Svenskt Vatten

Swedish Water & Wastewater Association

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# Climate calculation tool for water and wastewater treatment plants

User manual

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# Innehåll

# Conversion factors

Below is a list of common conversion factors that may be needed to perform climate calculations in the calculation tool. If plant-specific values for the methane and energy content of the biogas are available, these can be used instead of the suggestions below.

1 g/kWh = 1 kg/MWh

1 pe = 70 g BOD7/day

1 MWh fuel oil = 0,085 ton = 0,1 $m^3$

1 kg $N_2O$-N = 1,57 kg $N_2O$

1 kg $CH_4$-C = 1,33 kg $CH_4$

1 ton of digested, dewatered sludge = 1 $m^3$ digested, dewatered sludge

1 $Nm^3$ upgraded gas = 0,7 kg = 9,8 kWh = 0,0098 MWh

1 $Nm^3$ raw biogas = 1,1 kg = 6,5 kWh = 0,0065 MWh

Methane content in raw biogas about 65%

# 1 Background

This manual presents the structure of an industry-wide climate calculation tool for the Swedish Water and Wastewater industry. The tool, which has been developed in Excel, should enable water and wastewater utilities to calculate their climate impact from the operation of water and wastewater facilities in a simple way. The term "water and wastewater facilities" refers to drinking water plants, sewer system and wastewater treatment plants. Based on the results of the climate calculations, water and wastewater utilities should then be able to gain more knowledge about the climate impact of their facilities, distribution of impact between different parts of the facility as well as different types of emissions, and then start working to reduce the facility's climate impact.

The aim of developing the tool is to lower the threshold and make the work with climate calculations more efficient for the Svenskt Vatten members. It is also to facilitate comparison, cooperation and benchmarking within the Water and Wastewater industry through jointly defined system boundaries and emission factors.

The manual also includes instructions on how users can calculate the climate impact of the operation of water and wastewater facilities. The structure of the calculation tool and user instructions can be found in Chapter 2 and 3. Chapter 4 gives tips and advice on how the user can quality assure own emission factors. The manual also discusses uncertainties in the tool and possible improvement measures (Chapter 5) and all references used in both the calculation tool and manual (Chapter 6).

## 1.1 Other climate calculation tools

Swedish wastewater treatment plants can already calculate their climate impact in a tool developed by VA-teknik Södra (2021). The tool was developed in 2012-2013 and updated with new emission factors in 2021. The tool allows both site-specific and estimated emission factors and the result are presented on an annual basis in a similar way as in this tool. The VA-teknik Södra tool can be considered more complex and the threshold for climate calculations is thus higher. The tool is also not adapted for drinking water plants.

Svenskt Vatten's counterpart in Norway and Denmark; Norsk Vann and DANVA have also developed climate calculation tools in Excel for 2020 and 2021 that are adapted to both wastewater treatment plants and drinking water plants.

# 2 Tool structure

The climate calculation tool is developed in Excel and consists of nine tabs which are presented in detail below. The tool is based on life-cycle analysis and calculates the climate impact at the plant level where it is the operational emissions that are calculated: both direct emissions from the plant and even emissions that occur upstream (e.g. chemical production) and downstream (e.g. treatment of residual products). The data requested in the tool is provided on an annual basis and it is the facility's climate impact for a calendar year that is calculated.

The calculation tool is based on the GHG protocol (e.g. "Greenhouse gas protocol ") and its structure, but does not follow it to the letter. The GHG Protocol is a collection of standardised frameworks for calculating climate impacts at the organisational level, but also at the product level (Greenhouse Gas Protocol, 2022). The GHG protocol is an internationally recognised framework and is used as a basis for calculation for organisations that want to join the Science Based Targets (2022).

The GHG protocol categorises an organisation's direct and indirect emissions of greenhouse gases into three so-called " scopes ". Scope 1 includes direct greenhouse gas emissions from sources owned by the organisation in question. Scope 2 includes indirect emissions of greenhouse gases originating from the production of purchased electricity, heat and steam. Scope 3 includes other indirect emissions, for example from purchased materials, waste management and emissions from transport where the vehicles are not owned by the organisation in question (Science Based Target, 2022).

There are a number of activities and areas which are normally included in a calculation according to the GHG protocol for organisations, but which are not included in this calculation tool because they are not relevant to plant operations. The activities not included here are capital goods, business travel, employee travel to and from work, investments, franchises, and leased assets. The figure below presents the demarcations made with regards to the GHG protocol.

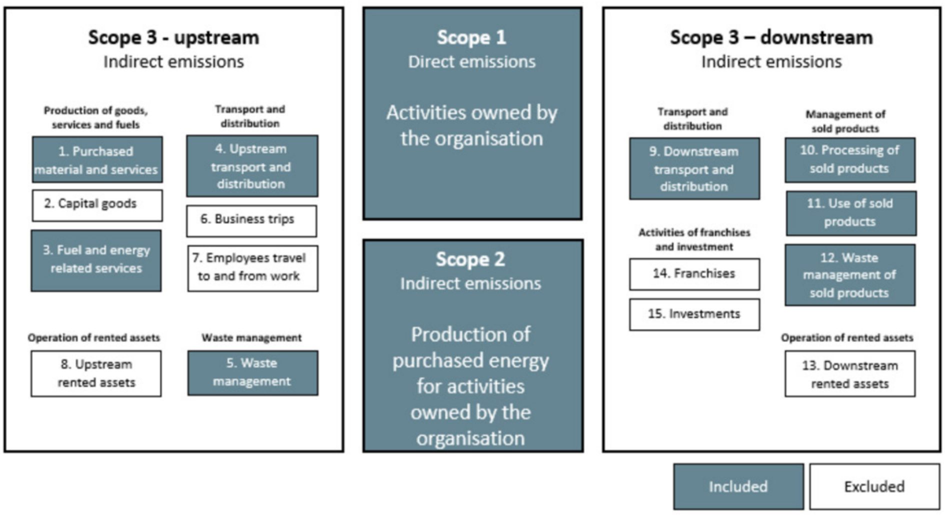



**Figure 1**
Boundaries of the GHG protocol, where the coloured boxes show included scope and sub-scope.

The tool calculates the climate impact excluding biogenic carbon, i.e. emissions of carbon dioxide from bio-based sources are excluded in the calculations (the carbon uptake from the atmosphere is offset against the carbon emitted during combustion or similar). An example of biogenic carbon is the carbon contained in gaseous and liquid biofuels. The carbon in the fuel is initially taken up from the atmosphere and then released back into the atmosphere during combustion. The incoming carbon sink and resulting carbon dioxide emissions are not included because the carbon balance over a certain period is zero.

## 2.1 System boundaries

The system boundary of the climate calculation tool is set to the operation of drinking water production and wastewater treatment plants. The tool is divided into two plant parts, wastewater treatment plants and drinking water plants, where the sewer system is included and accounted for separately in each plant part. The figures below show the system boundaries of the developed climate calculation tool. Most of the operation-related emissions, including upstream and downstream emissions, are included in the system boundaries. Examples of upstream emissions include the production of fuels, electricity and chemicals, and examples of downstream emissions are the handling of residual products. Emissions of methane and nitrous oxide in the sewer system are not included.

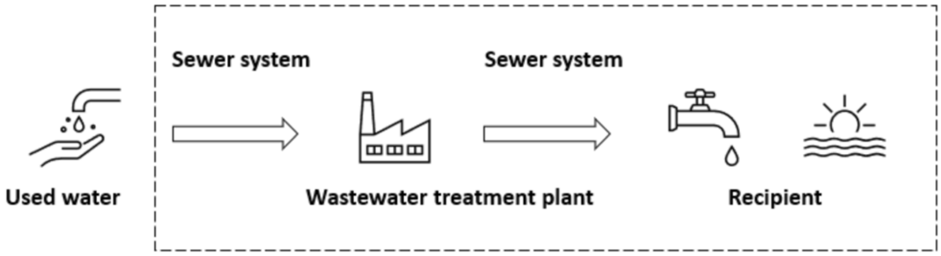



**Figure 2**
System boundaries for wastewater treatment plants in the climate calculation tool.

The figure below presents similar system boundaries for drinking water plants. Again, all operation-related emissions are included. The tool does not take into account different qualities of drinking water or possible impurities that may accompany it.

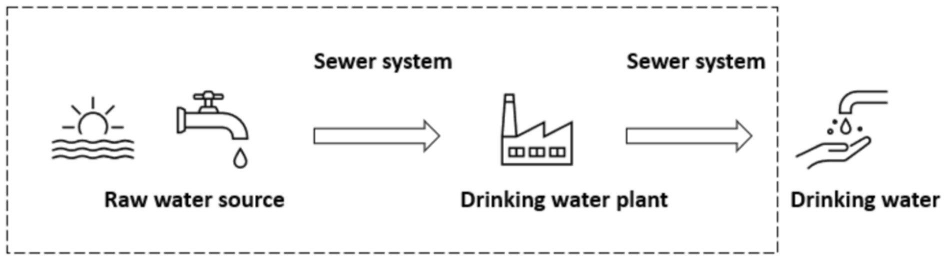



**Figure 3**
System boundaries for drinking water plants in the climate calculation tool.

Infrastructure, such as buildings, process equipment, renovations and new investments in equipment are excluded. Filter media (sand and activated carbon) are counted as consumables here and are therefore included in the climate calculations.

# 3 Instruction for calculation

In section 3.1–3.4 the structure and content of the climate calculation tool for drinking water and wastewater treatment plants are presented in detail. The aim is to use this information as a guide when carrying out the climate calculations.

Throughout the calculation tool, the idea is that the user should enter data or information in the boxes marked in green. Other boxes do not require any additional information from the user. Depending on the section, not all green boxes need to be filled with data but only a selection. This is clarified in the tool and in the different sections below. Avoid entering text in the green boxes as this will cause calculation errors in the tool. Rather, use the sheet at the back of the tool to write notes.

## 3.1 Cover page

The first tab ("Instructions") contains general information and instructions on the basic functions of the calculation tool, such as where the user enters data, where the result is presented and where additional information can be found, see the figure below.

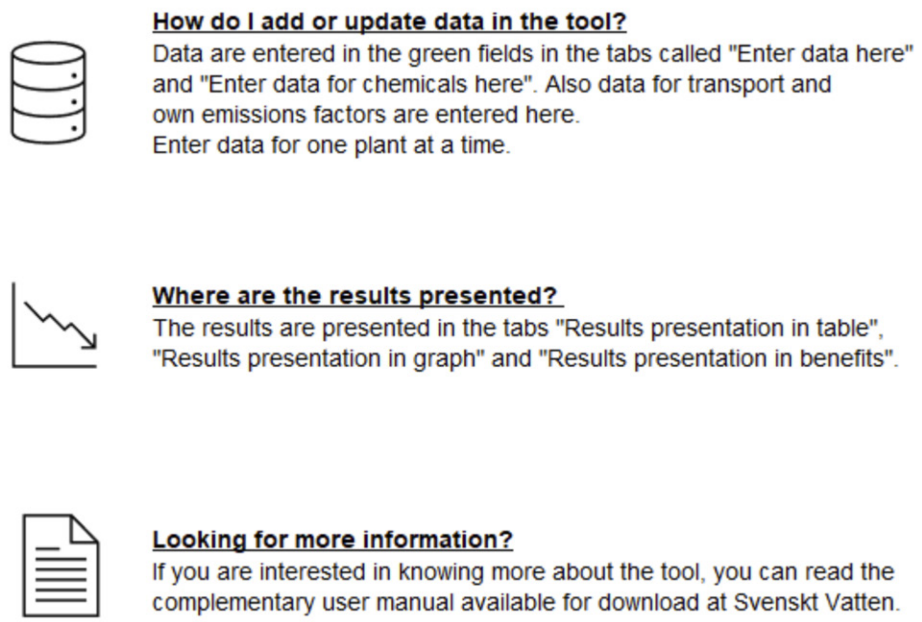



**Figure 4**
Summary information for the user in the introduction to the tool.

On the front page, the user can also enter basic information about the facility for which the climate calculation is being made in the green marked fields, see the figure below. The purpose of this is to make it easier for larger water utilities that have several facilities to calculate for, as well as to be able to follow up the results more easily between different years. It is optional to enter information in the green fields here, but it may facilitate future checks.

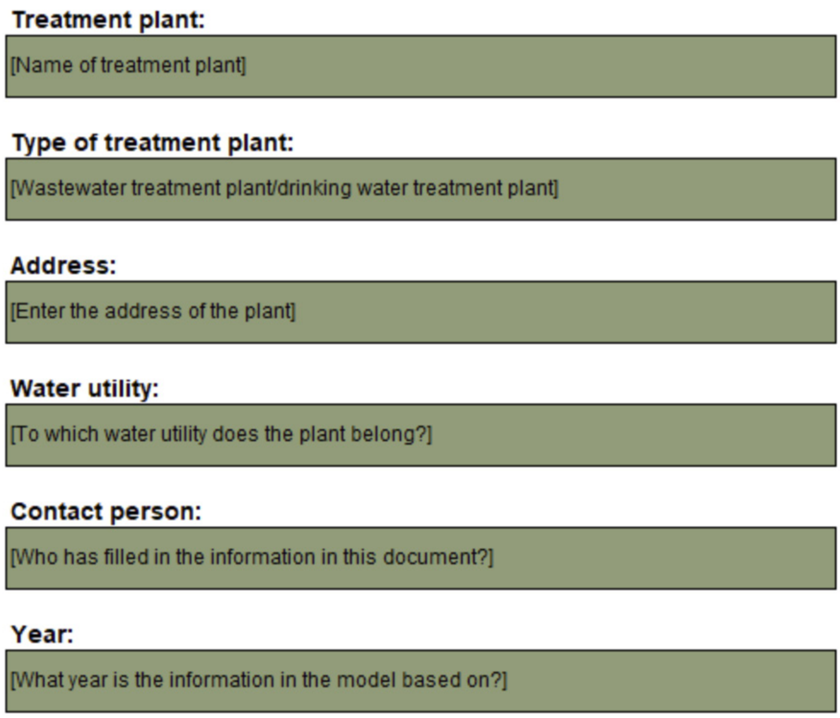

**Treatment plant:**
[Name of treatment plant]
**Type of treatment plant:**
[Wastewater treatment plant/drinking water treatment plant]
**Address:**
[Enter the address of the plant]
**Water utility:**
[To which water utility does the plant belong?]
**Contact person:**
[Who has filled in the information in this document?]
**Year:**
[What year is the information in the model based on?]

**Figure 5**
Information about the plant that the user can fill in.

## 3.2 Inputs to the calculation tool

The calculation tool is developed with two input tabs, one listing all chemicals that can be used in connection with drinking water production and wastewater treatment and the other containing all other items for calculating climate impact: fuel, electricity and heat consumption, treatment of residual products and direct emissions from wastewater treatment plants. The tool is divided into two input tabs for practical reasons, there is no other difference between the tabs. Both drinking water and wastewater treatment plants must fill in information in both tabs; the tool is not divided into a tab per type of facility.

For most sections of the tool, many options are offered, for example several different waste management methods. It is important to remember that all lines do not have to be filled in, but the user selects the options that are relevant for the facility.

In connection with the input fields, the emission factors of the materials are also presented. An emission factor is a number that describes the environmental impact of the material, in this case climate impact, in a life cycle perspective and where all greenhouse gases have been converted to a common basis of calculation: carbon dioxide equivalents. For example, an emission factor may be calculated as 1000 kg of carbon dioxide equivalents per kg of a certain chemical, describing the climate impact of the chemical from a life cycle perspective, from extraction of raw materials, transport of raw materials, energy consumption during production, management of production waste until the product is finished and ready to be shipped to customers.

Most emission factors are given with a high degree of accuracy, but it is important to bear in mind that for some emission factors the figures are not exact. This is the case for example for chemical emission factors, where the number should be seen as an indication rather than an exact value despite the large number of values.

### 3.2.1 Key indicators

At the top of the first input tab ("Enter data here") is a section for key indicators which are used to relate the calculated result to various metrics. For drinking water and wastewater treatment plants the user should fill in information on three indicators each, as shown in the figure below. All measurements must be filled in on an annual basis for the year in question. When filling in the data in the tool, it is advantageous to use the data reported in the environmental report.

Person equivalents (pe) is calculated as 70 g BOD7 per person per day.

One metric for wastewater treatment plants is the amount of reduced nitrogen during the year in question, both with and without specific nitrogen treatment. If the wastewater treatment plant in question has no reduced nitrogen, the field is either left blank or a zero is entered in the field.

Drinking water treatment plant

| Intake of raw water [m$^3$/yr] | Produced drinking water [m$^3$/yr] | Consumed drinking water [m$^3$/yr] |
|---|---|---|
| | | |

Wastewater treatment plant

| Amount of water treated during the year [m$^3$/yr] | Amount of nitrogen reduced during the year [kg N-tot/yr] | The load to the treatment plant [pe] |
|---|---|---|
| | | |

**Figure 6**
Indicators requested by the user, and which is used to calculate the result in relation to them.

In future applications of the calculation tool, the indicators can be used to compare climate impacts between different plants. It is also possible to add more indicators or metrics in future versions of the climate calculation tool.

### 3.2.2 Electricity and heat consumption

#### 3.2.2.1 Electricity consumption

In the next section of the first input tab ("Enter data here"), the user can enter information about the plant's total electricity and heat consumption during the current year. The electricity consumption is divided into plant operation and sewer system operation. This breakdown is made in order to be able to distinguish between the share of electricity consumption used for plant's operation and operation of the sewer system. In some cases, the operation of the sewer system can contribute to a high climate impact depending on geography, type of electricity contract and type of facility (drinking water plant or wastewater treatment plant). The input field is shown in the figure below.

| Electricity consumption | Grid consumption [MWh/yr] | Plant operation comsumption [MWh/yr] | Emissions factor [kg $CO_2$ e/MWh] |
|---|---|---|---|
| Nordic residual mix | | | 524 |
| Hydropower | | | 3 |
| Wind power | | | 21 |
| Solar power | | | 30 |
| Nuclear power | | | 4 |
| Biogas, internally produced | | | 0 |
| *Other* | | | |

**Figure 7**
The input field for the electricity consumption of the plant.

The user enters the current electricity consumption for sewer system and plant operation on the row or rows that match the water utility's current electricity contract. If the water utility buys origin-labelled electricity, the quantities for the current year are entered in the relevant rows.

If the water utility does not have a specific agreement for origin-labelled electricity, the consumption is entered in the row "Nordic residual mix ". This is calculated annually by the Energy Market Inspectorate (2025) and includes the electricity that remains from the Nordic electricity mix after the consumption of customers with contracts for origin-labelled, renewable electricity has been deducted. The reason why a Nordic electricity mix has been chosen as the basis is because the Nordic countries have a common electricity market.

If you have your own information from your electricity supplier about the climate impact of the purchased electricity, the user can enter this in the last line ("Other") and enter the current emission factor and the current consumption there.

#### 3.2.2.2 What is included in the operation of plants and sewer system?

Plant operation includes all steps and processes from the time the water enters the plant until the water leaves the drinking water plant or wastewater treatment plant. Inlet pumps and groundwater pumps must be included in plant operation if they are located adjacent to the plant.

For drinking water plants, the operation of the sewer system shall include the network both upstream and downstream of the plant. The operation shall include sewer system from the raw water source to, but not including inlet pumps and groundwater pumps if these are located adjacent to the plant. In addition, the operation of the sewer system must also include the pumping of purified drinking water out of the facility up to the customer's connection point. This information can be obtained from the municipalities that own the sewer system.

For wastewater treatment plants, the operation of sewer system shall include the network from the customer's connection point to, but not including inlet pumps as these are included in the plant operation. In addition, the operation of the sewer system must also include possible pumping of treated wastewater from the plant to the recipient. In the case of the self-collection, no electricity is normally required for the operation of the sewer system.

For all plants, the total electricity consumption of grid operation must be divided by the number of plants that share the wiring space. This does not always give a fair picture if one facility is large and another small, but for the sake of simplicity this principle is nevertheless applied.

#### 3.2.2.3 Heat consumption

In the same section of the first input tab ("Enter data here"), the user can enter data for the plant's heat consumption during the year. A number of possible heat sources are listed, and in the last line ("Other") the user can enter own emission factor if a different heat source other than those listed is used (see figure below). In Chapter 4, there is a description of what the user should consider when using an own emission factor. Not all rows need to be filled in, but the user selects the heat sources that are relevant for the plant.

| Heat consumption | Consumption [MWh/yr] | Indirect emissions, [kg $CO_2$ e/MWh] | Direct emissions, [kg $CO_2$ e/MWh] |
|---|---|---|---|
| Fuel oil | | 21 | 268 |
| Natural gas (also city gas and LPG) | | 42 | 206 |
| Biogas, internally produced | | 0 | 0 |
| District heating, local environmental values* | | | 0 |
| District cooling, local environmental values** | | | 0 |
| *Other* | | | |

**Figure 8**
The input field for the plant's heat consumption.

The emission factors are divided into two parts, direct (emissions from combustion) and indirect (emissions from production of the fuel). The reason for this is that different parts of the emissions are divided into different scopes in the GHG protocol. The direct emissions are allocated to scope 1, while the indirect emissions are allocated to scope 3. Renewable fuels have no direct emissions as this calculation tool does not take biogenic carbon dioxide into account.

Emission factors for district heating are obtained in a separate Excel file from Energiföretagen (2024). In this file, the user can retrieve the climate impact of local district heating. The fields "Combustion" and "Transport and production of fuels" needs be summed up before they are entered into the calculation tool. The user should also be aware that the unit, g carbon dioxide equivalents per kWh, is equal to kg carbon dioxide equivalents per MWh. The values are updated annually, therefore the user should ensure that the latest version of the tool is used in the calculations.

For district cooling, there is unfortunately no similar compilation of climate impact as for district heating (Energiföretagen, 2024). Instead, it is recommended that the user contact the district cooling supplier and request similar environmental information as for district heating, i.e., climate impact in kg of carbon dioxide equivalents per MWh of cooling delivered.

### 3.2.3 Fuel and backup power

In the next section of the first input tab ("Enter data here"), the user can enter data for fuel consumption during the current year. Fuel should only be reported for the company-owned vehicles and for backup power. For transport of products and residual products by external carriers, transport distance and fuel must be reported in the calculation tool in relation to the products and residual products that are transported. See section 3.2.5 for more details.

The figure below presents the list of fuels, where the user can enter their own fuel options with emission factors. Note that here also, the fuel's emission factor must be divided into direct and indirect emissions for correct mapping against the GHG protocol. Renewable fuels have no direct, fossil carbon dioxide emissions. All lines do not need to be filled in, but the user selects the fuels that are relevant for the plant.

| Fuel type | Consumption [liter/yr] | Indirect emissions, [kg $CO_2$ e/liter] | Direct emissions, [kg $CO_2$ e/liter] |
|---|---|---|---|
| Diesel MK3 | | 0.3 | 2.68 |
| Petrol MK1 | | 0.3 | 2.32 |
| E85 | | 1.07 | 0 |
| HVO (100%) | | 0.56 | 0 |
| FAME (100%) | | 1.10 | 0 |
| LNG [kg] | | 0.40 | 0 |
| Biogas, externally produced [kg] | | 0.36 | 0 |
| *Other* | | | |
| *Other* | | | |

**Figure 9**
The input field for the plant's fuel consumption for vehicles and backup power.

For water utilities that have vehicles that cannot be easily divided between different facilities, the user can divide the total amount of fuel consumed by the number of drinking water plants and wastewater treatment plants that share the vehicles.

There is no specific emission factor for the fuel EcoPar, which is used by some plants in backup power plants. Here the user is recommended to enter the amount of EcoPar consumed in the field for Diesel MK1 as an approximation for EcoPar and to avoid data gaps.

In the tool in general, it is the person who created the waste that must also bear the burden of transporting the waste to the disposal site. This also applies to smaller treatment plants that do not have their own sludge treatment and therefore send the sludge to larger treatment plants. The climate burden arising from the transport of this material must therefore be mapped at the plant generating the waste. However, for individual sewers, which are not covered by this climate calculation tool, the receiving plant should include the climate burden from transport. This can be done, for example, in the fuel table above.

In the absence of emission factors for certain fuels in the table above, a tip is to check at the pump when refuelling to get approximate emission factors for the fuel one uses (Ny Teknik, 2021).

### 3.2.4 Residual products

In this tool, no distinction is made between waste and sold products, but all residual fractions that leave the plant are referred to as residual products. According to the GHG protocol, both waste management and the climate impact of sold products must be mapped in scope 3.

In this category, the climate impact from handling residual products and from transporting the residual products to a disposal site is calculated. For more information on how to fill in information for transport, see section 3.2.5below.

The user must fill in quantities of the residual products generated at the facility, expressed in tons per year. All lines do not need to be filled in with information, but the user enters quantities of the residual products that are relevant for the facility. The figure below presents the section for residual products.

| Residual products | Handling | Weight [tonnes/yr] | Transport distance [km] | Truck fuel (diesel or fossil free) | Emissions factor [kg $CO_2$ e/tonne] | Emissions factor [kg $CO_2$ e/tkm] |
|---|---|---|---|---|---|---|
| Sand | Recycling | | 100 | | 0 | 0.07 |
| | Landfill | | 100 | | 20 | 0.07 |
| Activated carbon | Reactivation* | | 100 | | 0 | 0.07 |
| | Incineration | | 100 | | 1 600 | 0.07 |
| Screenings | Incineration | | 100 | | 420 | 0.07 |
| Sludge from wastewater treatment plants | Treatment of undigested sludge in other WWTP** | | 100 | | 0 | 0.07 |
| | Incineration | | 100 | | 124 | 0.07 |
| | Landfill coverage | | 100 | | 360 | 0.07 |
| | Soil production | | 100 | | 360 | 0.07 |
| | Spreading on arable land | | 100 | | 180 | 0.07 |
| Sludge from drinking water plant and similar residual products from precipitation of organic substances | Recycling | | 100 | | 0 | 0.07 |
| | Landfill | | 100 | | 20 | 0.07 |
| Lime sludge and similar residual products from water softening | Recycling | | 100 | | 0 | 0.07 |
| | Landfill | | 100 | | 20 | 0.07 |

**Figure 10**
Input field for the facility's residual products and their transport out of the facility.

The residual products that have been identified for drinking water plants and wastewater treatment plants are:

- Sand
- Activated carbon
- Screenings
- Sludge from wastewater treatment plants
- Sludge from drinking water plants and
- Lime sludge or pelletised lime

Biogas and its provision are specified in the climate calculation tool in the section below.

A number of alternative handling methods are available to choose from for most materials. If the facility's residual products are disposed of in other ways, the user should select the option in the list that can be considered most similar to the actual disposal to avoid data gaps.

All residual products are stated in their wet weights. For sludge from wastewater treatment plants, the emissions during handling depend on the TS content rather than the wet weight, however, the TS content for sludge from wastewater treatment plants is specified later in the tool in one of the sections below. Residual product amounts generated are stated for the current calendar year.

#### 3.2.4.1 Climate impact from sludge from drinking water plants

For sludge from drinking water plants, the emission factors for handling still need to be developed. A common disposal method today is to divert the sludge to wastewater treatment plants, which contributes to an increased load on the wastewater treatment plant. At present, there is no way to easily distinguish the additional climate load the sludge from drinking water plants contributes to a wastewater treatment plant, and therefore the emission factor has been set to zero, although this can be misleading. Even for other disposal methods (spreading on arable land or as an additive in digesters) fair emission factors are missing. However, the resulting effect on the overall climate impacts of the plant is considered to be low, as it is mainly the production of chemicals that contributes to the climate impact of a drinking water plant.

#### 3.2.4.2 Wastewater treatment plant without its own sludge treatment

For the often smaller wastewater treatment plants that do not have their own sludge treatment but send the sludge for treatment at another wastewater treatment plant, the amount of sludge (wet weight) is indicated in the line "Treatment of undigested sludge at other WWTPs" and the transport distance to the treatment plant. The climate burden resulting from sludge handling (for example digestion, dewatering, storage) is mapped at the receiving facility, as are any benefits resulting from sludge handling.

### 3.2.5 Transport of inputs and residual products

Transports of residual products and inputs contribute to the overall climate impacts of the facilities. The transports are carried out, in the vast majority of cases, by external carriers. In the calculation tool, the transport impact of the input goods and residual products is calculated in connection with the inventory of these products, because the transport impact is dependent on, for example, the amount of purchased products.

The calculation tool asks for information on:

- Transport distance between the producer and the facility one-way, alternatively the distance between the facility and the disposal site if it concerns residual products, and
- Type of fuel.

Today, the user can choose between two different fuels: diesel MK1 and fossil-free, which in this case is based on an emission factor for HVO. Other renewable fuels, such as biodiesel, have similar emission factors as for HVO and it can therefore be a good estimate if the fuel type is unknown. Only truck transport is currently available in the tool.

A pre-filled transport distance is available for most materials. The purpose of this is that if you do not have any information about transport distances, you can still calculate the transport's climate impact based on an estimated distance of either 100 or 300 km. This avoids a data gap if the transport distance is unknown.

Information on transport distance and fuel type is available in environmental and emissions reports from suppliers and transporters. It is important to enter the distance between the plant and, for example, the disposal site by road, and not to enter the total distance travelled during the year by the transporter, otherwise the climate calculations will be incorrect.

### 3.2.6 Direct emissions of methane from digesters, sludge treatment and biogas handling

In the next section of the climate calculation tool, emissions of methane from the digestion and treatment of sludge at wastewater treatment plants and from the use of biogas are calculated. Treatment of sludge entails the initial treatment which usually happens at the facility just after the digestion: sludge buffer storage, dewatering and storage of sludge in silos or tanks. Emissions from sludge storage, or hygienisation, is instead included in the next section: Other direct emissions.

If the user fills in the data for a drinking water plant, this part can be skipped. If the wastewater treatment plant does not have its own sludge management, this section can also be skipped. In the figure below, input fields for calculating emissions from digesters and sludge treatment are presented.

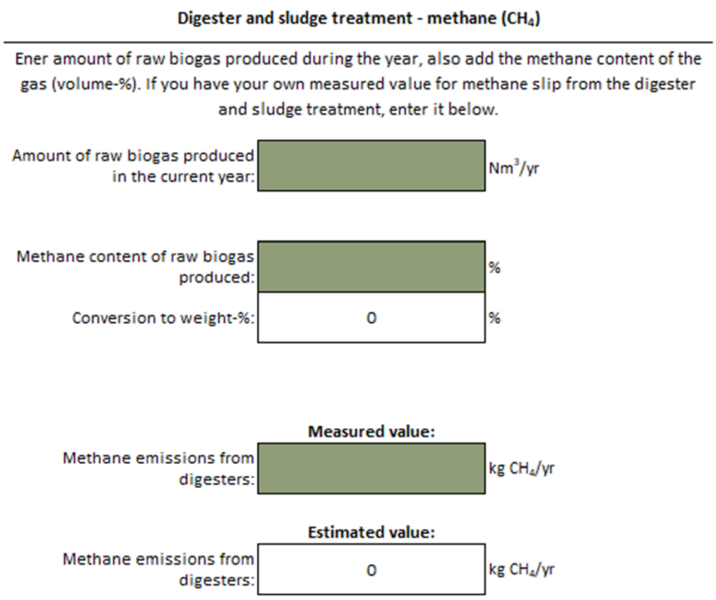



**Figure 11**
Input fields for the plant's biogas production and digester.

In order to be able to calculate emissions from digesters and the digester building, additional information is needed on how much biogas was produced during the year and the methane concentration in the biogas. The content is automatically converted to weight percent.

The user can enter a measured value for methane slip from the digester, or an estimated value is calculated based on an emission factor which is based on a compilation of measurements from the EgMet system. It is important to remember that if there is a measured value, but the value is zero, i.e., there are no emissions, the user should enter a low value (e.g., 0.00001 or similar) otherwise the tool applies the estimated value instead of the measured value.

What is included in the estimated emission factor is dewatering, milling, and mixing tank and digester (Mganusson & Yngvesson, 2023). Digester tanks, dewatering and temporary sludge storage are included in the selected emission factor. Emissions from hygienisation of sewage sludge is included in section 3.2.7 below. Data for emissions are requested in the unit kg methane per year, relevant conversion factors can be found at the beginning of the manual.

For biogas, five alternative disposal options are available: flaring, cold flaring, combustion in a boiler and upgrading in-house or under the auspices of others. A distinction is made between self-directed and third-party upgrading because the resulting emissions are mapped in different scopes in the GHG protocol. Emissions from upgrading under own auspices are mapped in scope 1, while emissions from upgrading under the auspices of others are mapped in scope 3. Here, too, the user can enter an own measured value for site-specific emissions of methane during upgrading (see figure below).

**Upgrading and use of biogas - methane ($CH_4$)**

Enter amounts of raw biogas produced from the digester that goes to the respective deposit. If you have your own measured value for slip from the upgrade facility, enter it in the first box.

| | Measured value | |
|---|---|---|
| Methane emissions from upgrading (in-house): | | kg $CH_4$/yr |

| Handling | Amount [$Nm^3$/yr] | Slip [%] |
|---|---|---|
| Upgrading (in-house) | | 0.49% |
| Upgrading (third party) | | 0.49% |
| Combustion in boiler | | 0.03% |
| Flaring | | 2.0% |
| Cold flaring | | 100% |

**Figure 12**
Input field for the plant's provisions for biogas. In the first cell, a possibly measured value is entered.

For the upgrade, methane emissions in the residual gas and ventilation losses are included, where the methane in the residual gas accounts for the largest losses (Magnusson & Yngvesson, 2023). This emission factor is also based on a compilation of measurements from the EgMet system.

Currently, the addition of propane when upgrading is excluded. Propane is sometimes added during upgrading when the gas is fed into the grid, depending on, among other things, volume, flow, and agreement with the grid owner. Propane is a fossil gas and burning it contributes to the greenhouse effect. The reason why it has been excluded in this calculation tool is because the biogas production itself does not require an addition of propane, but it depends on the agreement with the grid owner. That the burden should be allocated to the wastewater treatment plant is not entirely clear in this case. The addition of natural gas to the biogas network is also excluded.

### 3.2.7 Other direct emissions of methane and nitrous oxide from wastewater treatment plants

In the last section of the first input tab ("Enter data here"), the user can enter information about direct emissions from wastewater treatment plants. This part is therefore not relevant for drinking water plants. The emissions mapped here are:

- Methane emissions from water phase
- Nitrous oxide emissions from water phase (biological treatment)
- Nitrous oxide emissions from separate reject water treatment
- Methane and nitrous oxide emissions from sludge storage
- Methane and nitrous oxide emissions from recipient

Carbon dioxide emissions arising from respiration of carbon sources are calculated in connection with the section where the user specifies the amount of carbon sources purchased, see section 3.2.8 below. However, these direct emissions are mapped in scope 1.

For all the categories above, the user can enter an own, measured value from the facility if it is available, except for emissions from the recipient where it is assumed that there are no measured values available. It is important to remember that if there is a measured value, but the value is zero, i.e., there are no emissions, the user should enter a low value (e.g., 0.00001 or similar) otherwise the tool applies the estimated value instead of the measured value. The measured value always precedes an estimated value in the climate calculations, even if both fields are filled. If there is no measured value, the user can leave the field blank and instead use the estimated value as a template in the calculation tool.

Common to all sections in this part of the climate calculation tool are the relatively large uncertainties in measurement data and estimated values from literature. The variations are usually large between different facilities, and it is therefore difficult to give an accurate picture of the facility's climate impact based on emission factors from the literature.

#### 3.2.7.1 Methane emissions from water phase

The calculation tool takes into account emissions of methane from incoming wastewater in the wastewater treatment plant. Methane is formed, among other things, in the sewer system from anaerobic metabolism of organic material by microorganisms. The methane that is dissolved in incoming water is then released into processes at the wastewater treatment plant (Tumlin et al, 2014).

The user can enter his own measured value for methane emissions from the wastewater treatment plant, see the figure below. Note that the emission measurements should not include emissions of methane from the sludge phase (dewatering, digester, flare, and digester management). If there is no measured value, the emissions are calculated based on literature data. In this tool, the same emission factor is used as in VA- teknik Södra's tool (2021): 0.0027 kg methane per kg incoming COD (Gustavsson & Tumlin, 2013). The estimate is based on measured emissions from the Henriksdal and Bromma wastewater treatment plants in Stockholm and are measured in the collected exhaust air from the water phase.

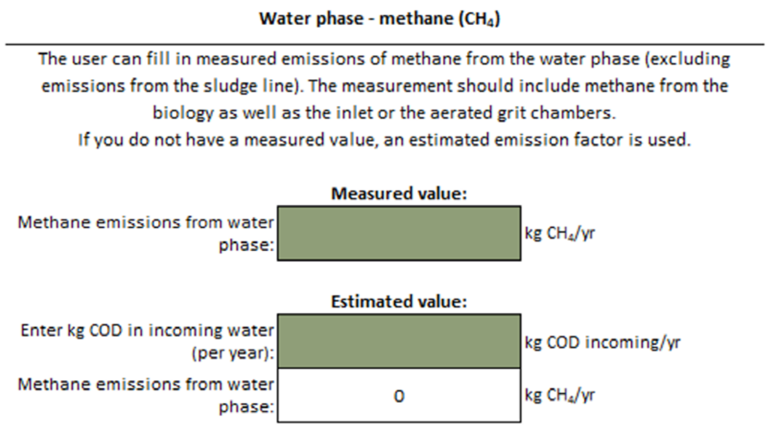



**Figure 13**
Input field for emissions of methane from the water phase.

There are large variations in measured values from different facilities, and the variations can be due to the incoming water temperature (Tumlin et al, 2014). For example, Baresel et al (2022) have measured methane emissions of between 8 and 40 g methane per kg incoming COD (compared to the chosen emission factor of 2.7 g methane per kg incoming COD). IPCC (2019) rekommenderar en utsläppsfaktor på 7,5 g metan per kg inkommande COD.

#### 3.2.7.2 Nitrous oxide emissions from biological treatment

Emissions of nitrous oxide originate mainly from the biological nitrogen removal processes; nitrification and denitrification when the processes are incomplete. Here, too, there are large uncertainties in measured values from different plants, and seem to be due, among other things, to carbon shortage, low oxygen levels and rapid process changes (Tumlin et al, 2014).

The user can enter their own measured value for nitrous oxide emissions from the biological treatment, and if there is no measured value, the nitrous oxide emissions are calculated based on a literature value and the amount of influent total nitrogen during the year. The emission factor for nitrous oxide (as N) is estimated to 1.1% of the incoming nitrogen to the treatment plant (Andrews & de Haas, 2022). Note that the internal nitrogen load should be included in the amount of influent nitrogen to be able to calculate the emissions correctly.

While choosing a representative emission factor for nitrous oxide emissions, two other factors were evaluated: IPCC (1.6%) and the Danish, national factor of 0.84% (Miljöstyrelsen, 2020). The emission factor of 1.1% was chosen since it considers both IPCC's references, corrects errors, and also considers new references (including the Danish, national factor of 0.84%). The emission factor is recalculated in the tool from nitrous oxide (as N) into nitrous oxide.

In a previous version of the tool, the nitrous oxide emissions were estimated based on the amount of reduced nitrogen during the current year, the same as in VA-teknik Södra's tool (2021) of 0.0157 kg of nitrogen per kg of denitrified nitrogen. This change was implemented since emission factors based on the amount of influent nitrogen is more common, and to enable easier comparisons to other climate calculations, both national and international.

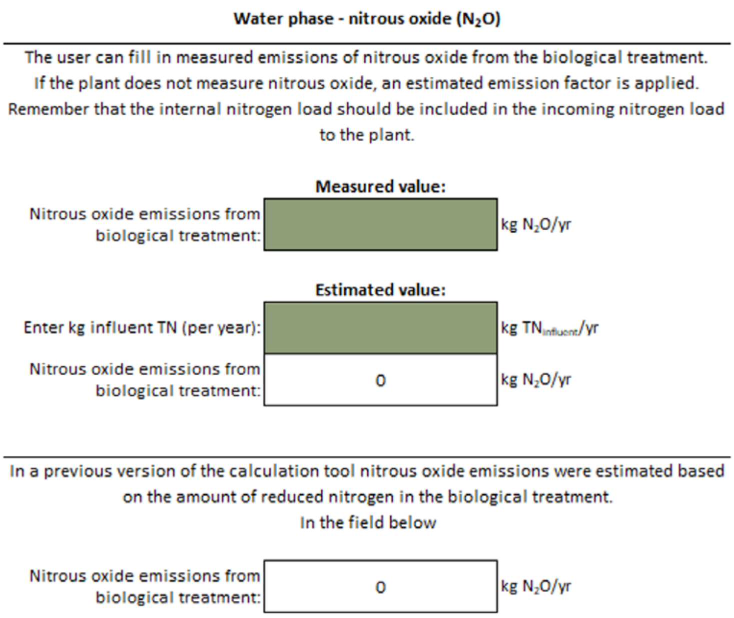



**Figure 14**
Input field for emissions of nitrous oxide from the biological treatment. The amount of reduced nitrogen during the year is listed among the indicators at the top of this input sheet.

### 3.2.7.3 Nitrous oxide emissions from separate reject water treatment

In the tool, there is the option of entering measured nitrous oxide emissions from separate reject water treatment if such is available at the facility (see the figure below). If there is no separate reject water treatment at the facility, all fields can be left blank.

If no own measured values are available, the user can enter the total amount of reduced nitrogen under the heading "Nitrification- denitrification in SBR" if the facility has such a technology, alternatively under the heading " Nitritation-deammonification " if the facility instead has such a technology. Nitrous oxide measurements from an ANAMMOX plant in Olburgen, The Netherlands, have been used as an estimated value for all techniques applying nitritation and deammonification. The emission factor used is 2.7% nitrous oxide per kg of reduced nitrogen, recalculated from 1.6% nitrous oxide (as nitrogen) per kg of reduced nitrogen. The emission factor for nitrification is chosen to be 6.3% if no own measured value is available.

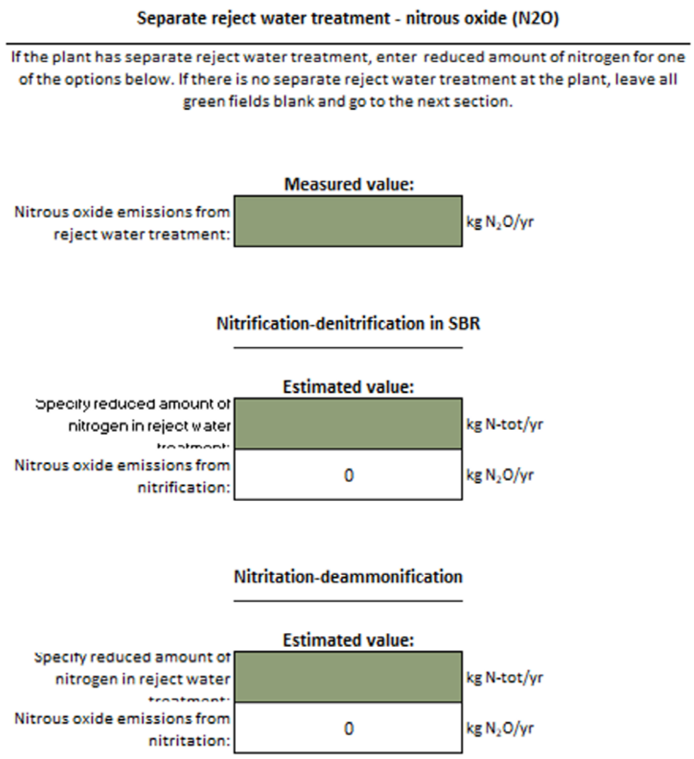



**Figure 15**
Input field for calculating nitrous oxide emissions from separate reject water treatment.

#### 3.2.7.4 Methane and nitrous oxide emissions from sludge storage

Below is an example of how direct emissions are requested in the calculation tool, in this case emissions of methane and nitrous oxide from sludge deposits. If the wastewater treatment plant sends its undigested sludge for treatment at another wastewater treatment plant, this section is left blank.

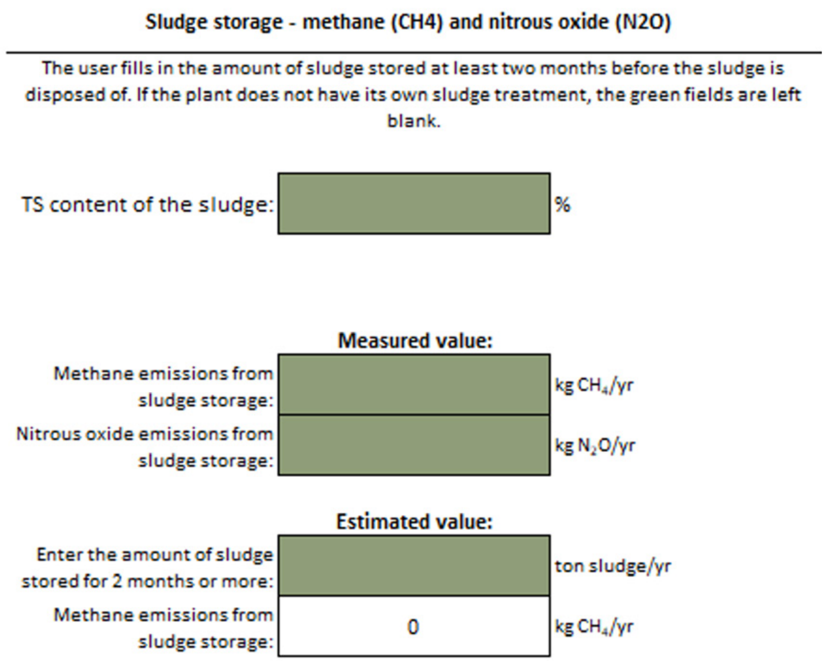



**Figure 16**
A section of the input field for direct emissions from sludge storage.

For the wastewater treatment plants that generate sludge that is stored, the amounts are given below. The user can enter their own measured values for emissions of nitrous oxide and methane from open sludge deposits and, if relevant, closed sludge deposits.

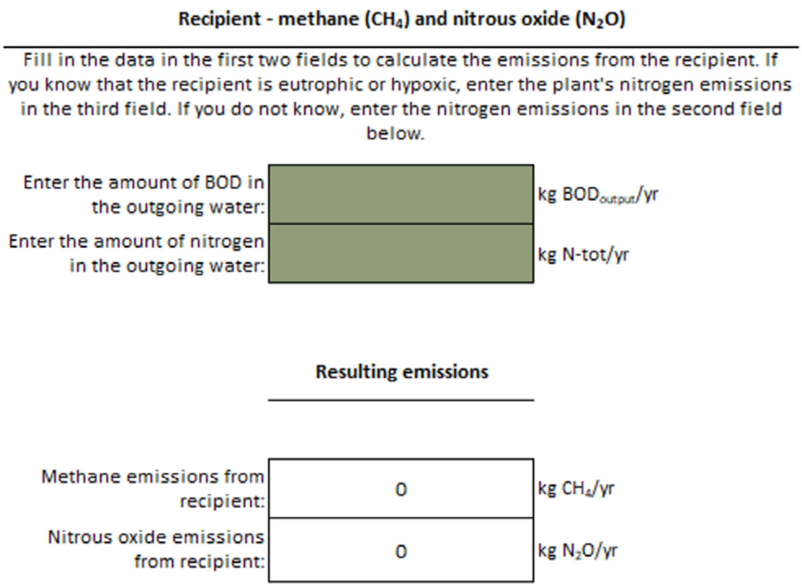
One area that is fortified with great uncertainties is precisely emissions from sludge deposits. If the plant does not have its own measured value, emissions from sludge storage are approximated in this calculation tool with a measured value from sludge storage in Linköping (Nilsson -Påledal et al. 2020). In the study, methane emissions were measured with a hyperspectral camera on sludge piles stored on a sludge plate for six months. The sludge had been digested under mesophilic conditions. The very largest amount of methane was emitted at the beginning of the storage period and after four months the emissions were very small (Nilsson -Påledal, 2021). According to the report (Nilsson- Påledal et al, 2020), approx. 90% of the emissions had been emitted in the first two months, therefore this tool asks how much sludge has been stored for two months or more.

In an ongoing SVU project, which is going to be reported in October 2025, measurements of methane and nitrous oxide emissions from sludge storages are carried out. Preliminary results show that methane emissions from different wastewater treatment plants sludge storages are somewhere in the range of 11 and 25 kg of methane per tonne of TS sludge (the current emission factor in the tool is 27 kg of methane per tonne of TS sludge). The study also confirms that a major part of methane emissions is emitted in the first part of the storage time (Magnusson, 2025). When the final report is released the chosen emission factor in the tool might be updated based on new recommendations.

Factors such as the temperature in sludge after dewatering and in storage, the TS content in sludge, as well as the degree of decay in sludge during digestion affect emission levels and vary greatly between different wastewater treatment plants, resulting in large uncertainties when calculating the climate impact of sludge storage.

#### 3.2.7.5 Methane and nitrous oxide emissions from recipient

Emissions of methane and nitrous oxide that occur in the recipient as a result of emissions of nitrogen and BOD are mapped in scope 1 of this calculation tool, even though the emissions occur outside the facility's boundaries. The emissions do not occur as a result of waste management or handling of sold product, and thus do not belong in scope 3. Since the emissions are strongly associated with plant operation, the emissions have nevertheless been included in the tool. In the figure below, the input fields for receipt emissions are presented.


**Recipient - methane ($CH_4$) and nitrous oxide ($N_2O$)**

Fill in the data in the first two fields to calculate the emissions from the recipient. If you know that the recipient is eutrophic or hypoxic, enter the plant's nitrogen emissions in the third field. If you do not know, enter the nitrogen emissions in the second field below.

| | | |
|---|---|---|
| Enter the amount of BOD in the outgoing water: | | kg $BOD_{output}$/yr |
| Enter the amount of nitrogen in the outgoing water: | | kg N-tot/yr |

**Resulting emissions**

| | | |
|---|---|---|
| Methane emissions from recipient: | 0 | kg $CH_4$/yr |
| Nitrous oxide emissions from recipient: | 0 | kg $N_2O$/yr |

**Figure 17**
Input field for calculating methane and nitrous oxide emissions from the recipient.

Discharge of BOD to watercourses acts as a substrate for the formation of methane in the recipient. Depending on whether the recipient is a stagnant body of water, for example lakes, the methane formation potential is higher, while in rivers, rivers and more the methane formation potential is lower. In this tool, an emission factor is used for all recipients, and no difference is made as to what type of watercourse the recipient is. The emission factor is calculated as an average value of the methane formation potential for several different types of recipients (IPCC, 2019).

Release of nitrogen to the recipient contributes to the formation of nitrous oxide in the recipient and depending on the nutritional and oxygen status of the recipient, the formation of nitrous oxide can be higher. In this tool, the same emission factor is used for all recipients, but for recipients where eutrophication or low oxygen content is a problem, the emission factor may be an underestimate.

### 3.2.8 Carbon sources

In the second input tab ("Enter data for chemicals here"), the user can enter information on consumed amounts of carbon sources for the current year. This part is only relevant for wastewater treatment plants. A number of different carbon sources from different origins are available in the list, see the figure below. The user can also enter their own emission factors for carbon sources if data is available from the supplier. All rows do not have to be filled in, but the user selects the carbon sources that are current for the plant.

**Figure 18**
Input field for the amount of carbon sources purchased by the wastewater treatment plant.

| Carbon source | Amount consumed [tonnes/yr] | Truck transport distance [km] | Truck fuel (diesel or fossil free) | Emission factor carbon source production [kg $CO_2$ e/tonne] | Emission factor carbon source respiration [kg $CO_2$ e/tonne] | Transport emission factor [kg $CO_2$ e/tkm] |
|---|---|---|---|---|---|---|
| Methanol, fossil | | 300 | | 800 | 1 400 | 0.07 |
| Methanol, bio-based | | 300 | | 760 | 0 | 0.07 |
| Ethanol, fossil | | 300 | | 2 000 | 1 900 | 0.07 |
| Ethanol, bio-based | | 300 | | 1 100 | 0 | 0.07 |
| Sekundol/isopropanol | | 300 | | 2 000 | 2 200 | 0.07 |
| Brenntaplus | | 300 | | 342 | 0 | 0.07 |
| *Other* | | 300 | | | | 0.07 |
| *Other* | | 300 | | | | 0.07 |

The emission factors are also divided in this section into indirect (production) and direct emissions (respiration) because different types of emissions are mapped in different scopes in the GHG protocol. Bio-based carbon sources have no direct emissions of fossil carbon dioxide during respiration.

If none of the listed options match the plant in question, and the own emission factor is missing, the user is recommended to enter the purchased quantities under the line for "Ethanol, fossil" or "Ethanol, bio-based" if the raw material is renewable.

In connection with the user specifying amounts of carbon sources, transport of the carbon sources must also be reported. Separate instructions for this are given in section 3.2.5.

### 3.2.9 Coagulants

In the second input tab ("Enter data for chemicals here"), the user can enter information about consumed amounts of coagulants. In this section, both wastewater treatment plants and drinking water plants must state consumption figures. A number of different aluminium- and iron-based coagulants are available in the list. The user can also enter their own emission factors for coagulants if data is available from the supplier. The majority of emission factors for coagulants are obtained by producers Kemira (2024) and Feralco (2024) and are based on a study from 2023 by the industry association

INCOPA. All rows do not have to be filled in, but the user selects the precipitants that are relevant for the plant.

| Coagulants | Amount consumed [tonnes/yr] | Truck transport distance [km] | Truck fuel (diesel or fossil free) | Emission factor chemical [kg $CO_2$ e/tonne] | Emissions factor [kg $CO_2$ e/tkm] |
|---|---|---|---|---|---|
| Ferric chloride (PIX-111) | | 300 | | 136 | 0.07 |
| Ferric chloride (Plusjärn S 314) | | 300 | | 140 | 0.07 |
| Ferrous sulphate (e.g. Quickfloc) | | 300 | | 132 | 0.07 |
| Ferric sulphate (PIX-113) | | 300 | | 108 | 0.07 |
| Ferric chloride sulphate (PIX-118) | | 300 | | 86 | 0.07 |
| Aluminium ferric chloride (Ekomix 1091) | | 300 | | 246 | 0.07 |
| Aluminium sulphate (ALG) | | 300 | | 294 | 0.07 |
| PAC (Ekoflock 54) | | 300 | | 156 | 0.07 |
| PAC (Ekoflock 70) | | 300 | | 202 | 0.07 |
| PAC (Ekoflock 75) | | 300 | | 216 | 0.07 |
| PAC (Ekoflock 90, 91, 92) | | 300 | | 259 | 0.07 |
| PAC (Ekoflock 96) | | 300 | | 277 | 0.07 |
| PAC (Pluspac S 1465) | | 300 | | 209 | 0.07 |
| PAC (PAX-15) | | 300 | | 215 | 0.07 |
| PAC (PAX-215) | | 300 | | 61 | 0.07 |
| PAC (PAX-XL60) | | 300 | | 215 | 0.07 |
| PAC (PAX-XL260) | | 300 | | 60 | 0.07 |
| PAC (PAX-XL100) | | 300 | | 267 | 0.07 |
| *Other* | | 300 | | | 0.07 |
| *Other* | | 300 | | | 0.07 |

**Figure 19**
Input field for the quantities of precipitants purchased by the plant.

If none of the alternatives in the list match the facility's precipitation chemical, the user is directed to either ask for the chemical 's climate impact from the manufacturer, or alternatively, and if possible, to select a chemical in the list that is most similar to the one used.

In connection with the user specifying quantities of precipitation chemicals, transports of these must also be reported. Separate instructions for this are given in section 3.2.5.

### 3.2.10 Polymer

In the second input tab ("Enter data for chemicals here"), the user can enter information about consumed amounts of polymers. In this section, both wastewater treatment plants and drinking water plants must state consumption figures. Only one option for polymer is listed, as no vendor-specific emission factors were available at this time (see figure below). The emission factor can be seen as representative of many polymers, even those not based on polyacrylamide. The user can also enter their own emission factors for polymers if data is available from the supplier.

| Polymer | Purchased weight [ton/yr] | Truck transport distance [km] | Truck fuel (diesel or fossil free) | Emission factor chemical [kg $CO_2$ e/ton] | Emission factor [kg $CO_2$ e/tonkm] |
|---|---|---|---|---|---|
| Polyacrylamide | | 300 | | 3 200 | 0.07 |
| *Other* | | 300 | | | 0.07 |
| *Other* | | 300 | | | 0.07 |

**Figure 20**
Input field for the quantities of polymer purchased by the plant.

In connection with the user specifying quantities of polymer, transports of these should also be reported. Separate instructions for this are given in section 3.2.5.

### 3.2.11 Other chemicals

In the second input tab ("Enter data for chemicals here"), the user can enter information about all other chemicals consumed for the plant for the current year. This section is relevant to both drinking water and wastewater treatment plants.

First of all, wastewater treatment plants can indicate their consumption of drinking water for, for example, flushing. Here, the user should enter an own emission factor from the local producer of drinking water.

| Water consumption at WWT | Quantity consumed [$m^3$/yr] | Emission factor [kg $CO_2$ e/$m^3$] |
|---|---|---|
| Drinking water (for wastewater treatment plants)* | | |

** Enter the emission factor for drinking water produced from the local supplier.*
*For drinking water plants the resulting emission factor will be zero due to internal flow.*

**Figure 21**
Input field for the plant's drinking water consumption. Note that the field only applies to wastewater treatment plants.

A variety of different types of chemicals are available in the list, see the figures below. The user can also enter their own emission factors for chemicals if data is available from the supplier, or if a chemical is missing from the list. Not all rows need to be filled in, but the user selects the chemicals that are relevant for the plant.

| Chemicals | Amount consumed [tonnes/yr] | Truck transport distance [km] | Truck fuel (diesel or fossil free) | Emission factor chemical [kg $CO_2$ e/tonne] | Emission factor [kg $CO_2$ e/tkm] |
|---|---|---|---|---|---|
| Activated carbon, fossil origin | | 300 | | 7 000 | 0.07 |
| Activated carbon, reactivated | | 300 | | 2 000 | 0.07 |
| Activated carbon, coconut based | | 300 | | 1 100 | 0.07 |
| Sand | | 300 | | 6 | 0.07 |
| Quicklime (CaO) | | 300 | | 1 150 | 0.07 |
| Calcium hydroxide (Ca(OH)2) | | 300 | | 890 | 0.07 |
| Limestone (CaCO3) | | 300 | | 44 | 0.07 |
| Sodium chloride | | 300 | | 17 | 0.07 |
| Sodium hydroxide (50 %) | | 300 | | 330 | 0.07 |
| Sodium hydroxide (25%) | | 300 | | 165 | 0.07 |
| Chlorine | | 300 | | 710 | 0.07 |
| Sodium hypochlorite (50 %) | | 300 | | 320 | 0.07 |
| Sodium hypochlorite (13%) | | 300 | | 83 | 0.07 |
| Hydrogen peroxide (49%) | | 300 | | 530 | 0.07 |
| Sulphuric acid (96 %) | | 300 | | 200 | 0.07 |
| Sulphuric acid (36%) | | 300 | | 75 | 0.07 |
| Hydrochloric acid (32 %) | | 300 | | 120 | 0.07 |
| Nitric acid (60 %) | | 300 | | 450 | 0.07 |
| Ammonium sulphate | | 300 | | 500 | 0.07 |
| Sodium silicate | | 300 | | 500 | 0.07 |
| Sodium carbonate | | 300 | | 500 | 0.07 |
| Carbon dioxide | | 300 | | 500 | 0.07 |
| Citric acid | | 300 | | 2 000 | 0.07 |
| *Other* | | 300 | | | 0.07 |

**Figure 22**
Input field for the quantities of all other chemicals purchased by the plant.

In connection with the user specifying quantities of other chemicals, transports of these must also be reported. Separate instructions for this are given in section 3.2.5.

## 3.3 Calculation of climate benefits

In a third reporting tab, potential climate benefits from by-products from wastewater treatment plants and drinking water plants are calculated. The reporting tab is completely optional, and the result from these calculations should not be added to the other result as the methodology here differs from the normal approach in the GHG protocol. The resulting climate benefits are presented at the top of the tab together with an index that indicates in percentage how large the climate benefits are in relation to the facility's total climate impact. This index can change from year to year, partly depending on how much energy and resources the facility utilises, partly depending on the climate impact the avoided emissions have. It can e.g. turn out that the facility's climate benefits decrease over the years despite the fact that energy and resources are utilised and this may be due to the alternative production of energy and resources changing to a more low-carbon production.

Potential climate benefits can arise at the facilities from upgrading biogas, sold electricity and heat, nutrients, and stored carbon in sludge from wastewater treatment plants and recycled lime pellets from drinking water plants.

Within the energy section, four potential benefits have been identified: biogas that is upgraded to vehicle fuel, sold electricity from own solar cells or wind turbines, sold electricity or heat from burning biogas in a boiler, heat recovery from burning grid cleaners and sludge from wastewater treatment and sold heat from heat exchange of wastewater pipes. The identified benefits can only occur at wastewater treatment plants. Biogas that is flared is not attributed to any climate benefit. Produced heat and electricity that is also consumed internally at the plant should not be entered here because no direct climate benefit occurs. Rather, the benefit arises from the fact that less electricity and heat need to be purchased externally.

The figure below presents the input requested by the user regarding potential benefits from energy recovery. Upgraded biogas is assumed to be able to replace a fossil fuel equivalent (94 g carbon dioxide equivalents per MJ) in a 1:1 ratio (i.e., 1 MWh of upgraded biogas can replace 1 MWh of fossil fuel). Surplus electricity is assumed to be able to replace Nordic residual mix, and surplus heat is assumed to be able to replace locally produced district heating, also in a 1:1 ratio. The emission factor for local district heating is entered by the user their self, see instructions under 3.2.2.3. In the same way as for other categories, information is requested here on an annual basis.

| Handling method | Annual volumes [MWh] | Emission factor avoided production [kg $CO_2$ e/MWh] | Specification | Quality factor | Potential climate benefits [kg $CO_2$ e/yr] |
|---|---|---|---|---|---|
| Vehicle fuel produced | | 338 | Upgraded biogas replaces a fossil fuel. | 1 | 0 |
| Surplus electricity sold on the grid | | 90 | Electricity sold to the grid replaces the Nordic residual | 1 | 0 |
| Surplus heat sold to industry or households* | | | Sold heat replaces local district heating mix. | 1 | 0 |
| Heat from incineration of sludge and cleaning* | 0 | | Sold heat replaces local district heating mix. | 1 | 0 |
| *Other* | | | | | 0 |

**Figure 23**
Input field for calculating the plant's potential climate benefits from biogas.

For the incineration of sludge from wastewater treatment plants and screenings, the amount of heat recovered is automatically calculated because the treatment plants do not have direct control over this step, but it is usually done by local or regional heating plants or cogeneration plants. However, the user needs to enter the emission factor for the local district heating network. Today, sludge from wastewater treatment plants is usually incinerated together with household waste and depending on how sludge management looks in the future, mono-incineration of sludge can give rise to a climate benefit through the recovery of both energy and phosphorus from the ash.

The figure below presents the input data requested from the user regarding the utilisation of sludge from wastewater treatment plants. The potential uses that have been identified for sludge that are used as construction soil as well as use as an organic fertiliser. Benefits from sludge being incinerated are calculated in the section above.

| Handling method | Annual volumes [tonnes] | Emission factor avoided production [kg $CO_2$ e/MWh] | Specification | Quality factor | Potential climate benefits [kg $CO_2$ e/yr] |
|---|---|---|---|---|---|
| Soil production | 0 | 1 000 | Composted sludge replaces peat (1 $m^3$/1 $m^3$). | 0.2 | 0 |
| Spreading on arable land, nitrogen (N) as tot-N | | 3 600 | Nitrogen in sludge replaces AN. | 0.3 | 0 |
| Spreading on arable land, phosphorus (P) as tot-P | | 1 000 | Phosphorus in sludge replaces TSP. | 0.7 | 0 |
| *Other* | | | | | 0 |

| Handling method | Carbon content of sludge [% of TS] | Amount of sludge recovered [tonnes/yr] | Specification | Share of carbon assumed to sequester into soil | Potential climate benefits [kg CO2 e/yr] |
|---|---|---|---|---|---|
| Carbon storage in soils fertilized with sludge | | 0 | Carbon sequestered in the soil is calculated as avoided carbon dioxide | 0.05 | 0 |
| Carbon stored in soils fertilized with sludge biochar | | | Carbon sequestered in the soil is calculated as avoided carbon dioxide | 0.9 | 0 |

**Figure 24**
Input field for calculating the plant's potential climate benefits from sludge from wastewater treatment plants.

For soil production, a replacement ratio of 1:1 in terms of volume is assumed and this is assumed to correspond on average to a factor of 0.2 for sludge from wastewater treatment plants (Boldrin et al. 2009). For phosphorus and nitrogen in the sludge, degrees of 0.7 and 0.3 are used for plant-available fractions (Svanström et al. 2016). Both nutrients are assumed to replace mineral fertilisers: ammonium nitrate and triple superphosphate. In the same way as for other categories, information is requested here on an annual basis.

In the calculation tool, it is also possible to calculate potential climate benefits from the storage of carbon in sludge that is spread on arable land, used as construction soil, and used for landfill cover. In the current version of the calculation tool it is also possible to calculate a potential carbon storage in sludge biochar. A share of the carbon in sludge is assumed to be stabilized in the ground and is calculated as a negative emission, aka a potential climate benefit, and the rest of the carbon is assumed to be emitted as carbon dioxide within a period of 100 years.

In a previous version of the calculation tool, the potential climate benefit from carbon storage in sludge was assumed to be 35% (Börjesson, 2021). This assumption has been revised since that emission factor likely does not consider a time horizon of 100 years, which is considered good practice when it comes to the GHG protocol. In the current version of the tool, it is instead assumed that 5% of the carbon in sludge is stabilized in the ground within a time frame of 100 years, while 90% of the carbon in sludge biochar is assumed to be stabilized (Faragó et al. 2022). These factors are uncertain.

Seen from a global perspective, it can be argued that an increase in soil carbon in one location causes a decrease or removal of soil carbon in another location. An example could be that the food we eat absorbs carbon from the soil in one field and then ends up as soil carbon in another field. A higher humus content in the soil can contribute to a higher water-holding capacity and better soil structure.

For drinking water plants, a potential climate benefit has been identified: recovery of lime granules from water softening (see figure below). The lime is then assumed to replace ground limestone. For all categories, the user can enter his own emission factor if the facility in question utilises the residual products in ways other than those listed above.

**Figure 25**
Input field for calculating climate benefits from drinking water plants.

| Faction and handling method | Årsvolymer [ton] | Emission factor avoided production [kg $CO_2$ e/ton] | Specification | Quality factor | Potential climate benefits [kg $CO_2$ e/yr] |
|---|---|---|---|---|---|
| Lime granules, recycling | 0 | 24 | Recycled lime granules replace limestone. | 1 | 0 |
| *Other* | | | | | 0 |

## 3.4 Results presentation

The results of the climate calculation are presented in three tabs in the calculation tool: one in tabular form and two in graphical form.

### 3.4.1 Presentation in tabular form

In the first tab ("Result presentation in table"), the key figures are presented at the top, see the figure below. After the user has filled in all the necessary fields in previous tabs, the key figures are calculated by dividing the facility's total climate impact over the current year by the specified key figures, for example the wastewater treatment plant's load expressed in person equivalents.

Wastewater treatment plants

| Kg $CO_2$ e per $m^3$ treated water | Kg $CO_2$ e per kg reduced nitrogen | Kg $CO_2$ e per person equivalent |
|---|---|---|
| Enter the number of cubic metres of treated water under the previous tab | Enter the amount of reduced nitrogen under the previous tab | Enter the number of person equivalents in the previous tab |

Drinking water plants

| Kg $CO_2$ e per $m^3$ raw water intake | Kg $CO_2$ e per $m^3$ produced drinking water | Kg $CO_2$ e per $m^3$ consumed drinking water |
|---|---|---|
| Enter the number of cubic metres of raw water intake in the previous tab | Enter the number of cubic metres of produced drinking water in the previous tab | Enter the number of cubic meters of consumed drinking water in the previous tab |

**Figure 26**
Presentation of the result expressed in the indicators defined earlier.

The key indicators present the climate impact of the plant divided into different categories, see the figure below. The categories partly follow the structure of the GHG protocol, and partly a more detailed table with information on which parts of plant operation contribute to climate impact. The purpose of this is to give the water utilities a deeper understanding of the facility's contribution to climate change and which parts of the operation contribute the most.

| Direct emissions from company-owned cars, reserve power and heat | Direct emissions of $N_2O$ | Direct emissions of $CH_4$ | Direct emissions of $CO_2$ from respiration of carbon source | Electricity, heating and district cooling consumption | Indirect emissions from company-owned cars and reserve power | Indirect emissions from the production of chemicals | Purchased transport, by logistics companies | Emissions from residual products | Total climate impact |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e |

| Scope 1 emissions | Scope 2 emissions | Scope 3 emissions Upstreams | Scope 3 emissions Downstreams |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e | ton $CO_2$ e |

**Figure 27**
The result for the facility's climate impact distributed over a number of important items.

Below the summarised tables of the facility's climate impact, a detailed view of all items is presented. Here, if interested, the user can see, for example, which chemicals contribute the most to climate change and where in the facility the largest methane emissions occur.

### 3.4.2 Presentation in graphical form

In the next two tabs, the results are presented in graphic form. The "Result presentation in graph" tab presents the upper table in Figure 27above where the total climate impact is excluded in the graph. The bars are also color-coded to make it easier to distinguish which emissions are mapped in scope 1, 2 and 3.

In the tab "Result presentation of benefits" the same graph presents emissions according to scope 1, 2, 3 as well as avoided emissions from vehicle fuel, electricity, heat, sludge from wastewater treatment plants and lime pellets. Emissions and avoided emissions are not added together because communication of a net value of emissions and benefits can be interpreted as emissions being "conjured up" by accounting.

# 4 How do you ensure the quality of your own emission factors?

With the aim of increasing the tool's flexibility and adaptation to different water utilities, there is the option of entering your own emission factors, either for more specialised subjects that are not already listed in the tool or for subjects where you have a supplier-specific emission factor. In both cases, the user of the tool needs to ensure that the data is of good quality, is comparable to other emission factors and that it is representative from a temporal, technical and geographical perspective.

Emission factors can be obtained from an EPD (Environmental Product Declaration), an LCA study or a carbon footprint study. EPDs are a third-party verified and public declaration of a product or service's environmental impact. The result is based on a life cycle analysis that follows calculation rules according to product-specific rules. An LCA or carbon footprint does not need to be third-party verified, and the calculation rules are freer than for an EPD.

What the user needs to pay particular attention to when using emission factors from LCA and carbon footprint studies, and in some cases also EPDs, are:

- Which functional unit is used? Does the unit need to be recalculated to fit the climate calculations?
- What are the system limits of the study (" cradle -to-gate" or " cradle -to-grave")? The system boundaries should be " cradle -to-gate" for inputs such as chemicals. Fuels and propellants should be separated between indirect emissions (from production) and direct emissions (combustion during use). " Cradle -to-gate" means that the product's entire environmental impact is included, from the extraction of natural resources up to the factory gate.
- Is the study an accounting LCA or a consequence LCA? The study should be an accounting LCA to match the system limits for the remaining emission factors.
- Is biogenic carbon dioxide excluded in the result for climate impact? If not, can it be separated easily?
- What year is the data based on? Is the data still current?
- Is the study third-party reviewed? This is not a requirement but can increase the reliability of the study.

If the supplier supplies generic data from a database and believes that it is representative of their production, the quality can be equated with many of the emission factors listed in the tool.

# 5 Further development of the tool

A number of areas have been previously mentioned where potential for improvement of the calculation tool has been identified. This mainly applies to a lack of emission factors for residual products from drinking water plants and emission factors for methane from sludge layers adapted to plant level. Currently, no specific emission factors for residual products from drinking water plants are available. In this tool, it has instead been assumed that residual products on landfill can be approximated with inert material on landfill. In order for the tool to provide as accurate a result as possible, specific emission factors for drinking water plant products will be requested in the future.

Sludge storage can look different depending on the plant: fresh sludge can be stored in silos or on an open slab, and the methane produced can either be treated (few plants) or flared/discharged without treatment (most plants). Today, the tool does not take into account local conditions (unless the facility measures its own methane emissions from sludge storage) but it is assumed that all sludge is stored on an open plate immediately after digestion. The tool also does not take into account differences in emissions from thermophilic digested sludge or undigested sludge.

The result from the calculation tool is expressed in a number of key figures, where the idea is to be able to use these figures for follow-up from year to year or in comparisons between different facilities. The key figures requested today are based on requests from a test group of 18 water utilities and may be changed or expanded in the future depending on the needs of the water utilities.

The climate calculation tool's system limits have also been extensively discussed during the development phase, above all how and whether the energy consumption of the sewer system should be included in the facility's total climate impact or not. Pumps distributed in the sewer system can in some cases have a large energy consumption depending on the type of installation and geography. Today, the energy consumption of the sewer system is included, but nitrous oxide emissions from the sewer system are not.

Today, the tool is mainly adapted to calculate the climate impact for operation at plant level, for one plant at a time, but if a water utility wants to calculate the climate impact of operation for several plants at the same time, the tool can be used for this as well. The interpretation of the key figures requested at the beginning of the tool will not be correct if, for example, a water utility fills in data for both wastewater treatment plants and drinking water plants, but the results are calculated for the data entered into the tool.

Updates of the calculation tool should take place annually, at least with regard to some emission factors. This primarily applies to emission factors for the residual mix in the Nordics and the climate impact of district heating, but also emission factors for new technology that is put into operation, for example alternative technologies for sludge management, nitrogen purification, pharmaceutical purification, PFAS purification, microplastic purification or the like. The calculation tool is tool adapted to today's systems and technologies.

In January 2020, the Investigation into a non-toxic and circular return of phosphorus from sludge (SOU 2020:3) presented its report, and it remains to be seen whether and what the future of sludge handling will look like in Sweden. Will sludge management continue as it is today, or will mono incineration take place with subsequent extraction of phosphorus from ash? This is just one example of how the tool may need to be adjusted to adapt to future technologies. The calculation tool is currently based on what has happened in the past year. Any updates to future sludge handling scenarios will therefore only become relevant when some decisions are made and when new facilities are commissioned.

# References

Below is a list of full references from the manual and the calculation tool.


Arom Dekor (2020). Klimatavtryck för biometanol BioMCN. Tillgänglig hos VA-teknik Södras klimatberäkningsverktyg: https://va-tekniksodra.se/klimatpa- verkan-berak-ningsverktyg/. Hämtad: 2021-09-01.

Baresel, C., Yang, J., Bornold, N., Tjus, K., Kanders, L., Westling, K. (2022). Direct GHG emissions from a pilot scale MBR-process treating municipal wastewater. Advances in climate change research, vol. 13(1), ss. 138-145.

Brenntag (2023). Klimatavtryck för Brenntaplus. Personal communication with Hjalmar Loeb, Business Manager, September 2023.

Boldrin, A., Andersen Kragh, J., Möller, J., Höjlund Christense, T., Favoino, E. (2009). Composting and compost utilization: accounting of greenhouse gases and global warming contributions. Waste Management and Research, 27(8), 800-812. https://doi.org/10.1177/0734242X09345275

Brown, S., Beecher, N., Carpenter, A. (2010). Calculator tool for determining greenhouse gas emissions for biosolids processing and end use. Environmental Science & Technology, vol. 44(24), ss. 9509–9515.

Börjesson, G. (2021). Slamspridning på åkermark – mullhaltens betydelse. SVU-rapport 2021–9.

Calcium Carbonate Association Europe (CCA-Europe) (2021). Dry ground calcium carbonate (GCC-dry) Fine – Sector EPD. EPD registration number S-P-05192.

CarbonCloud (2025). Climate footprint of ethanol. Tillgänglig: https://apps.carboncloud.com/climatehub/product-reports/id/11607069111. Hämtad: 2025-04-01.

Energiföretagen (2024). Lokala miljövärden 2021 (Excelfil). Tillgänglig: https://www.energiforetagen.se/statistik/fjarrvarmestatistik/miljovardering-av-fjarrvarme/. Hämtad: 2025-04-01.

Energiföretagen (2021). Frågor och svar om inrapportering av lokala miljövärden. Tillgänglig: https://www.energiforetagen.se/statistik/fjarrvarmestatistik/ miljovardering-av-fjarrvarme/fragor-och-svar-om-fjarrvarmens-lokala-miljovarden/. Hämtad: 2022-01-05.

Energimarknadsinspektionen (2025). Residualmix 2023. Tillgänglig: https:// ei.se/bransch/ursprungsmarkning-av-el/residualmix. Hämtad: 2025-04-01.

Energimyndigheten (2025). Växthusgasutsläpp. Tillgänglig: https://www.energimyndigheten.se/statistik/ovrig-energistatistik/statistik-om-biobranslen-och-drivmedel/. Hämtad 2025-04-01.

EU-direktiv 2018/2001. Renewable Energy Directive II.

Euro Chlor (2022). Eco-Profile and Environmental Product Declaration of Chlorine (the Chlor-Alkali process).

European Lime Association (EuLA) (2024). Sector EPDs of Quicklime and Hydrated lime.

Faragó, M., Damgaard, A., Logar, I., Rygaard, M. (2022). Supporting Information for the manuscript: Life cycle assessment and cost-benefit analysis of technologies in water resource recovery facilities: the case of sludge pyrolysis.

Feralco (2024). Personal communication with Kalle Pelin, Circularity Manager, January 2024. Carbon footprints for inorganic coagulants based on report from INCOPA (2023).

Foley, J., Lant, P., Donlon, P. (2008). Fugitive greenhouse gas emissions from wastewater systems. Water vol. 38, ss. 18–23.

Foley, J., de Haas, D., Hartley, K., Lant, P. (2010). Comprehensive life cycle inventories of alternative wastewater treatment systems. Water research, vol. 44, ss. 1654–1666.

GC Rieber (2022). Environmental Product Declaration of Sodium chloride in bulk (NaCl) from rock salt – Stradasalt Icebreaker Rock/Norsal Rock/ Rock salt/Feed salt/ Industrial salt/Fishery salt/Water softning salt.

Gode, J., Martinsson, F., Hagberg, L., Öman, A., Höglund, J., Palm, D. (2011). Miljöfaktaboken 2011 – Uppskattade emissionsfaktorer för bränslen, el, värme och transporter.

Greenhouse Gas Protocol (2022). About us. Tillgänglig: https://ghgprotocol.org/about-us. Hämtad: 2022-01-25.

Grundestam, C., Johansson, K., Mellin, A., Malmaeus, M., Rahmberg, M. (2020). Konsekvensbeskrivning för framtida slamhantering och fosforåtervinning. IVL- rapport C541.

Gustavsson, D.J.I., Tumlin, S. (2013). Carbon footprints of Scandinavian Wastewater Treatment Plants. Water Science & Technology 68(4), ss. 887-893.

de Haas, D., Andrews, J. (2022). Nitrous oxide emissions from wastewater treatment - Revisiting the IPCC 2019 refinement guidelines. Environmental Challenges 8 (2022) 100557.

Hoyer, K., Höglind, L., Sjölin, A., Cimbritz, M. et al. (2022) Kvartär rening vid Sjölunda ARV – ozonering vid höga bromidhalter och regenerering av aktivt kol.

INCOPA (2023). Carbon footprints of inorganic coagulants produced by INCOPA member organisations, an executive summary. Based on IVL report U6780 (2023).

IPCC (Intergovernmental Panel on Climate Change) (2019). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2 Energy & Volume 5 Waste. Tillgänglig: https://www.ipcc-nggip.iges.or.jp/ public/2019rf/index.html. Hämtad: 2022-01-26.

Kemira (2024). Personal communication with Eva Mattsson, Specialist Inorganic Coagulants, January 2024. Carbon footprints for inorganic coagulants based on report from INCOPA (2023).

Magnusson, A. & Yngvesson, J. (2023). Sammanställning av data från metanmätningar enligt Egenkontroll metanemissioner åren 2019–2021, samt jämförelse med tidigare år.

Magnusson, A. Personlig kommunikation under Mars 2025. Mätkonsult, Nitoves.

Methanol Institute (2022). Carbon footprint of methanol. Tillgänglig: https://www.methanol.org/. Hämtad: 2025-04-01.

Miljöstyrelsen (2020). MUDP Lattergaspulje Dataopsamling på måling og reduktion af lattergasemissioner fra renseanlæg. ISBN: 978-87-7038-254-0.

NCC (2022). Climate declaration for aggregates from Stockholm terminal – Vårby. EPD registration number S-P-06091.

Nilsson-Påledal, S., Séhlen, R., Johansson, C., Gålfalk, M., Yngvesson, J. (2020). Innovativ teknik för mätning av växthusgaser från avloppsreningsverk. SVU- rapport 2020–10.

Nilsson-Påledal, S. (2021). Mejlkorrespondens under november 2021. Processingenjör, Tekniska Verken Linköping.

Nouryon (2023). Environmental Product Declaration of hydrogen peroxide. Tillgänglig: https://www.environdec.com/library/epd11034. Hämtad: 2024-01-22.

NTM (Network for Transport Measures) (2020). Road cargo transport baselines 2020 EU. Tillgänglig: https://www.transportmeasures.org/en/wiki/evaluation-transport-suppliers/road-transport-baselines-2020/. Hämtad: 2022-01-10.

Ny Teknik (2021). Nu måste pumpen visa vilken klimatpåverkan bränslet har. Artikel publicerad 2021-10-04. Tillgänglig: https://www.nyteknik.se/premium/nu-maste-pumpen-visa-vilken-klimatpaverkan-branslet-har-7021841. Hämtad: 2022-06-23.

Sandgren, A-M., Nilsson, J. (2020). Emissionsfaktor för nordisk elmix med hänsyn till import och export. Tillgänglig: https://naturvardsverket.diva-portal.org/smash/record.jsf?pid=diva2%3A1540012&dswid=-8422. Hämtad: 2025-04-01.

Science Based Targets (2022). FAQs. Tillgänglig: https://sciencebasedtargets. org/faqs#what-are-the-emissions-scopes-which-scopes-do-targets-have-to-cover-. Hämtad: 2022-01-25.

SGC (Svenskt Gastekniskt Center) (2012). Basdata om biogas.

Stenström, F., la Cour Jansen, J., Andersson Chan, A., Eliasson, M., Eriksson, Y., Marsteng, A-K., Sehlén, R., Thelin, G. (2017). Rejektvattenbehandling – en kunskapssammanställning. SVU-rapport 2017–11.

Svanström, M., Heimersson, S., Harder, R. (2016). Livscykelanalys av slamhantering med fosforåterföring. SVU-rapport 2016–13.

Svensk solenergi (2022). Solelens klimatnytta. Tillgänglig: https://svensksolenergi.se/om-solenergi/solelens-klimatnytta/. Hämtad 2023-05-30.

Svenskt Vatten (2025). Metanemissioner från avloppsreningsverkens slamhantering. Tillgänglig: https://www.svensktvatten.se/forskning/forskningsprojekt/hitta-forskningsprojekt/metanemissioner-fran-avloppsreningsverkens-slamhantering/. Hämtad: 2025-04-01.

Tumlin, S., Gustavsson, D., Bernstad Saraiva Schott, A. (2014). Klimatpåverkan från avloppsreningsverk. Svenskt Vatten Utveckling, rapport nr 2014-02.

Vattenfall (2025). EPD of electricity from Vattenfall's Nordic wind farms.

Vattenfall (2021). EPD of electricity from Vattenfall's Nordic hydropower.

Vattenfall (2022). EPD of electricity from Vattenfall's Nuclear Power Plants.

Vilén, A., Laurell, P., Vahala, R. (2022). Comparative life cycle assessment of activated carbon production from various raw materials. Journal of Environmental Management 324 (2022) 116356.

Östlund, C. (2003). Förbränning av kommunalt avloppsslam. VA-forsk rapport Nr B 2003–102.

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