulk
Bulk carrier	Irtolastialus	Dry bulk
Tanker	Säiliöalus	Liquid bulk
Gas tanker	Kaasusäiliöalus	Liquid bulk
Chemical tanker	Kemikaalisäiliöalus	Liquid bulk
Oil tanker	Öljysäiliöalus	Liquid bulk
Container ship	Konttialus	Container ship
RoPax (RoRo Passenger)	Ro-Ro-Matkustaja-Alus	RoPax
RoRo (Cargo)	Ro-Ro-Lastialus	RoRo

Vehicle carrier	Ajoneuvojenkuljetusalus	RoRo
Other vessel	Muu alus	Other vessel
Tugboat	Hinaaja	Tugboat
Barge	Proomu, Pusku-Proomu	Barge

Ship data

The length of the vessel should be added in meters, deadweight tonnage and gross weight (Brutto tonnage) in tonnes. Main engine power is another very important piece of information and must be added for each ship in kWh.

During the pilot tests for the tool, it was noticed that the main engine power might not have been reported for every vessel and the listed value is 0. In that case, a calculation is triggered to estimate the main engine power of that vessel based on the known Brutto/gross weight tonnage. While the estimation may achieve similar results compared to the real engine power, it might also differ significantly and cause a deviation from the actual value of the emitted greenhouse gases. Differences in the total carbon footprint of ocean-going vessels were found to sum up to between 2 to 16% during the tests when comparing estimations and real data.

If missing main engine powers are detected, the port authority should evaluate whether it is worth putting more effort into the calculation and find out those missing values to increase the accuracy of the carbon footprint calculation. However, as every ship with missing main engine power needs to be processed individually, this is a time-consuming effort. A potential data source is, for example, the webpage MarineTraffic[3], where information about a ship's machinery is collected and in general accessible to subscription users.

Manoeuvring time

Estimating the manoeuvring time of visiting vessels is an important step for calculating emissions. Next to the columns with space for copying the data from the port's management system to the calculation tool, there is a column reserved for entering the manoeuvring time of one vessel inside the port area or the area controlled by the port in hours. This provides the possibility to add individual times to each visiting ship (for example, depending on the vessel's length or the time of arrival). However, if only one assumption for all ships can be made, then it is also possible to use the same value for all listed ships. This column must be filled out, as otherwise the emissions caused during the manoeuvring are assumed to be zero.

Please consider the time the vessel spends manoeuvring inside the port area and the area under the control of the port (channel) during arrival and departure. The expansion of the considered area depends on the port and could equal, for example, a channel of one nautical mile as illustrated in Figure 6. Considerations could look like this: From entering the channel

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[3] MarineTraffic (https://www.marinetraffic.com/)

under the port's control to when the vessel is arriving at a standstill at the quay, a visiting vessel usually requires 0.75 hours. During departure, the ship manages the same in 0.5 hours. Thus, the total manoeuvring time sums up to 1.25 hours per visiting vessel. In case the length of the individual vessels or the seasonal characteristics of the port cause significant differences in manoeuvring time, those factors should be taken into consideration and adding a universal manoeuvring time for all vessels should be avoided.

■ Harbour area under direct control of the port authority

■ Harbour area and channel for incoming visiting vessels under direct control of the port authority

Figure 6. Example for harbour area and channel under control of port authority for the estimation of the manoeuvring time of visiting vessels.

Onshore power supply

In case the port offers onshore power supply (OPS) to visiting ocean-going vessels, the usage needs to be indicated in the table for each ship separately. A drop-down menu offers the possibility to choose 'yes' in the OPS column under 'Additional information'. Choosing 'yes' will trigger the assumption that the vessel turns off all engines (main, auxillary and boiler) while at berth. OPS consumption needs to be reported separately under the energy tab of the tool,

presumably under Scope 2 emissions when the port authority is responsible for supplying the ships.

Additional assumptions

Following the Sulphur Emission Control Area – Baltic Sea, it is assumed that most vessels are running on MDO/MGO fuels (main engine, auxiliary engine, and auxiliary boiler). Container ships are assumed to utilise SSD main engines and Tugboats feature HSD main engines. For all other types of ships MSD main engines are utilised for the calculation of emissions. Auxiliary engines always follow the characteristics of an MSD engine, while auxiliary boilers are represented by steam turbines. In case engine specifications are known, it is possible to make adjustments to those stated assumptions. An explanation of how to make those changes can be found in the advanced part of the manual.

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

Harbour crafts

The 'HC' sheet can be reached from the 'SUMMARY' page by clicking the green 'Harbour craft'-button or the orange 'Own harbour craft'-button in the navigation panel.

Before filling in the details about the harbour crafts, it is recommended to first assess the emissions caused by the visiting ocean-going vessels. Especially the self-assessment helping tool for determining the activity hours for harbour crafts only works when data was provided about the number of vessels coming to the port (doesn't apply to the approach based on Satamatieto & Portensys).

Emissions from harbour crafts are divided into two different scopes depending on their ownership. All vessels owned and operated by the port authority are part of Scope 1. Harbour crafts operated by a company as part of the port's activities or on behalf of the port authority are allocated to Scope 3. Harbour crafts include various tugboat categories, crew and workboats, excursion and government vessels, as well as ferries and icebreakers. Pilot boats are assessed in a separate category at the end of the excel sheet.

Two different calculation approaches are available for the harbour craft emissions considering different available information: activity-based or based on the fuel consumption. Both methods can be used for Scope 1 and 3, respectively. Pilot boat emissions are based on the annual number of serviced ocean-going vessels. Every harbour craft operated as part of the port's operation should be added individually to the tool.

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A) Activity-based approach

1. Choose the type of vessel from the drop-down menu and enter its name for clarity reasons. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow. Further instructions on the different available types of vessels can be found down below in Table 2.

2. Provide information on the year of manufacturing. This is important information because the emission factors are applied to the vessel depending on the engine's age.

3. Fill in the main engine power and auxiliary engine power in kW. In case the engine powers are unknown, enter x. This will trigger the usage of rough averages reported for the specific vessel type (not recommended for an accurate carbon footprint).

4. Consider the annual activity hours for the main engine and auxiliary engine, respectively. Please try to make estimations if the exact times are unavailable. If no estimations can be made, enter x. This results in the usage of rough averages reported for the specific vessel type (not recommended for an accurate carbon footprint).

The tool features a self-assessment possibility for activity hours of harbour crafts based on the visiting ocean-going vessel. This only works properly if a management system other than Satamatieto/Portensys was used for the assessment of visiting vessels. The lengths of the visiting vessels need to be known for the tool to function properly.

a) Tugboats
   1. Decide on the length categories. Enter the minimum and maximum length of ocean-going vessels in meters.
   2. The number of vessels fitting those categories is added automatically if the information is available from the 'OGV_Ship calls' sheet.
   3. Enter the number of tugboats needed per length category.
   4. Add the estimated activity required of one tugboat when servicing one visiting vessel of a specific length category (in hours). Consider arrival, departure, and potential assistance during the stay.
   5. The annual activity hours for the tugboat's main and auxiliary engines are automatically calculated. The values can be used as estimation or simple guidance when determining the activity hours of the individual tugboats.
b) Icebreakers
   1. Enter the number of visiting vessels during the icebreaking season.
   2. Add the estimated activity of one icebreaker per visiting vessel (in hours). Consider arrival, departure, and potential assistance during the stay.
   3. The activity hours for one icebreaker's main and auxiliary engines are automatically calculated and can be used as estimation and guidance when determining the necessary information for the activity-based approach.

5. If applicable to the harbour craft, provide the onshore power supply consumption in kWh.

6. Clarify the type of electricity used for the onshore power supply. You can either choose 'Finnish average' or '100% renewable energy' from the drop-down menu. These options will appear after selecting the cell and clicking on the button with the downward-pointing arrow.

> Selecting '100% renewable energy' will result in an emission factor of zero. If 'Finnish average' was chosen, the tool will automatically choose the appropriate emission factor depending on the year, which must be provided on the 'SUMMARY' page.

> Emission factors for electricity consumed in Finland are available for the years 2018, 2019, 2020 and 2021 (as reported by Fingrid[4]). By default, all other years are assigned the same value as 2021. However, it is also possible to provide a new value by changing the hidden formula sheet. A more detailed explanation of how to make those changes and access the hidden sheets can be found in the advanced manual part.

B) Based on fuel consumption

1. Choose the type of vessel from the drop-down menu and enter its name for clarity reasons. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow. Further instructions on the different available types of vessels can be found down below in Table 2.
2. Decide on the type of fuel utilised by the harbour craft. Choose from the drop-down menu between motor gasoline, gas/diesel oil, LPG, kerosene, lubricants, CNG and LNG.
3. Enter the annual amount of fuel consumed in litres.
4. If applicable to the harbour craft, provide the onshore power supply consumption in kWh.
5. Clarify the type of electricity used for the onshore power supply. You can either choose 'Finnish average' or '100% renewable energy'.

> Selecting '100% renewable energy' will result in an emission factor of zero. If 'Finnish average' was chosen, the tool will automatically supply the appropriate emission factor depending on the year, which must be provided on the 'SUMMARY' page.

> Emission factors for electricity consumed in Finland are available for the years 2018, 2019, 2020 and 2021 (as reported by Fingrid[5]). By default, all other years are assigned the same value as 2021. However, it is also possible to provide a new value by changing the hidden formula sheet. A more detailed explanation of

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[4] Fingrid Oyj, 2020 (https://www.fingrid.fi/en/electricity-market/electricity-market-information/real-time-co2-emissions-estimate/).

[5] Fingrid Oyj, 2020 (https://www.fingrid.fi/en/electricity-market/electricity-market-information/real-time-co2-emissions-estimate/).

how to make those changes and access the hidden sheets can be found in the advanced manual part.

Tugboat categories

The tool offers the possibility to assign a ship type to each harbour craft. The categories are based on the Port of Long Beach's Air Emission Inventory and are meant to provide estimations for the calculation if specific information is unavailable.

Harbour tugs are small boats only operated in port areas of big ports. Workboats and crew boats are meant for carrying workers from one place to another. A typical Finnish port most likely operates at least a tugboat that fits in the 'Ocean tugboat' category. As seen during the testing of the tool, most of the time their engine power might even be double the one listed below. This makes it necessary to try and provide as many details as possible on the tugboats operated in your port to reduce potential inaccuracies during the calculation process.

Table 2. Data used for estimating the main engine (ME) and auxiliary engine (AE) powers, as well as annual operating hours for tugboats if the information is (partially) unavailable [POLB's 2019 Air Emission Inventory[6]].

Type of craft	Main engine average power	Annual operating hours (ME)	Auxiliary engine average power	Annual operating hours (AE)
	kW	h	kW	h
Assist tugboat	1473.94	1340	135.33	1478
Crew boat	454.54	790	43.39	886
Excursion vessel	278.02	1293	44.13	1746
Ferry	1361.41	1065	49.28	1089
Governement vessel	1126.78	1445	635.47	933
Ocean tugboat	1594.56	1358	102.23	1169
Harbour tugboat	664.89	661	61.05	656
Icebreaker	1594.56	1358	102.23	1169
Workboat	350.83	365	51.48	421

If detailed data is not available, Table 2 presents the information used for the estimation of engine powers and operating hours depending on the type of harbour craft. Please choose the one that seems to be the most fitting.

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[6] Port of Long Beach, 2020, 2019 Air Emissions Inventory (https://safety4sea.com/wp-content/uploads/2020/10/Port-of-Long-Beach-Air-Emissions-Inventory-2019-2020_10.pdf).

C) Pilot boats

Pilot boats are usually operated by a service provider and not the port authority. However, the operation of pilot boats is seen to be an integral part of the port and therefore their activity is also considered in this calculation tool. The onshore power supply is only to be filled in if the pilot boats are located in the assessed harbour. Otherwise only the number of vessels serviced by the specific pilot boat is required. Utilised emission factors for the calculation of emissions caused by the operation of pilot boats are based on numbers reported by Finnpilot[7]. The emission factors are available for the years 2018-2021. All other years are automatically assigned the factor for 2021. It is also possible to provide a new value by changing the hidden formula sheet. A more detailed explanation of how to make those changes and access the hidden sheets can be found in the advanced manual part.

1. Choose the type of vessel from the drop-down menu: Fast pilot boat, pilot cutter and hydrocopter. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.
2. Enter the name or another identification for the pilot boat.
3. If applicable to the harbour craft, provide the onshore power supply consumption in kWh. This is only relevant if the pilot boat stays at berth in your port.
4. Clarify the type of electricity used for the onshore power supply. You can either choose 'Finnish average' or '100% renewable energy'.

   Selecting '100% renewable energy' will result in an emission factor of zero. If 'Finnish average' was chosen, the tool will automatically supply the appropriate emission factor depending on the year, which must be provided on the 'SUMMARY' page.

   Emission factors for electricity consumed in Finland are available for the years 2018, 2019, 2020 and 2021 (as reported by Fingrid[8]). By default, all other years are assigned the same value as 2021. However, it is also possible to provide a new value by changing the hidden formula sheet. A more detailed explanation of how to make those changes and access the hidden sheets can be found in the advanced manual part.
5. Enter the number of visiting vessels serviced by the pilot boat.

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

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[7] Finnpilot Pilotage Oy, 2022, Vuosikertomus 2021 (https://finnpilot.fi/wp-content/uploads/2022/03/Finnpilot_vuosikertomus_2021.pdf)

[8] Fingrid Oyj, 2020 (https://www.fingrid.fi/en/electricity-market/electricity-market-information/real-time-co2-emissions-estimate/).

Cargo handling equipment

The 'CHE' sheet can be reached from the 'SUMMARY' page by clicking the green 'Cargo handling equipment'-button or the orange 'Own cargo handling equipment'-button in the navigation panel.

Emissions caused by the operation of cargo handling equipment are allocated to the scopes based on ownership. If the equipment is owned or rented by the port authority, the machines should be added to Scope 1. Equipment operated in the port area by a specific company as service for the port is part of Scope 3. The calculation of emissions caused by cargo handling equipment is based on the fuel or electricity consumption of the machines.

1. Choose the type of equipment from the drop-down menu, which will appear after selecting the cell and clicking on the button with the downward pointing arrow. Available types are cranes, forklifts, reach stackers, tractors, and wheel loaders.
2. Enter any relevant specification, the amount of equipment of the specific type, as well as the owner or rental company, to properly organise the assessed machines. This information is not relevant to the calculation itself but might help organise the data.
3. Choose the type of fuel from the drop-down menu: Motor Gasoline, Gas/Diesel Oil, LPG, Kerosene, Lubricants, CNG or LNG.
4. Add the total fuel consumption in litres per year and/or the total electricity consumption in kWh.
5. If applicable, clarify the type of electricity. You can either choose 'Finnish average' or '100% renewable energy'.

> Selecting '100% renewable energy' will result in an emission factor of zero. If 'Finnish average' was chosen, the tool will automatically supply the appropriate emission factor depending on the year, which must be provided on the 'SUMMARY' page.

> Emission factors for electricity consumed in Finland are available for the years 2018, 2019, 2020 and 2021 (as reported by Fingrid[9]). By default, all other years are assigned the same value as 2021. However, it is also possible to provide a new value by changing the hidden formula sheet. A more detailed explanation of how to make those changes and access the hidden sheets can be found in the advanced manual part.

In case a list of equipment is not available, enter the total fuel consumption of all machines in one row (labelled accordingly). However, it is important to at least split the fuel consumption in relation to the scopes based on ownership.

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[9] Fingrid Oyj, 2020 (https://www.fingrid.fi/en/electricity-market/electricity-market-information/real-time-co2-emissions-estimate/).

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

On-road heavy-duty vehicles

The 'Road' sheet can be reached from the 'SUMMARY' page by clicking the green 'Heavy road traffic'-button in the navigation panel.

The assessment of emissions caused by visiting trucks in the harbour area is based on their activity. Two approaches are possible, depending on the availability of information. One approach uses specific data, the second one is based on estimated shares of truck types.

A) Activity-based, specific information available

1. Choose the type of truck. The different types can be found in the drop-down menu including their typical payload capacity in tonnes: Delivery lorry light (3.5 t), Delivery lorry heavy (9 t), Semi-trailer (25 t), Full-trailer (40 t), Full-trailer (9 axles, 51 t) and Earthmoving truck (19 t). The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.
2. Enter the number of trucks per type.
   > The calculation tool also features a <u>self-assessment possibility</u> to help with estimating the number of trucks based on the annual cargo tonnage handled in the port.
   > 1. Enter the cargo tonnage per year.
   > 2. Decide on the typical type of truck visiting the harbour. You can also split the total cargo tonnage and assign different types of trucks to the partial values. The different types of trucks can be chosen from the drop-down menu.
   > 3. Add the payload capacity of the typical truck in tonnes. You can find the required value listed with the type of truck in the previous column.
   > 4. The number of trucks needed to transport the entered cargo tonnage with a certain type of truck is automatically calculated. This value can now be used as an estimation or guidance for the actual calculation.
3. Specify the year of manufacturing or the emission standard (EURO). Choose from the drop-down menu. This is important information because the emission factor applied to the type of truck depends on its age. In case the necessary data is not available and can't be estimated, Table 3 provides an overview of average emission standards in Finland in 2016.
4. Define the idle time per truck in hours, meaning the time the truck's engine is running when the truck is standing still. This might occur, for example, during loading time.

5. Add the round-trip distance a truck usually must drive around the port area. Consider the distance from entry to exit gate in kilometres. If no exact information is available, it is recommended to undertake measurements based on maps or directly at the location.
6. Special case: Transporter van.
    1. Enter the number of transporter vans.
    2. Choose the year of manufacturing from the drop-down menu. For an average emission standard used in Finland in 2016 see Table 3.
    3. Add the round-trip distance the transporter vans drive inside the port area between the entry and exit gate in kilometres.

B) Activity-based, based on estimated shares

1. Enter the total number of trucks visiting the port in a year.
2. Choose the type of trucks visiting the port. The different types can be found in the drop-down menu including their typical payload capacity in tonnes: Delivery lorry light (3.5 t), Delivery lorry heavy (9 t), Semi-trailer (25 t), Full-trailer (40 t), Full-trailer (9 axles, 51 t) and Earthmoving truck (19 t).
3. Add the estimated share of the type of truck in relation to the total number of port visits in percent.
4. Specify the year of manufacturing or the emission standard (EURO). Choose from the drop-down menu. This is important information because the emission factor applied to the type of truck depends on the age. In case the necessary data is not available and can't be estimated, Table 3 provides an overview of average emission standards in Finland in 2016.
5. Define the idle time per truck in hours, meaning the time the truck's engine is running when the truck is standing still. This might occur, for example, during loading time.
6. Add the round-trip distance a truck usually must drive around the port area. Consider the distance from entry to exit gate in kilometres. If no exact information is available, it is recommended to undertake measurements based on maps or directly at the location.
7. Special case: Transporter van.
    1. Enter the estimated share of transport vans in relation to the total number of visiting trucks.
    2. Choose the year of manufacturing from the drop-down menu. For an average emission standard used in Finland in 2016 see Table 3.
    3. Add the round-trip distance the transporter vans drive inside the port area between the entry and exit gate in kilometres.

In case the year of manufacturing (or EURO category) of the visiting trucks is unknown and can't be estimated, it is possible to utilise the average reported categories for trucks operating in Finland in 2016 (see Table 3) as reported by VTT.

Table 3. Average emission standards of heavy-duty vehicles operated in Finland in 2016 [VTT[10]].

Type of truck	Average emission standard (year or EURO)

[10] VTT LIPASTO, 2017 (http://lipasto.vtt.fi/yksikkopaastot/tavaraliikennee/tieliikennee/tavara_tiee.htm).

Delivery lorry, light	2008-2013 (EURO 5)
Delivery lorry, heavy	2008-2013 (EURO 5)
Semi-trailer	2008-2013 (EURO 5)
Full-trailer	2008-2013 (EURO 5)
Full-trailer (9 axles)	2014- (EURO 6)
Earthmoving	2008-2013 (EURO 5)
Van	2007-2011 (EURO 4)

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

Rail transport

The 'Rail' sheet can be reached from the 'SUMMARY' page by clicking the green 'Rail transport'-button in the navigation panel.

Emissions caused by trains visiting the port area are assessed based on the travelled distance and the propulsion method used by the train.

A) Diesel train

1. Enter the name of the operator, if known.
2. Choose the type of train from the drop-down menu: General cargo train/mixed freight train, container train or raw wood train. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.
3. Specify the length of the railroad network inside the port area, meaning the round-trip distance for one visiting train. If no exact information is available, it is recommended to undertake measurements based on maps or directly at the location.
4. Add the number of trains per year. "One train" means that the train is coming first loaded with empty containers or empty carriages, leaves empty (only the locomotive), comes back empty (only locomotive) to collect loaded containers/carriages and leaves loaded with the cargo (full containers and carriages) **OR** the other way around for exporting goods.

B) Electric train

1. Enter the name of the operator, if known.
2. Specify the length of the railroad network inside the port area, meaning the round-trip distance for a one visiting train. If no exact information is available, it is recommended to undertake measurements based on maps or directly at the location.
3. Add the number of trains per year. "One train" means that the train is coming first loaded with empty containers or empty carriages, leaves empty (only the locomotive),

comes back empty (only locomotive) to collect loaded containers/carriages and leaves loaded with the cargo (full containers and carriages) **OR** the other way around for exporting goods.

4. Choose the type of electricity used by the visiting train. You can either choose 'Finnish average' or '100% renewable energy'.

> Selecting '100% renewable energy' will result in an emission factor of zero. If 'Finnish average' was chosen, the tool will automatically supply the appropriate emission factor depending on the year, which must be provided on the 'SUMMARY' page.

> Emission factors for electricity consumed in Finland are available for the years 2018, 2019, 2020 and 2021 (as reported by Fingrid[11]). By default, all other years are assigned the same value as 2021. However, it is also possible to provide a new value by changing the hidden formula sheet. A more detailed explanation of how to make those changes and access the hidden sheets can be found in the advanced manual part.

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

Stationary energy sources

The 'Stationary sources' sheet can be reached from the 'SUMMARY' page by clicking the green 'Stationary energy sources'-button or the orange 'Own stationary energy sources'-button in the navigation panel.

Emissions caused by the operation of stationary energy sources are allocated to the scopes based on ownership. If the equipment is owned or rented by the port authority, the stationary sources should be added to Scope 1. The emissions will be part of Scope 3 if the equipment is operated in the port area but by a specific company as a service for the port. The calculation of emissions caused by stationary energy sources is based on the fuel consumption of the machines.

1. Enter the type of stationary source. This could be, for example, an oil heater or a generator.
2. Specify the owner or operator of the stationary energy source for Scope 3 emissions.
3. Add the number of stationary sources of the specific type.
4. Choose the type of fuel from the drop-down menu. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.

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[11] Fingrid Oyj, 2020 (https://www.fingrid.fi/en/electricity-market/electricity-market-information/real-time-co2-emissions-estimate/).

The following fuels are available in the calculation tool: Municipal Wastes (non-biomass), Waste Oils, Peat, Wood, Other Primary Solid Biomass, Charcoal, Biogasoline, Biodiesels, Other Liquid Biofuels, Landfill Gas, Sludge Gas, Other Biogas, Municipal Wastes (biomass), Crude Oil, Natural Gas Liquids, Motor Gasoline, Shale Oil, Gas/Diesel Oil, Residual Fuel Oil, Liquified Petroleum Gases, Ethane, Other Petroleum Products, Lignite, Oil Shale and Tar Sands, Brown Coal Briquettes, Natural Gas.

5. Fill in the annual fuel consumption of the listed stationary energy sources.
6. Choose the unit of the provided fuel consumption from the drop-down menu: kilogram or litre.

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

Passenger vehicles & Commuting

The 'Passenger vehicles' sheet can be reached from the 'SUMMARY' page by clicking the orange 'Own car fleet'-button or the green 'Employees' commuting'-button in the navigation panel.

Passenger vehicles are allocated to two different scopes. Vehicles that are owned by the port authority and are part of the port's car fleet belong to Scope 1. The commuting of the port authority's employees by car is calculated as part of Scope 3. In addition, also commuting utilising other modes of transportation is assessed and allocated to Scope 3.

A) Port authority's own car fleet

Emissions for passenger vehicles belonging to the port's car fleet are either calculated based on the annual travelled distance of a vehicle in combination with the type of fuel or following the fuel or electricity consumption per year. Choose the option that fits best with the information available to you. The available types of fuel vary slightly between the two calculation approaches.

a) Based on travelled distance

1. Enter the type of vehicle.
2. Specify the year of manufacturing or the emission standard (EURO). You can choose from the drop-down menu, which will appear after selecting the cell and clicking on the button with the downward pointing arrow. This is important information because the emission factor applied to the vehicle depends on the age.

3. Add the yearly travelled distance of the vehicle in kilometres.
4. Choose the type of fuel from the drop-down menu: Petrol, Diesel, Electricity, PHEV, CNG, Biogas, High-blend ethanol.

b) Based on the fuel consumption

1. Enter the type of vehicle.
2. Choose the type of fuel from the drop-down menu: Petrol, Diesel, Electricity, PHEV, CNG. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.
3. Add the annual fuel consumption in litres and/or the annual electricity consumption in kWh, depending on the chosen type of fuel. PHEVs need to have fuel and electricity consumption listed, while electric vehicles should only have a consumed amount of electricity. For all other fuel types, the fuel consumption in litres is to be added.

B) Commuting of port authority's employees

Emissions related to the commuting of the port authority's employees are based on the one-way commuting distance and the working days per year. There are calculation spots available for up to 60 employees commuting by car and the same number for people commuting by other modes of transportation. Each column represents one employee. The tool provides the opportunity to also add modes of transportation that do not result in emitted greenhouse gases, like biking or walking. Adding this information is voluntary and not required for the calculation of the carbon footprint.

a) Commuting by car – based on travelled distance

1. Enter the type of vehicle used by the employee.
2. Specify the year of manufacturing or the emission standard (EURO). You can choose from the drop-down menu, which will appear after selecting the cell and clicking on the button with the downward pointing arrow. This is important information because the emission factor applied to the vehicle depends on the age.
3. Add the one-way commuting distance of the employee in kilometres.
4. Define the employee's commuting days per year.
   - Example: 4 working days with commuting per week and 48 weeks of working time per year would sum up to 192 commuting days per year.
5. Choose the type of fuel from the drop-down menu: Petrol, Diesel, Electricity, PHEV, CNG, Biogas, High-blend ethanol.

b) Commuting by other modes of transportation – Based on travelled distance

1. Enter the mode of transportation used by the employee. Choose from the drop-down menu: Motorbike, Moped/Scooter, Taxi, Train, Bus, Bicycle and Walking. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.
2. Add the one-way commuting distance of the employee in kilometres.
3. Define the employee's commuting days per year.
    Example: 4 working days with commuting per week and 48 weeks of working time per year would sum up to 192 commuting days per year.

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

Construction equipment

The 'Const Equ' sheet can be reached from the 'SUMMARY' page by clicking the green 'Construction equipment'-button in the navigation panel.

Emissions caused by the operation of construction equipment in the port area are calculated based on the fuel consumption of the utilised machines. The results are part of Scope 3. Construction equipment could, for example, include the following: Dredges, Earthmoving equipment, Paving equipment, Portable concrete and asphalt batch plants, as well as portable worksite generators. Life-cycle emissions of the utilised construction material are not assessed in this calculation tool.

1. Enter the type of construction equipment.
2. Name the operator.
3. Choose the type of fuel from the drop-down menu: Motor Gasoline 2-stroke, Motor Gasoline 4-stroke, Gasoil/Diesel, Liquified Petroleum Gas, Kerosene, Lubricants, Compressed Natural Gas, Liquified Natural Gas. The drop-down menu will appear after selecting the cell and clicking on the button with the downward pointing arrow.
4. Add the annual amount of consumed fuel in litres.

The results of the calculation based on the entered data can be found on the 'SUMMARY' page. This sheet can be reached by clicking the red 'Back to summary page'-button at the top of the current sheet.

Advanced manual

This part of the manual is addressed to everyone who wants to dive deeper into the calculation approaches used for the tool. If you are only interested in using the tool, meaning simply filling in the required data step-by-step, it is not necessary to go through this section.

Accessing the hidden parts of the tool

The standard view of the carbon footprint calculation tool offers the possibility to add data to a handful of different sheets and to receive the final results as table and pie charts. To keep the tool as simple and user-friendly as possible, all sheets containing background data and formulas are hidden from view.

If you want to make changes to the calculation, add your own emission factors or just want a look at how the emissions are calculated you can get access to the data and calculation sheets by unhiding them. Besides the visible sheets where you can enter the port's data, the excel file features also two more hidden sheets for each visible page. Those include the calculation and the utilised background data.

By right-clicking on the list of all available sheets at the bottom of the window, a dialogue window will open and offer you the possibility to 'Unhide' hidden sheets (see Figure 7).
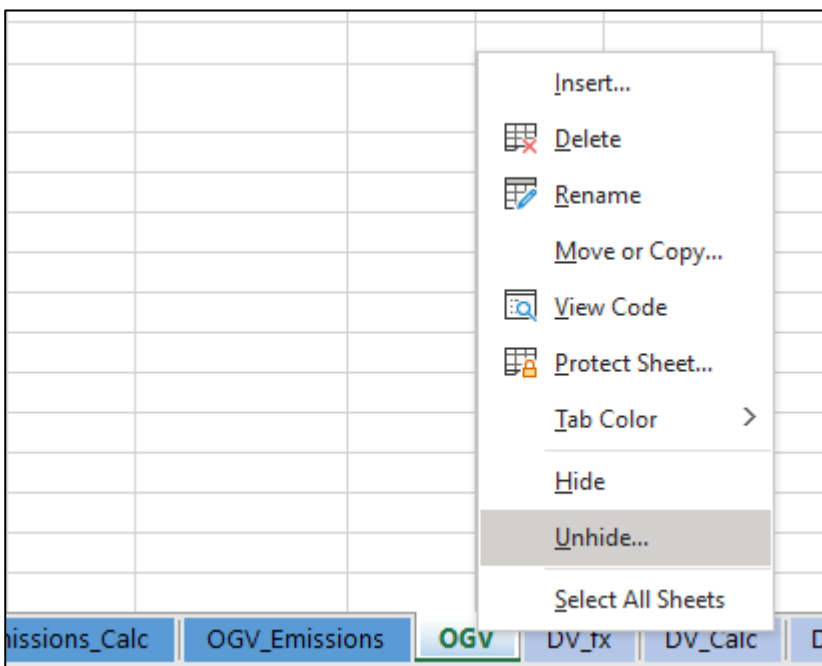

Figure 7. Dialogue window opening after right-clicking on the list of available sheets.

Choose this option. A new dialogue window will ask you to specify which sheet should be made visible (see Figure 8). Pages named "fx" contain the background data and the ones with "Calc" feature the calculations.
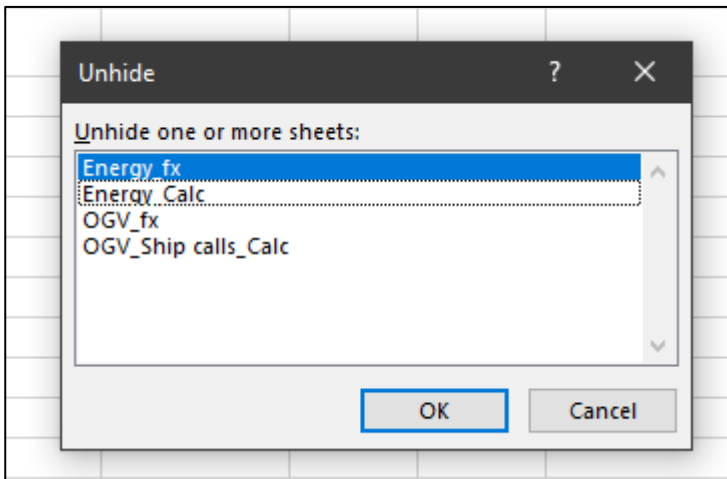
Figure 8. Dialogue window for unhiding hidden sheets.

Making changes to the formulas or background information

Please be aware that changes made to the previously hidden files will immediately affect the whole calculation. Therefore, you should only unhide the sheets and alter them if necessary. To prevent accidental changes, it is recommended to hide the sheets again after the alterations are saved.

To hide a sheet, use the right-click to open the dialogue window (see Figure 7). Choose the option 'Hide'. The selected sheet will now be hidden from view. For editing the content, it first needs to be unhidden again.

"Calc" sheets collect the data entered in the plain sheets and use the values to carry out the calculations. The used formulas can be seen by selecting a cell. Besides the manually entered data, the calculation also utilises estimated information and pre-defined emission factors. Those can be found in the "fx" sheets. However, not necessarily all information saved there is used for the calculation. To see which factors were used for the calculations it is necessary to follow the name of the cells connected to a certain calculation approach and check the value in the correct sheet. Referenced cells can be changed or replaced with other values.

Energy consumption emission factors

The assessment of emissions caused by the consumption of energy offers the possibility to enter an own value without changing the referenced cell in the formula. As emission factors for electricity or district heating are often newly released every year, the 'own value' cell enables the user to easily update the values (see Figure 9). So far, the tool can automatically supply the appropriate emission factors mainly for 2018, 2019, 2020 and 2021 in Finland. If the calculation is carried out for a year after 2021, the default value equals the one for 2021. To get more accurate results, it is recommended to replace the factor with the newest value. The calculation will refer to the entered value if the year of the calculation is not given as 2018,

2019, 2020 or 2021. Otherwise, you would need to change the values directly in the rows of the relevant year.

For Finnish ports, appropriate emission factors can be retrieved from, for example, Statistics Finland or directly from the providers, such as the transmission network operator Fingrid or the local district heat provider. References can be found in the main part of the manual.

Emission factor_Finland	
year	EF (g CO2/kWh)
2018	119
2019	101
2020	72
Own value	72

Figure 9. Emission factors for electricity consumed in Finland as listed in the tool's 'Energy_fx' sheet, including the cell for entering an own value.

Changes to the OGV sheets – adding more vessels

In its original form, the calculation tool allows the addition of up to 700 ship calls to the 'OGV_Ship calls' worksheet. This is relevant in case the port is using management software that does not provide information on the emissions caused by visiting vessels.

The cells with a grey background are ready to compute data in the hidden sheet. If more than 700 visits are registered in the port, the calculation sheet needs to be adapted. First, unhide the 'OGV_Ship calls_Calc' sheet. An explanation of how to do that can be found in an earlier section above. After accessing the sheet, scroll to the end of the columns filled with numbers (approximately row 700). The calculation sheet is formatted in such a way that everything entered in the 'OGV_Ship calls' sheet is automatically copied.

To add more cells to this formatting, first, select the last cell of a column that is still displaying a value. Navigate the mouse to the lower right corner of the cell. The cursor will switch to a little black cross (see Figure 10a). Click here, hold the mouse click and pull the selection down (see Figure 10b). This copies the formatting of the selected cell to the following cells. Repeat the same with all remaining columns of the worksheet. Make sure that all columns (from A to AM) are changed like this to guarantee a proper calculation.
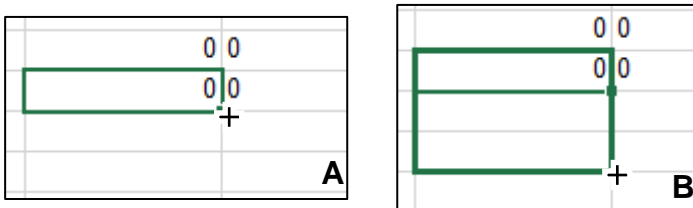
Figure 10. Changing the formatting of following cells in the 'OGV_Ship calls_Calc' work sheet.

Changes to the OGV sheets – adjusting engine specifications

Testing the calculation tool under real-life conditions revealed that usually, ports do not have ready access to more detailed technical information. For that reason, the tool is using default values for auxiliary engine power and auxiliary boiler power. In addition, the utilised fuels and engine types are chosen by default as well.

Following the Sulphur Emission Control Area – Baltic Sea, it is assumed that most vessels are running on MDO/MGO fuels (main engine, auxiliary engine, and auxiliary boiler). Container ships are assumed to utilise SSD main engines and Tugboats feature HSD main engines. For all other types of ships MSD main engines are utilised for the calculation of emissions. Auxiliary engines always follow the characteristics of an MSD engine, while auxiliary boilers are represented by steam turbines. In case engine specifications are known, it is possible to make adjustments to those assumptions.

First, unhide the 'OGV_Ship calls_Calc' sheet. An explanation of how to do that can be found in an earlier section above. After accessing the sheet, the estimated specifications can be found in columns V to AE. Formulas are listed in all cells to ensure the automatic calculation process. To replace those values, select the right cell and enter the new value. Be aware that some follow-up cells require a certain input. In addition, entering a new value will delete the formula. If the value was added falsely, copying the formula from a neighbouring cell of the column can remedy the mistake.

The auxiliary engine power can be manually added to column V for each ship individually in kW. There are no restrictions on the value that can be added here. Columns X and Y allow the updating of auxiliary boiler power in kW during the manoeuvring and hotelling phase, respectively.

The types of fuel are listed in columns Z, AB and AD. It is not recommended to make changes to those columns as the automatic calculation only functions properly for MDO/MGO fuel. Emission factors for other fuel types can be found in the 'OGV_fx' sheet. If the calculation is to be carried out with different fuel types, the formulas in columns AG to AL would need to be adapted manually.

The engine types can be changed between SSD, MSD and HSD engines in columns AA and AC. The type of the auxiliary boiler (column AE) can't be altered.

After making changes, ensure that the calculation is still working properly by checking the total emissions listed in column AM.

Piloting emission factors

Emission factors for pilot boats per pilotage assignments are provided for the years 2018, 2019 and 2020. Every other year is automatically assigned the value of 2020. However, own values can be added to the calculation tool as well.

First, unhide the 'HC_fx' sheet. An explanation of how to do that can be found in an earlier section above. After accessing the sheet, you can find the relevant table (see Figure 11) by scrolling down. Enter the new value in the highlighted cell. The calculation will refer to the entered value if the year of the calculation is not given as 2018, 2019 or 2020. Otherwise, you would need to change the values directly in the rows of the relevant year.

Emission factors pilot boats	
year	
	t CO2e/per pilotage assignment
2018	0.168
2019	0.166
2020	0.169
Own value	0.169

Figure 11. A table in the 'HC_fx' sheet listing the emission factors for pilot boats.