Water and Wastewater Companies for Climate Mitigation

WaCCliM

User Manual

Energy Performance and Carbon Emissions Assessment and Monitoring Tool - ECAM

Water and Wastewater Companies for Climate Mitigation

WaCCliM

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The Water and Wastewater Companies for Climate Mitigation (WaCCliM) project is a joint initiative between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the International Water Association (IWA). This project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) supports this initiative on the basis of a decision adopted by the German Bundestag.

On behalf of: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of the Federal Republic of Germany

Implemented by: giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH; IWA the international water association

Water and Wastewater Companies for Climate Mitigation
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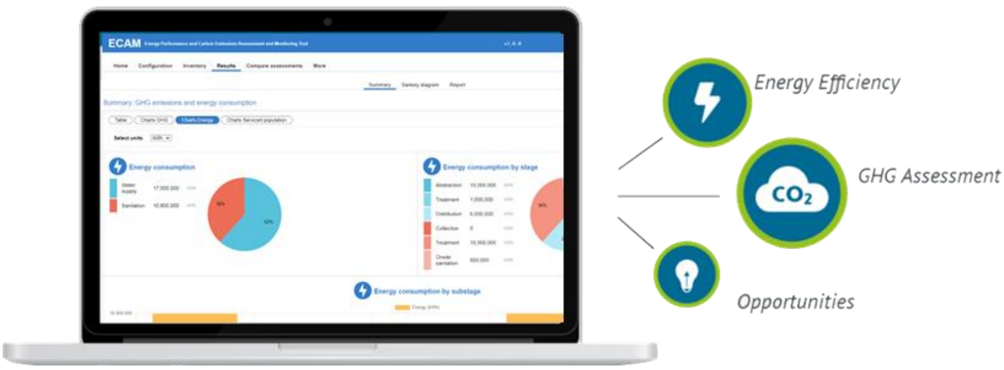
Executive summary

The **ECAM User Manual** was conceived in the context of **WaCCliM** (Water and Wastewater Companies for Climate Mitigation). WaCCliM is a global project implemented by the **Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)** GmbH in collaboration with the **International Water Association (IWA)**, which seeks to contribute to a low-carbon and climate-resilient water and sanitation sector. In this sense, WaCCliM developed the ECAM tool (Energy Performance and Carbon Emissions Assessment and Monitoring) to monitor greenhouse gases (GHG) emissions and their reduction achieved through the implementation of mitigation measures.

The **User Manual** was developed as an instrument to support the use of the **ECAM tool** (Energy Performance and Carbon Emissions Assessment and Monitoring). It can help users to estimate greenhouse gases (GHG) emissions from the **Urban Water Sector** activities. This document is intended to be practical, accessible and "straight to the point". To understand the conceptual framework of the ECAM tool, the user can consult the additional document "Methodology Guide".

The document is **organized into topics and sections covering** features and benefits of the tool; contextualization about the methodology; step-by-step instructions on how to use the main functions, including how to fill in data and generate results; case scenario examples and exercises; and a troubleshooting section.

The **ECAM tool** assists water utilities in using their own data to transform it into a source of valuable information on energy performance and GHG emissions. ECAM is the first of its kind to allow for a holistic approach of the urban water cycle to drive GHG emission reduction in water utilities, even those with limited data availability. It promotes transparency, accuracy, completeness, comparability, and consistency. It is designed to assess the carbon emissions that utilities can control within the urban water cycle and prepares utilities for future reporting needs on climate mitigation.



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Abbreviations

BMUV	German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
BOD	Biochemical Oxygen Demand
CC	Climate Change
CH_4	Methane
CO_2	Carbon Dioxide
CO_{2}-eq	Carbon Dioxide Equivalent
COD	Chemical Oxygen Demand
ECAM	Energy Performance and Carbon Emissions Assessment and Monitoring
EF	Emission Factor
EIB	European Investment Bank
GHG	Greenhouse Gas
GWP	Global Warming Potential
ICRA	Institut Català de Recerca de l'Aigua
IFI	International Financial Institutions
IKI	International Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
N	Nitrogen
N_2O	Nitrous Oxide
TN	Total Nitrogen
UNFCCC	United Nations Framework Convention on Climate Change
WaCCliM	Water and Wastewater Companies for Climate Mitigation
WWTP	Wastewater Treatment Plant
WTP	Water Treatment Plant

Glossary

Activated sludge	Flocs of sludge particles containing living microbes, mainly bacteria and protozoans, which are formed in the presence of oxygen in aeration tanks.
Activity data	Data on the magnitude of a human activity resulting in emissions or removals taking place during a given period. Data on energy use, metal production, land areas, management systems, lime and fertilizer use and waste arisings are examples of activity data.
Aerobic	Conditions with free oxygen in the wastewater.
Anaerobic	Conditions in which oxygen is not readily available. These conditions are important to produce methane emissions. Whenever organic material decomposes in anaerobic conditions methane is likely to be formed.
Assessment	Type of diagnosis that allows a utility to create an inventory over its activities within a period, of all its greenhouse gas emissions broken down by emission items
Base year	The starting year for the inventory.
Benchmark	Objective comparison of utilities or facilities.
Carbon footprint	A carbon footprint is the total greenhouse gas emissions caused by an individual, event, organization, service, or product, expressed as carbon dioxide equivalent.
Census	Data collected by interrogation or count of an entire population.
Chemical oxygen demand (COD)	An indication of the amount of organic matter in wastewater. It refers to the amount of oxygen equivalent consumed in the chemical oxidation of organic matter by strong oxidants such as potassium dichromate.
Code	In ECAM, a code is a name associated with a variable, which is used by the tool's algorithm for calculations. Example: "wwt_serv_pop" is the code for Serviced Population with wastewater treatment
Country-specific data	Data for either activities or emissions that are based on research carried out on sites either in that country or otherwise representative of that country.
Direct emission	Emissions originated from sources owned (or controlled) by the utilities. Some examples are CO_2 emissions from in-situ engines and CH_4 and N_2O emissions from wastewater treatment plants.
Dropdown menus	Selectable list in ECAM, based on a reference table.
Emission Factor	A coefficient that quantifies the emissions or removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions.

Glossary

Estimates	Input activity data that can be estimated by the tool or filled in by the user. The estimations are based in user input data.
Fossil carbon	Carbon derived from fossil fuel or other fossil source.
Fuel	Any substance burned as a source of energy such as heat or electricity.
Fuel combustion	Within ECAM, it is the intentional oxidation of materials within an apparatus that is designed to provide heat or mechanical work to a process, or for use away from the apparatus.
Global Warming Potential (GWP)	Global Warming Potentials (GWP) are calculated as the ratio of the radiative forcing of one kilogramme greenhouse gas emitted to the atmosphere to that from one kilogramme CO_2 over a period (e.g., 100 years).
Greenhouse gas	Gas that absorbs and emits radiant energy within the thermal infrared range and contributes to the global warming effect.
Indirect emission	Emissions derived from the acquisition of electrical or thermal energy, consumed by the utility. It also includes emissions that the utility considers that are not part of its operations, such as CH_4 emissions from wastewater generated by the population not connected to the sewer system.
Input	It includes both the activity data that must be added by the user and the estimates calculated by the software (or calculated by the user). It also includes data chosen from dropdown menus.
Inventory	List of emission sources and the associated emissions quantified using standardized methods.
Organic matter	Organic waste of plant or animal origin from homes or industry, or originated from storm water run-offs, and so on., which mainly contains volatile fraction of solids.
Output	Results of calculations performed by ECAM for GHG emissions and for Energy performance and Service Level indicators.
Output variable	Variable belonging to the outputs Section of ECAM.
Scope	The choice that the utility should do regarding the boundaries of its GHG assessment. It may include defining which emissions will be considered, or which stages will be accounted for.
Stage	Refers to "Water Abstraction", "Water Treatment", "Water Distribution", "Wastewater Collection", "Wastewater Treatment", and "Onsite Sanitation".
Substage	Refers to the facilities that are to be evaluated in each of the stages. Example: Pumping station number 1; or WWTP number 3.

Glossary

System	Refers to Water Supply and Sanitation.
Tier (Level of information)	A tier represents a level of methodological complexity. Usually, three tiers are provided. Tier 1 is the basic method, Tier 2 intermediate and Tier 3 most demanding in terms of complexity and data requirements. Tiers 2 and 3 are sometimes referred to as higher tier methods and are generally considered to be more accurate.
Uncertainty	Lack of knowledge of the true value of a variable that can be described as a probability density function characterizing the range and likelihood of possible values. Uncertainty depends on the analyst's state of knowledge, which in turn depends on the quality and quantity of applicable data as well as knowledge of underlying processes and inference methods.
Variable	Field name of an element used for ECAM calculations, whether in the Input section or output section. Example: "Serviced population with wastewater treatment.
Wastewater	The used water including solids discharged from communities, businesses, industry, or agriculture that flows into a wastewater treatment plant. Storm water, surface water, and groundwater infiltration also may be included.
Urban Water Cycle	It covers the engineered systems that provide essential and safe drinking water and ensure wastewater and sewage removal. In ECAM, those are the "Water Supply" and "Sanitation" systems, which are composed of six stages: "Water Abstraction", "Water Treatment", "Water Distribution", "Wastewater Collection", "Wastewater Treatment", and "Onsite Sanitation".
Urban Water Sector	Refers to utilities, facilities, and urban water activities.
Urban Water Services	Refers to activities provided by urban water utilities.
Urban Water System	Systems designed to meet human demands related to Water Supply and Sanitation.
Urban Water Utilities	Refers to the institutions (public or private) responsible for carrying out the urban water services of a municipality or state.

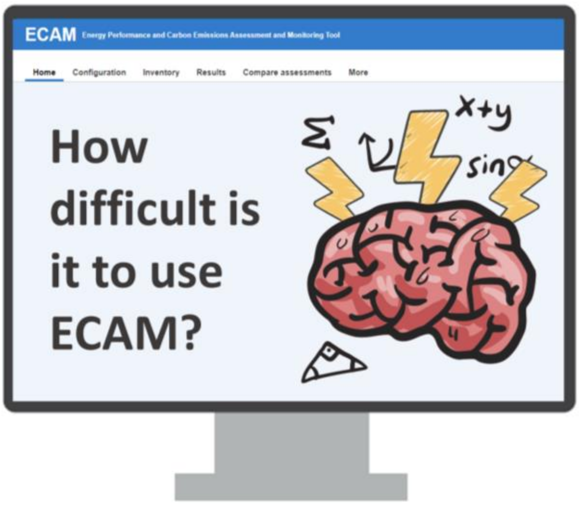
Note: This glossary describes the terms as they are used in this manual and ECAM.

ENERGY PERFORMANCE AND CARBON EMISSIONS ASSESSMENT AND MONITORING TOOL

ECAM may seem like a difficult tool to use**, but it is not.**

All equations and formulas are already loaded into the tool, which is programmed to calculate emissions without requiring you to pick up your calculator.

You, as a user, will need to give some inputs for these calculations to take place. You can fill in the activity data available for your utility. For several cases, the ECAM tool suggests estimates based on the Intergovernmental Panel on Climate Change (IPCC), on databases, and on reference literature[1].



Source: images adapted from Flaticon.com

The choice is yours:

- ECAM is a flexible tool that can work with detailed and high-quality data as well as estimations and minimal data to provide relevant outputs to users.
- ECAM performs an automated calculation of Greenhouse Gas (GHG) emissions in urban water and wastewater utilities, integrating the various stages of the water cycle.
- ECAM provides estimations based on literature references or calculations from databases.

[1] The ECAM User Manual does not address the sources behind the emission calculation process, nor the estimates that can be made. These sources can be consulted in the supporting document **"Methodology Guide"**.

Introduction

About the ECAM Tool

The Energy Performance and Carbon Emissions Assessment and Monitoring Tool (ECAM) is the first Greenhouse gases (GHG) emissions calculation tool focused on the urban water sector, which was developed to promote the reduction of GHG emissions in urban water utilities, designed for utilities with both high-quality data and limited data availability. The advantage over the isolated use of empirical formulas is the possibility of evaluating different systems in parallel, in addition to involving more variables in the calculations, increasing their precision, and facilitating the handling of emissions information by the urban water utilities.

The tool was developed within the framework of the Water and Wastewater Companies for Climate Mitigation - WaCCliM project, which is a joint initiative between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the International Water Association (IWA). WaCCliM is commissioned by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) in framework of the International Climate Initiative (IKI).

It has the purpose of evaluating and monitoring GHG emissions from water and sanitation utilities. ECAM is available online, open source and free to use. Together with IWA and GIZ, the web interface and features were developed by the Institut Català de Recerca de l'Aigua (ICRA). The tool was first developed for WaCCliM project in 2015 as a spreadsheet tool by the consortium Urban Water Commons (LNEC and ITA, Universitat Politècnica de València) in collaboration with Cobalt Water Global. The spreadsheet tool laid the foundation and basic equations for the web-tool.

To cover all utilities, including those that have limited data on their processes, the tool proposes default values based on the literature, which can be modified by the user to better illustrate local conditions. ECAM also allows to incorporate more data as the utility´s data management capacity grows. Methodologically, ECAM is based on the *Intergovernmental Panel on Climate Change* (*IPCC) Guidelines for National Greenhouse Gas Inventories,* including their 2019 refinement (IPCC, 2019).

Based on the GHG estimations generated by the tool, the utility can identify areas with GHG reduction potential and operating expenses, also strengthening performance monitoring and decision-making.

The tool's functionalities include:

- GHG emissions assessment
- Energy performance assessment
- Identification of opportunities for reducing GHG emissions and reducing energy consumption
- Developing scenarios when investigating possible measures to improve performance
- Monitoring the results after the implementation of improvement measures

In terms of data security and privacy, no information is stored in fixed memory on the users' server, but available as a downloadable file containing the assessment. Therefore, all data entered is processed locally and stored solely on the user's computer.

As first of its kind, ECAM follows a holistic approach to the urban water cycle, as it is designed to calculate GHG emissions at all stages of the cycle, enabling integrated comparisons and assessments. By this means, the user can create assessments accounting only some stages of a system, the complete system, or even all the systems of a utility.

It is also possible to include energy performance and service level analyses calculated by the tool, such as: topographic energy use; electromechanical efficiency; sludge management; treatment performance; biogas production; and more.

What ECAM can do:

ECAM can calculate the GHG emissions of urban water and wastewater utilities at each stage of drinking water supply and sanitation systems.

ECAM can evaluate energy performance and service level indicators.

What ECAM can be used for:

ECAM can be used to report and monitor GHG emissions. It allows users to compare the greenhouse gas emissions of a utility over time and with those of other utilities.

ECAM can be used to develop scenarios on the impact of GHG mitigation measures. It allows users to identify opportunities for action and facilitates decision making.

So, what are the **BENEFITS** of using ECAM?

ECAM is a first step towards a climate-smart urban water management. It provides a starting point for reducing greenhouse gas emissions and running a more efficient water facility.

About the User Manual

The **User Manual** has the aim of helping users to calculate emissions, present results, evaluate scenarios, and compare assessments using the ECAM tool. The target group for this document is composed by technicians, consultants, climate change professionals, academics, policy makers, and other general users who seek to calculate GHG emissions for the Urban Water sector.

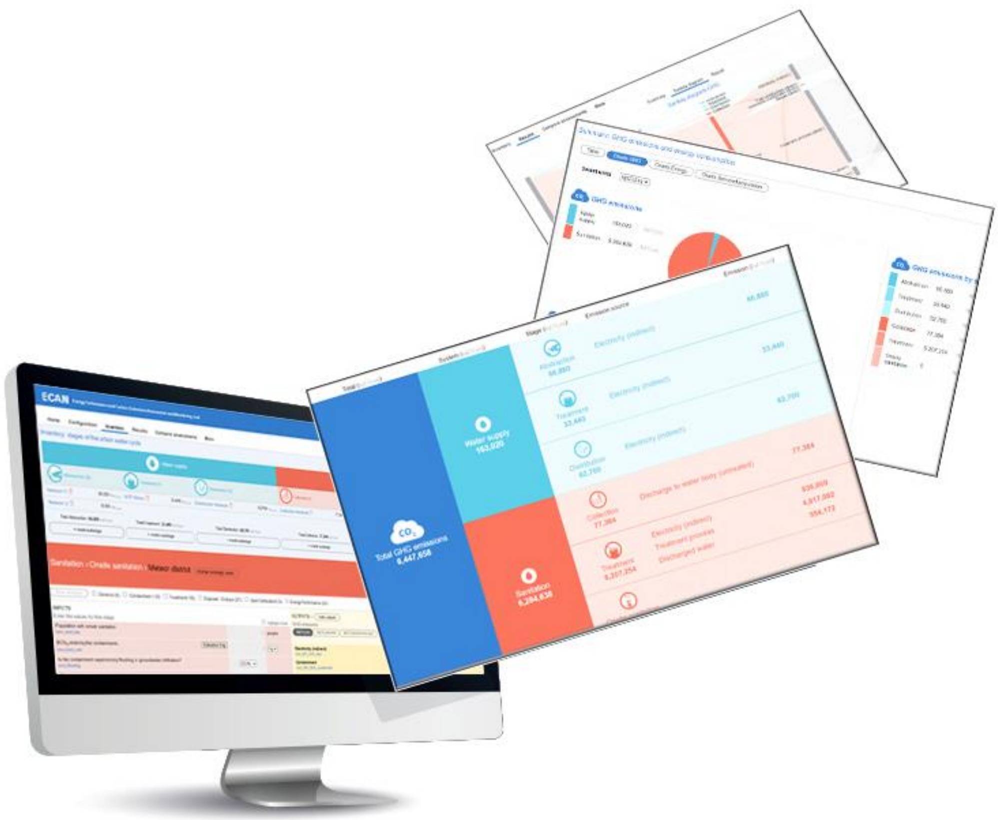
In this manual, the user will learn how to use the tool's functions through step-by-step instructions and with the help of screenshots and practical examples and exercises, which will strengthen the learning process. In topic "**Section 4: Key points when entering data in ECAM**" some key aspects will be explored when filling in the ECAM data, so check it if you have doubts about specific procedures.

In addition to describing the steps to use the tool, this document also includes a basic background that provides context to the user on the topic of GHG emissions in the urban water sector. This approach is quite brief, but it can be consulted in more detail in another support document for ECAM: the **Methodology Guide**.

Getting started as a new user

As a new user there are a few things you should **know and do** that will make your ECAM experience more effective:

- We encourage you to use spreadsheets to manage your input data. Input errors are easily made by users and will lead to incorrect results!
- Measurement units make all the difference. Use the correct unit. If necessary, it is possible to convert the units with the ECAM itself.
- If needed, there are other training materials that can enhance your ECAM experience.
- ECAM is available in both English and Spanish. Select the most convenient language for your use. Do not use automatic translation in your browser, as this may generate incorrect terms.
- Emission and country specific factors are under constant discussion and research, which means they can potentially change in the future. In this sense, when performing the exercises in this manual, chross-check the factors and, if necessary, change them before comparing the results.



Background

How are climate change and the urban water sector related?

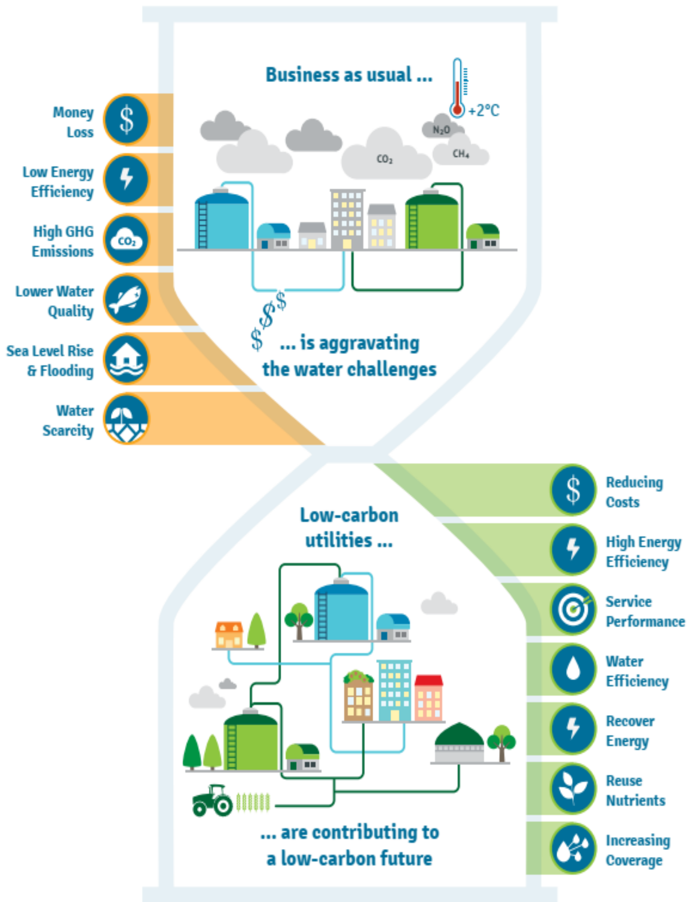
The impacts caused by climate change should be considered during design, construction, operation, and maintenance of the urban water sector infrastructure. These **impacts include**:

- Increased variability and uncertainty in hydrological cycles.
- Prolonged droughts and frequent flooding.
- Extreme hydrometeorological phenomena.
- Sea level rise.
- Increased evaporation and decreased precipitation rates accompanied by higher water extraction rates.

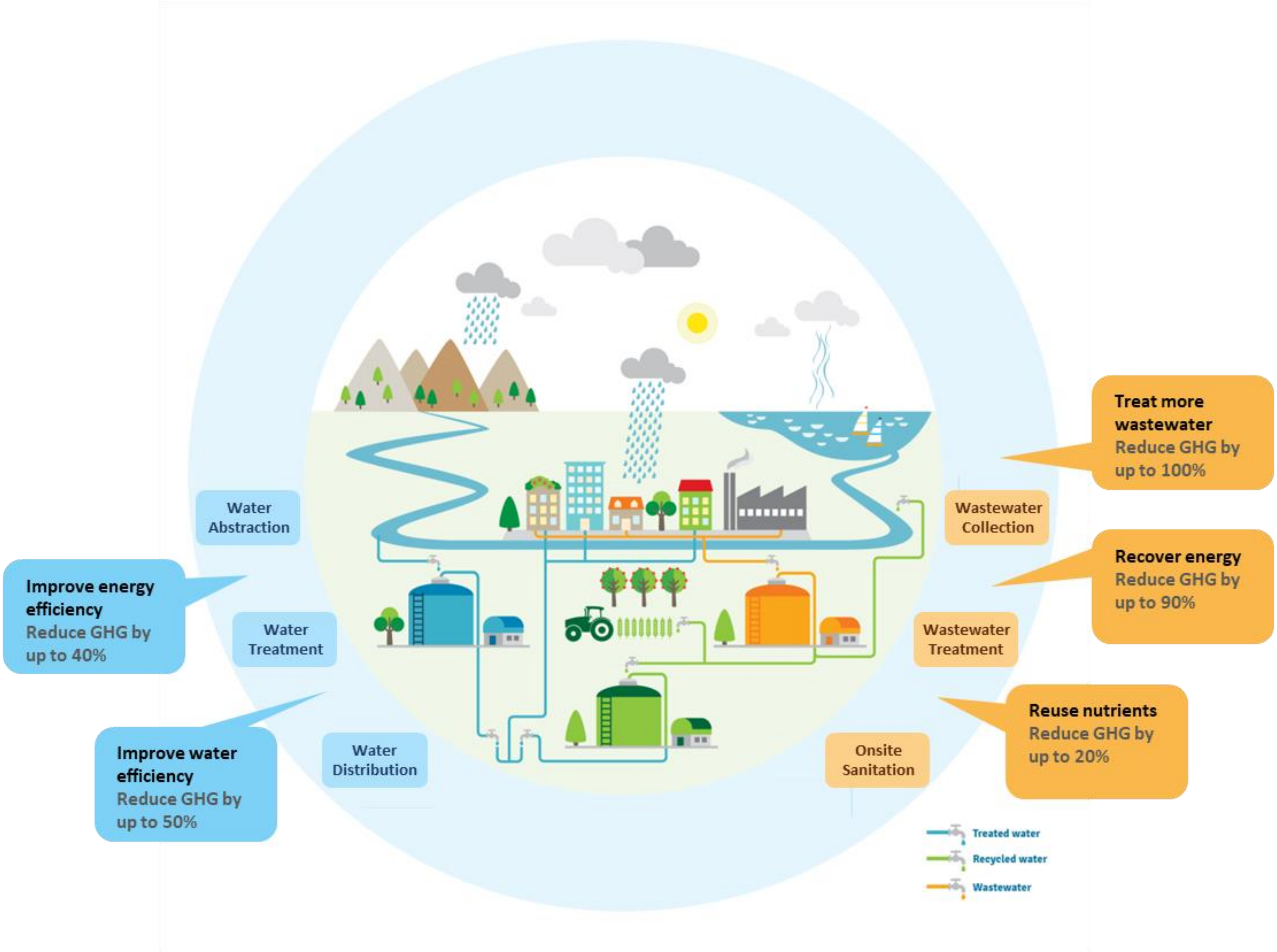
Along with pollution, the effects of climate change fall on the availability and quality of water sources for human consumption. In this sense, urban water utilities face increasing treatment requirements, while having to deal with structural damage caused by extreme weather.

From another perspective, the operation of urban water systems contributes to the generation of greenhouse gases (GHG) emissions, either directly or indirectly. These gases are the main drivers of climate change, which increases the occurrence of extreme events and hinders the availability of natural resources. Therefore, **the relationship between climate change and urban water utilities is cyclical and mutually impacting**.

In this context, business as-usual is no longer a viable option: utilities are challenged to adapt to impacts of climate change but also to champion the transition to a carbon-neutral future, to avoid compounding their challenges.



There is therefore a great opportunity to promote better planning of the urban water services. This also means creating mitigation strategies for GHG emissions within the operation of facilities, ensuring the sustainability of the services and benefiting human life.



- The urban water sector contributes **directly** and **indirectly** to the generation of GHG.
- GHG are the main drivers of climate change, which **increase the occurrence of extreme events** and **reduces the availability of resources**.
- The **greater occurrence** of extreme events and issues related to the resources **impact the urban water sector**.

Which methodology does ECAM use to account for GHG emissions?

The ECAM tool was developed to be consistent with the **Intergovernmental Panel on Climate Change (IPCC)** Guidelines for National Greenhouse Gas Inventories, including the IPCC 2019 refinement and peer-reviewed literature. The 2019 Refinement (IPCC, 2019) does not replace the original 2006 IPCC Guidelines (IPCC, 2006), but updates, supplements and elaborates it where gaps have been identified.

The IPCC Guidelines for National Greenhouse Gas Inventories have been used as the main reference for equations used to calculate the GHG emission from the different stages of the urban water cycle. In most cases the equations from the IPCC guidelines have been used directly, but in some cases alternate resources have been applied.

When actual data from the utility are not available, default values are set to calculate the GHG emissions. If in the assessment process real data are available, the user can change the default values and, in this way, increment the accuracy of the evaluation.

To consult more details about the conceptual framework of the ECAM tool, as well as the sources and equations used, we suggest accessing the **Methodology Guide** document.

Which greenhouse gases are generated in urban water services?

The three main GHGs emitted from urban water services are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Carbon Dioxide (CO_2)

Carbon dioxide is mainly associated with the burning of fossil fuels in stationary and mobile combustion engines. In the urban water sector, it is also the main GHG associated with the consumption of electrical energy from the grid. In many cases, the energy consumed is obtained from a traditional fossil fuel source, such as coal, oil or natural gas, and energy production from these sources generates carbon dioxide emissions. Water and Sanitation utilities encompass high energy-intensive processes, which makes this a significant emission to be considered.

Carbon dioxide can also be emitted from biogenic sources, i.e., emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvesting, digestion, fermentation, decomposition, or processing of bio-based materials. These emissions are not considered in the ECAM tool, and further discussion is given in the document **Methodology Guide**.

Methane (CH_4)

Methane is a gas generated by methanogenesis of organic matter under anaerobic conditions. These conditions can be present in wastewater and sludge. The amount of this gas generated is related to the amount of organic matter and the temperature.

Methane emissions from wastewater treatment can make up a significant portion of a Wastewater Treatment Plant (WWTP) carbon footprint. It also escapes from digested sludge storage facilities.

Methane could also be generated in flowing closed sewers, which is not considered in the ECAM tool. Further discussion is given in the document **Methodology Guide**.

Nitrous oxide (N_2O)

Nitrous oxide, on the other hand, is a GHG associated with the degradation of nitrogenous compounds present in wastewater, such as urea, nitrate, and proteins. Its production is associated with nitrification and denitrification processes. Both processes can occur in a WWTP and in the water body into which the treated and untreated wastewater is discharged.

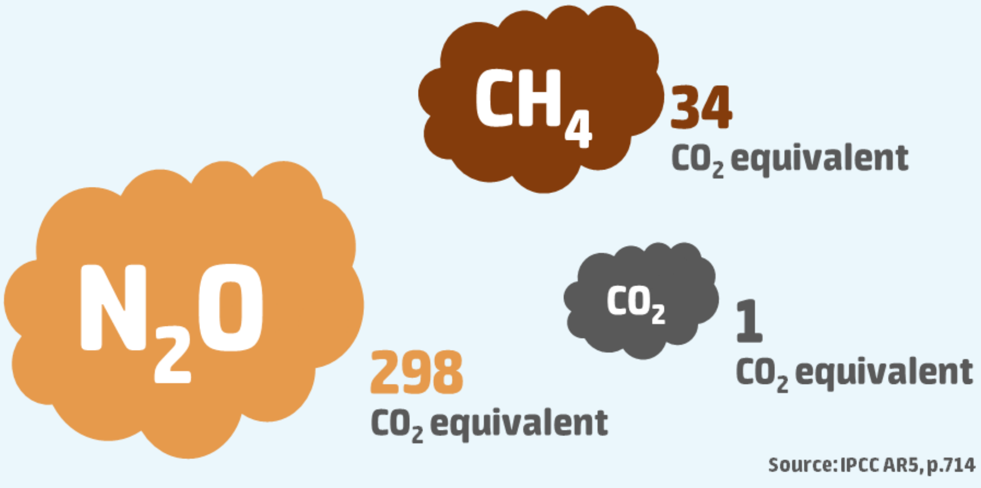
In WWTP, the highest production of nitrous oxide is generally associated with aeration processes, but it also occurs in other units, such as sludge recirculation, digester sludge, pre-treatment, effluent, and secondary clarifiers.

The generation of N_2O is a very complex process to properly estimate/quantify emissions. In the past, the UNFCCC did not consider WWTPs as relevant sources and further research is still being conducted to properly determine oxide nitrous emissions in wastewater treatment plants. Further discussion is given in the document **Methodology Guide**.

Different gases, different Global Warming Potential (GWP):

The reporting unit of emissions results is expressed as the mass (tons, gigagrams, megatons) of the emitted gas, converted to its CO_2 equivalent, that is, expressed in CO_2 equivalent (**CO_{2eq}**).

This conversion is based on the Global Warming Potential (GWP) of the specific gas. The ECAM tool does this conversion automatically.



Attention: some gases have very high GWP, for example the N_2O, and therefore small amounts of their emission are equivalent to large amounts of CO_{2eq}.

Which terms should I know before using the tool?

There are some essential terms that need to be known for the user to understand this manual and the basic functions of the ECAM tool. For additional terms, see the "**Glossary**" topic at the beginning of this document.

Activity data	The activity data is information that can be related to the magnitude of a human activity resulting in emissions or removals taking place during a given period. Some examples include population; energy consumption from the grid; fuel consumption; BOD load; etc.
Benchmark	Objective comparison of utilities or facilities.
Code	In ECAM, a code is a name associated with a variable, which is used by the tool's algorithm for calculations. Example: "wwt_serv_pop" is the code for Serviced Population with wastewater treatment.
Direct emissions	Emissions originated from sources owned (or controlled) by the utilities. Some examples are CO_2 emissions from in-situ engines and CH_4 and N_2O emissions from wastewater treatment plants.
Dropdown menu	Selectable list in ECAM, based on a reference table.
Emission Factors	A coefficient that quantifies the emissions or removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions.
Indirect emissions	Emissions derived from the acquisition of electrical or thermal energy, consumed by the utility. It also includes emissions that the utility considers that are not part of its operations, such as CH_4 emissions from wastewater generated by the population not connected to the sewer system.
Inputs	It includes both the activity data that must be added by the user and the estimates calculated by the software (or calculated by the user). It also includes data chosen from dropdown menus.
Inventory	List of emission sources and the associated emissions quantified using standardized methods.
Outputs	Results of calculations performed by ECAM for GHG emissions and for Energy performance and Service Level indicators.
Stages	It refers to “Water Abstraction”, “Water treatment”, “Water Distribution", “Wastewater Collection”, “Wastewater Treatment”, and “Onsite Sanitation”.
Substages	It refers to the facilities that are to be evaluated in each of the stages. It may be necessary to adapt them according to what you want to evaluate. For example: if the user needs to calculate the GHG emissions of a water pumping facility in the “Abstraction” stage, the substage will be the water pumping facility; if the user wants to evaluate the individual efficiency of the pumps in this system, each equipment must be a substage.
Systems	It refers to “Water Supply” and “Sanitation”.
Variable	Field name of an element used for ECAM calculations, whether in the Input section or Output section. Example: Serviced Population with wastewater treatment.

Which emissions can I calculate with ECAM?

Table 1 – List of emissions that can be calculated with ECAM, categorized according to the ECAM standard names for the urban water cycle stages.

	Water supply			Sanitation		
Emissions calculated by ECAM[2]	**Abstraction**	**Treatment**	**Distribution**	**Collection**	**Treatment[3]**	**Onsite Sanitation**
Direct emissions						
CO_2, CH_4, and N_2O from onsite engine stationary fossil fuel combustion.	●	●	●	●	●	●
CH_4 from sewers or biological wastewater treatment.				●	●	
N_2O from sewers or biological wastewater treatment.				●	●	
CH_4 and N_2O from collected wastewater discharge without treatment.				●		
CH_4 and N_2O from collected treated wastewater discharge.					●	●
CH_4 and N_2O from sludge digestion.					●	●
CH_4 from faecal sludge containment.						●
CH_4 and N_2O from faecal sludge treatment.						●
N_2O from open defecation.						●
Indirect emissions						
CO_2 from grid electricity usage.	●	●	●	●	●	●
CO_2, CH_4, and N_2O from the combustion of fossil fuels in vehicles.			●		●[4]	●
CH_4 and N_2O from sludge and faecal sludge management.[5]					●	●

[2] Further specifications on these emissions and a list of emissions that CANNOT be calculated by ECAM can be checked in the **Methodology Guide**.
[3] In ECAM, it includes emission from wastewater treatment and discharge.
[4] It includes emissions from sludge transport, but which are accounted in "sludge management"; and emissions from truck transport of reused water.
[5] In the case of wastewater treatment, it includes storage at WWTP (direct emission), transportation, and off-site final disposal. In the case of on-site sanitation, it includes transportation and final disposal.

Using ECAM

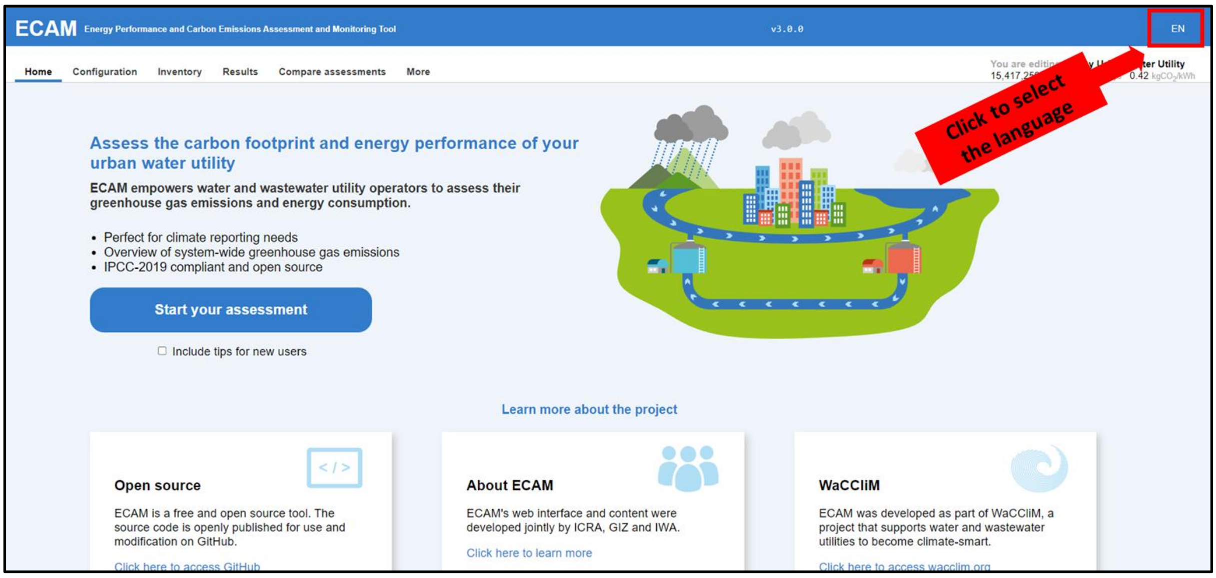
This topic presents the ECAM's features and how to use each one. The subtopics are divided according to the structure of the ECAM tool.

Section 1: Configuration

Select the language

The first thing you will probably feel the need to do is to select your preferred language.

ECAM currently has two language versions: **English** and **Spanish**. Click on the indicated location to select the language.

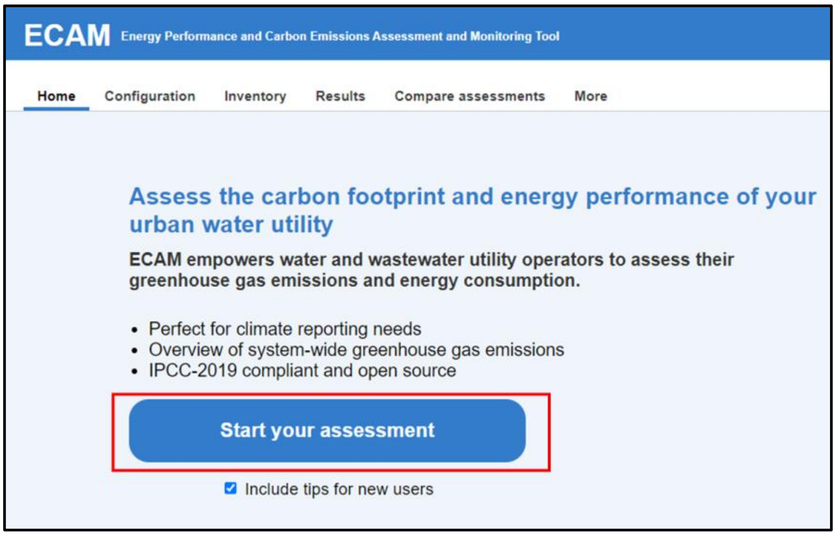


Attention: The use of automatic translation tools associated with the internet browser is strongly contraindicated, as it may lead to the use of incorrect terms.

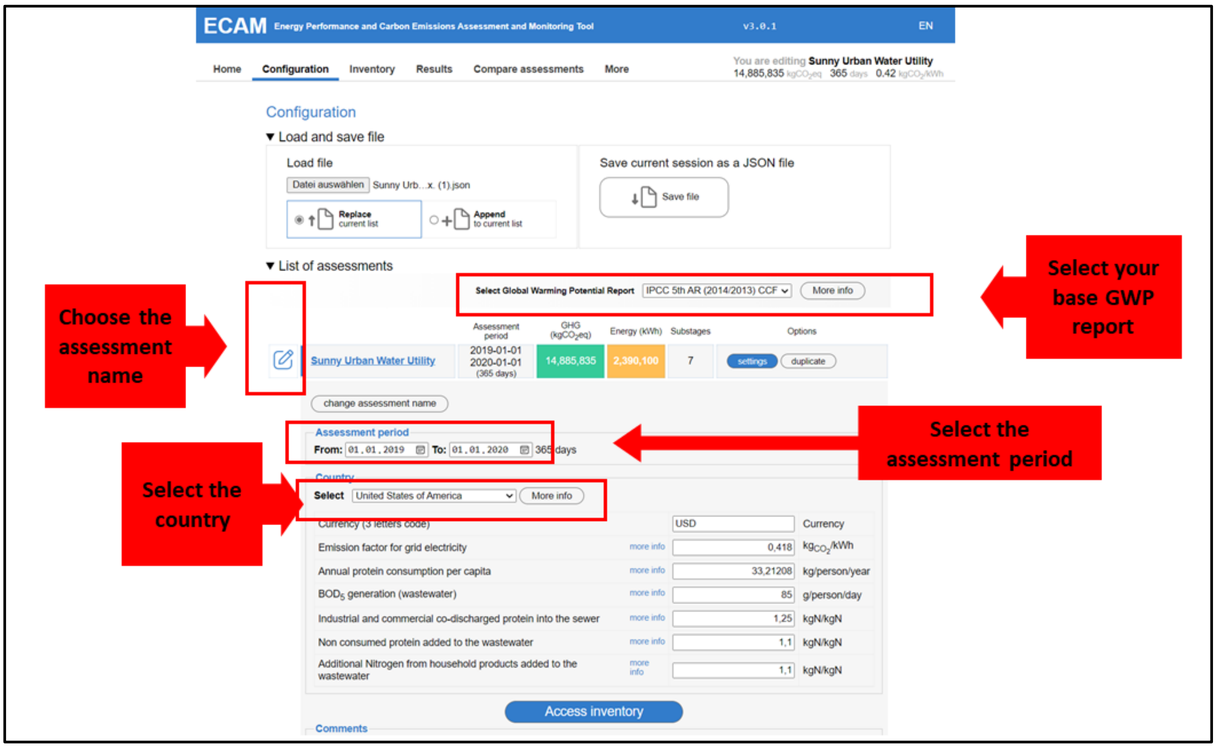
How to start and configure a new assessment

Setting the main functions

Click on the "**Home**" tab and access the "**Start your assessment**" option.



This will lead you to the **Configuration tab**, where the user can choose the Global Warming Report, and select country, evaluation period, file name, and currency.



Each of these functions should be chosen with care, since they will influence the entire assessment performed by the ECAM tool. However, the inputs can be also adapted subsequently. In the Configuration tab it is also possible to add comments for the assessment.

Reference GWP Report

Global Warming Potential (GWP) is the ratio of how many times a specific gas emitted is more potent than carbon dioxide (CO_2) in the ability to generate global warming. It is expressed as units of "CO_2 equivalent (**CO_{2eq}**)" (see also page 9).

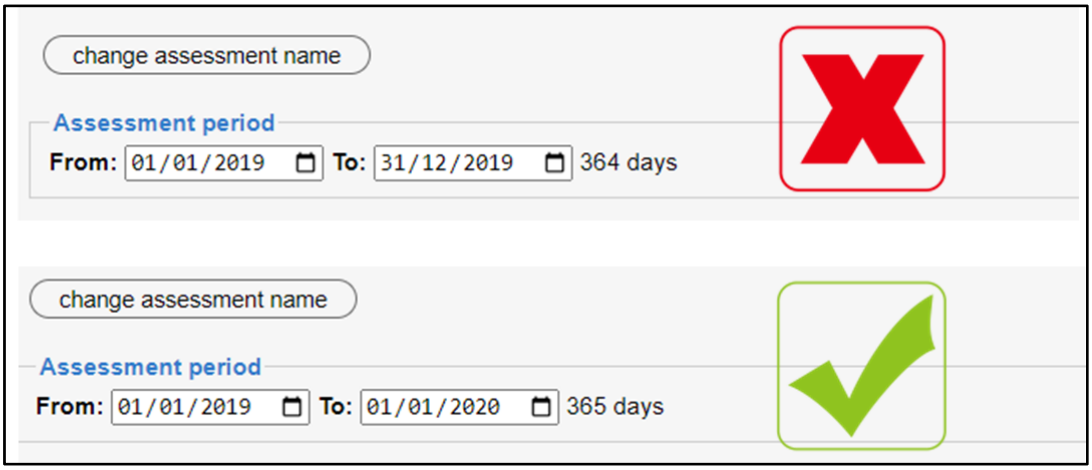
You must select the IPCC GWP Report that you want to use as a reference to convert your CH_4 and N_2O emissions to equivalent CO_2 emissions. **It is suggested to always use the most recent report**. But you may need to use an older version for comparison purposes, or as required by your institution.

Assessment name

You can select a name for your assessment. It is important that this name represents the scope of your analysis/inventory so that it is easier to use in future comparisons. For example, to differentiate two assessments of the same wastewater treatment plant, but with different technology solutions, you may want to add an additional identification in the title: "WWTP Central (activated sludge)" and "WWTP Central (UASB)".

Assessment period

The ECAM tool calculates the number of days from the start date to one day before the selected end date. In this sense, to consider a full complete year, the user must **select January 1st of the corresponding year as the start date**, and **January 1st of the following year as the end date**. The tool will also calculate for leap years.



The assessment period must be selected by the user based on the data that will be input into the tool. In this sense, all data will be associated with this period. For example: the user selects assessment period from 01/01/2019 to 01/01/2020. When filling in the energy consumption from the grid (kWh), the user must consider a consumption referring to the corresponding Assessment Period. In other words, the consumption during the 365 days included in 2019.

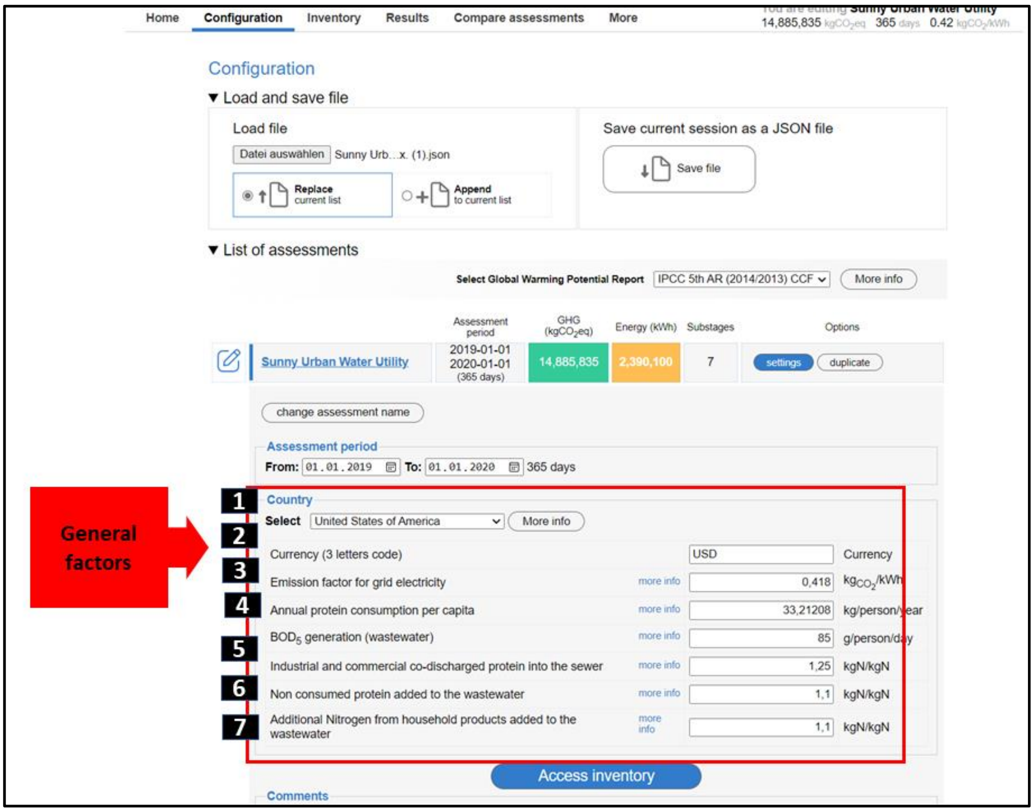
If the assessed period is less than one year, the ECAM emissions can be displayed for the chosen period or yearly. See topic "**How to show outputs**" for that.

Selection of the country

With this option you can select the country where your system is located. This selection is important since it defines the first four general factors, which will be used to **calculate emissions** and **estimate activity data** in the inventory tab.

Choosing the general factors

As stated in the previous topics, the selection of the IPCC GWP Report defines the conversions of quantified GHGs to CO_{2eq}, while the selection of the country defines the first four "General factors"[6]: (1) **currency**; (2) **emission factor for grid electricity**; (3) **annual protein consumption per capita**; and (4) **BOD_5 generation** (wastewater). The next three factors have default values adopted by the ECAM tool, they are: (5) **industrial and commercial co-discharged protein into the sewer**; (6) **non consumed protein added to the wastewater**; and (7) **additional nitrogen from household products added to the wastewater**.



Most of these[7] are all defined based on the IPCC Guidelines (2006 and 2019) and will be used for later calculations by the tool. You can keep the adopted values, or you can modify them by values of your own or from pertinent literature. In this case, expert judgement is recommended to proceed.

The following considerations regarding the exchange of these values by the user must be considered:

[6] It may be interesting for the user to modify these factors. Check the **"Methodology Guide"** document for more information.
[7] The exceptions are the **grid electricity fator** and the **annual protein concumption per capita**. Check the Methodology Guide for details on the sources of each one of them.

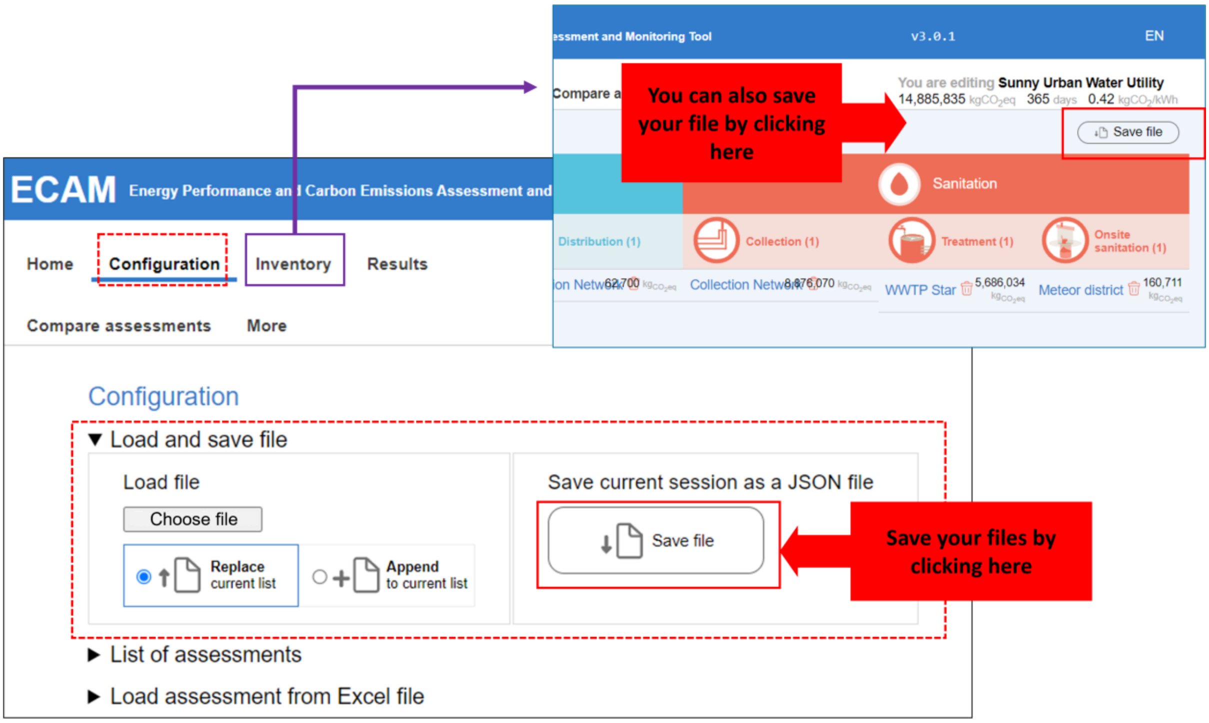
- Factor (1) refers only to the currency of the country. It is recommended for the user to modify it **only if there is apparently an error** by the tool.

- Factors (2), (3) and (4) are automatically selected by ECAM referring to tables based on the selected country. Modify these values only if you have **more updated values**, **from reliable methodology**, or **that are official in your country.** You might also check the Methodology Guide. Local factors (with a robust and reliable methodology) should be prioritized since they better represent the characteristics of the region's population.

- Factors (5), (6) and (7) are values that depend on conditions associated with each country's sanitation system. In ECAM, **the same default values are adopted for all countries**. Consult the Methodology Guide if you wish to modify them based on the IPCC. You can also use local values from a robust and reliable methodology.

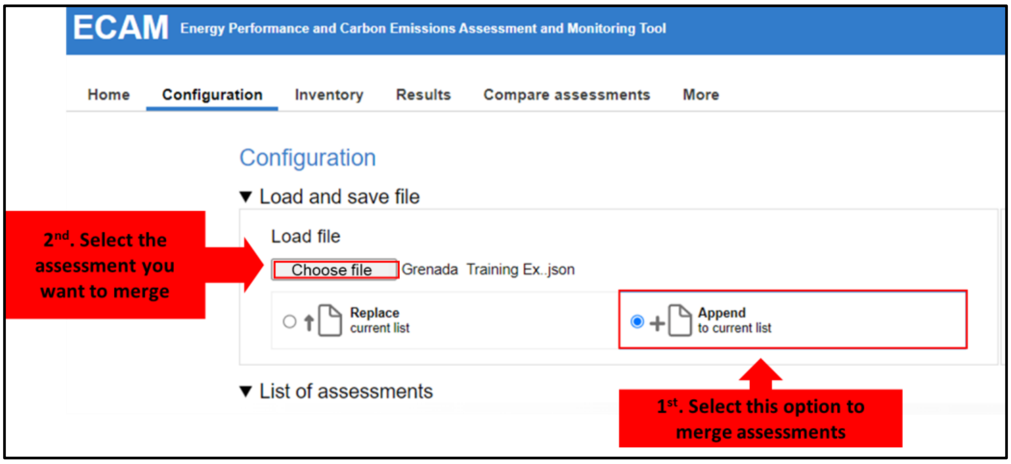
Save, Load, and Merge assessments

While in the "**Configuration**" tab, select "**load and save file**".



The files are saved with the extension JSON. The ECAM tool <u>does not store your information</u>, so if you want to <u>save your assessment</u> progress it is <u>highly recommended that you do so</u>. If you refresh the webpage, the tool will delete all data and calculations performed. You can also save the file from the Inventory Tab.

If you already have a JSON file, <u>you can load it as well</u>. You can merge multiple JSON files into one file by using the button 'Append'.



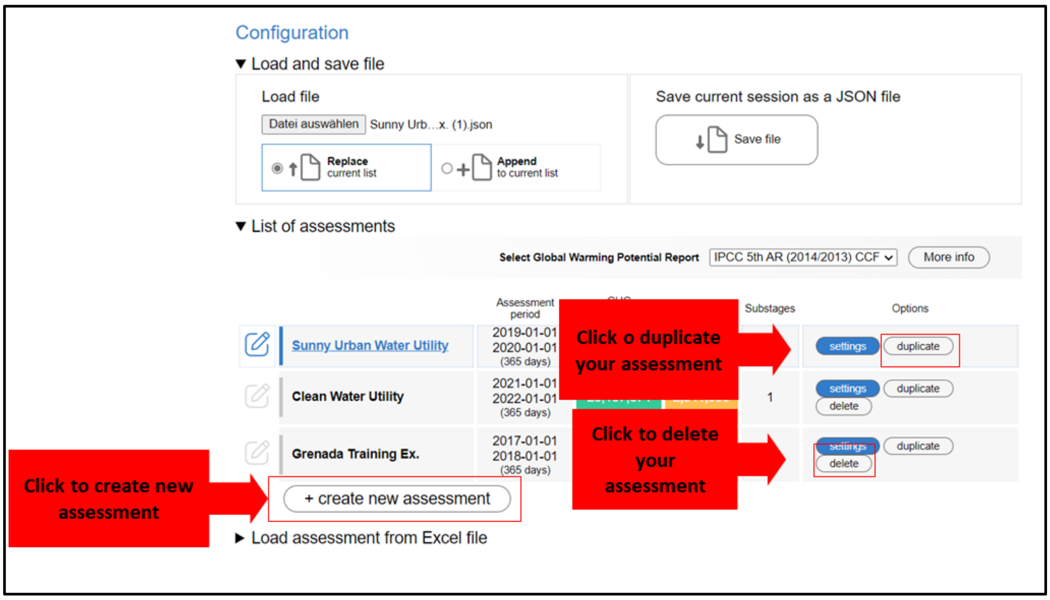
How to create multiple assessments

One of the options to start evaluating more than one assessment is by using the "Load" option as seen before. But the user may also want to <u>create more assessments</u> from scratch.

In "**List of assessments**", you can create an assessment by clicking in "+ **create new assessment**" and you can duplicate one by clicking on the button "**duplicate**".

You can use the duplicate feature if you want to create multiple assessments where most inputs remain the same, but only a few of the inputs need to the adapted. This is the case, for example, when you are evaluating a complete sanitation system and would like to change just the treatment technology for comparison. Comparing assessments is addressed in topic **Comparing assessments**.

You can delete an assessment by clicking "**delete**". Be aware that it is only possible to delete an assessment if it is not selected for editing.



You can only edit one assessment at a time. Click on the assessment that you would like to edit. It will turn blue once you have selected it. If you want to unfold country specific information, click on the assessment again or on the button 'settings'.

The process of creating new assessments can be useful in the following cases:

- **Comparing the time evolution of a system**.

- **Comparing a baseline scenario with project intervention in a same stage**. For example: the exchange of a WWTP composed of lagoons for a new activated sludge system.

- **Comparing different intervention options for the same stage**. For example: we currently send sludge to landfill, but now we would like to check if it is better to compost it or use a sludge digester.

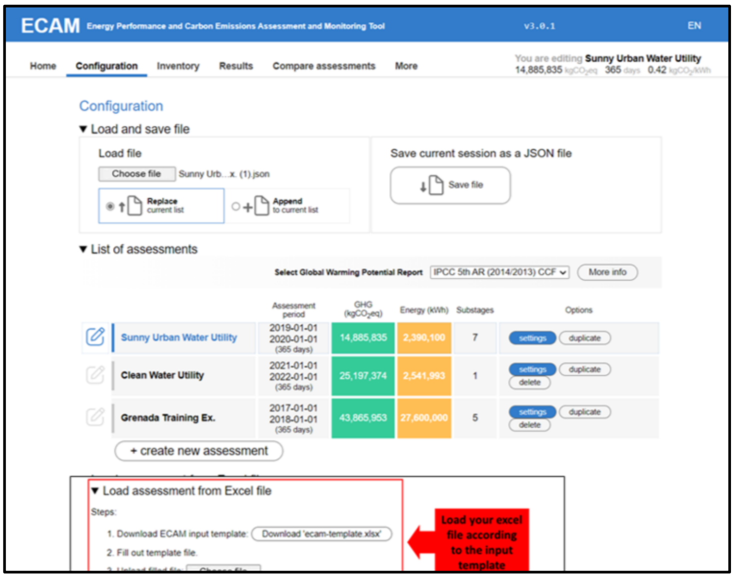
- **Comparing whole systems**. For example: a wastewater utility might want to compare the urban water system of two different cities. These systems would include sub-systems of several stages (collection + treatment + discharge).

- **Comparing solutions that involve more than one stage:** For example, the utility wants to compare the wastewater treatment of three different neighborhoods, but WWTP3 is also partially composed of on-site sanitation.

- And any other creative case the user may come up with!

How to load data from excel files

While in the Configuration tab, you can also **load an assessment in an Excel format**. You can do it by accessing the option "**Load assessment from Excel file**", and then choosing your file. Make sure you used the template provided in this space as a strict reference to allow data to be recognized.



Section 2: Inventory

Systems and stages

The "Inventory" tab is the place where the user should input data, which will be used as a basis for the tool to calculate GHG emissions and efficiency indicators.

Two types of systems can be calculated by ECAM: **Water Supply** and **Sanitation**.

For "**Water Supply**", the tool calculates emissions for the following stages of the urban water cycle: **Abstraction**; **Treatment**; and **Distribution**.

- "Water Abstraction" refers to the process of extracting water from the water source, whether surface or underground. Emissions generated at this stage are mainly calculated based on energy consumption and water abstraction volume.

- "Water Treatment" is the stage that may take place in a Water Treatment Plant (WTP), where the physical, chemical, and bacteriological characteristics are corrected, making it suitable for consumption. Emissions at this stage are calculated primarily based on the volume of treated water and energy consumption data.

- "Water Distribution" is the final stage for Water Supply, in which treated water is transported from the WTP to storage tanks or directly to the final consumer. In this stage, emissions are calculated primarily based on the volume of water injected to distribution, and energy consumption data.

For "**Sanitation**", the tool calculates emissions for the following stages of the urban water cycle: **Collection**; **Treatment**; and **Onsite Sanitation**.

- "Sanitation Collection" is the stage in which there is collection of wastewater generated by the population connected to the sewage system, which also includes wastewater that will not be treated later and will be discharged directly into water bodies. The emissions of this stage are calculated by ECAM mainly from the the loads of BOD and Nitrogen that enter the system, and the energy consumption.

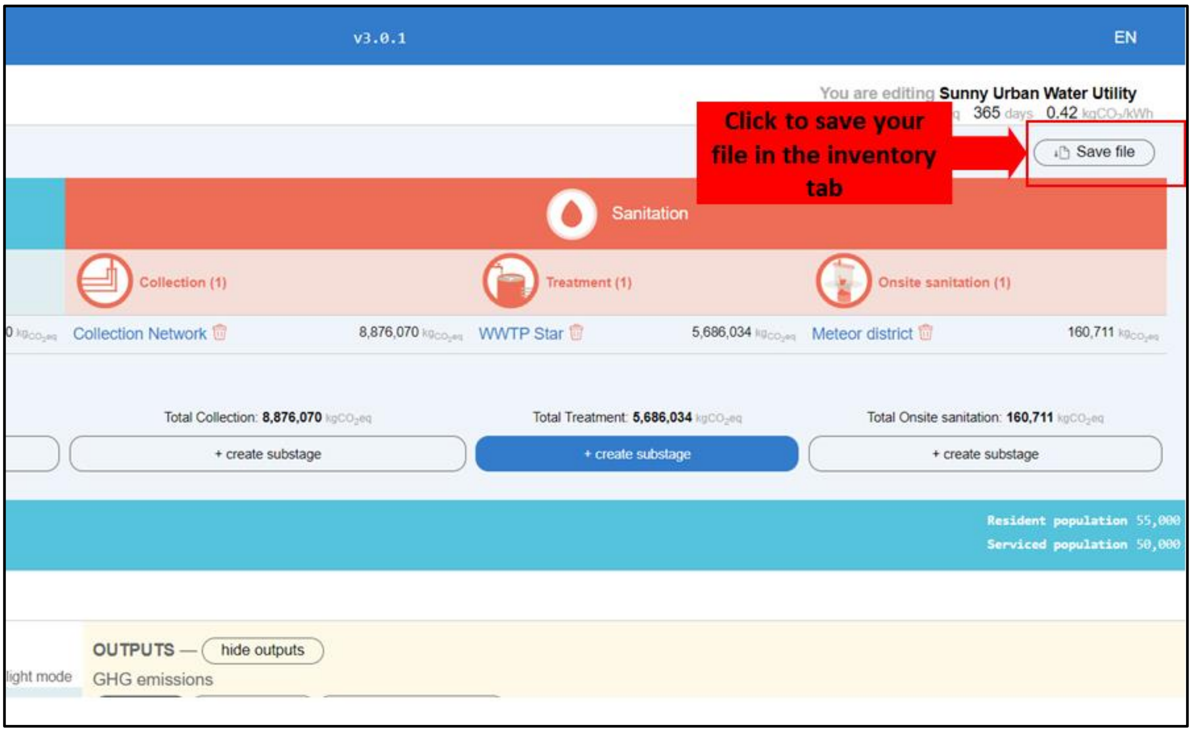
- "Sanitation Treatment" is the stage of the urban water cycle in which collected wastewater is treated at the WWTP. In ECAM, this stage also includes wastewater that is discharged into water bodies after treatment. Emissions are calculated primarily based on data about the influent and effluent BOD and Nitrogen loads, and energy consumption.

- "Onsite sanitation" refers, in the ECAM tool, to the onsite treatment of feacal sludge, ie, at this stage, emission calculations are carried out for decentralized sanitation. GHG calculations are primarily based on data about influent and effluent BOD and Nitrogen loads, and energy consumption.

How to save a file directly from the inventory

The user can also save an assessment directly from the inventory Tab.

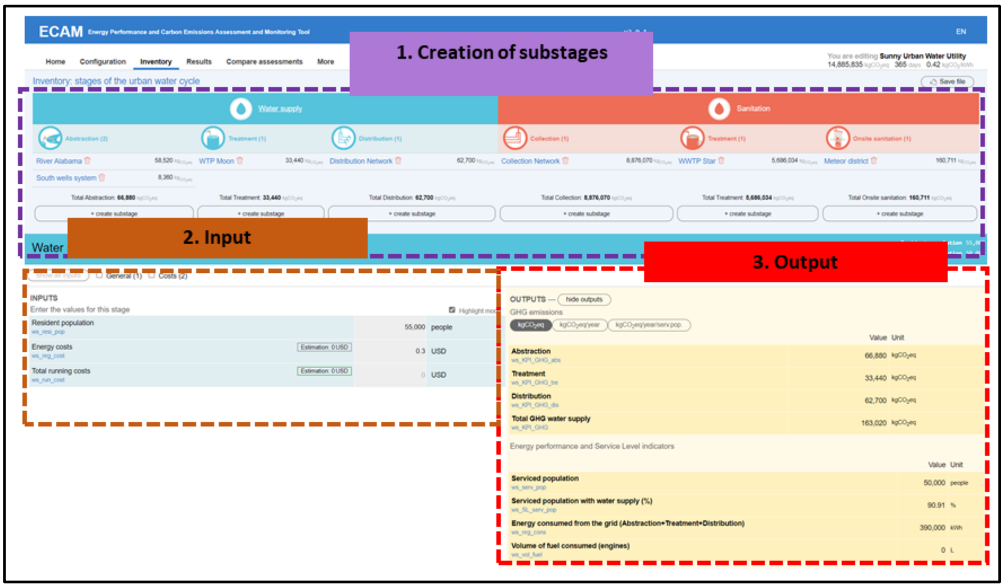
To do it, click on the "**Save File**" button in the top right corne of the tab.



Inputs

Where inputs are required

The Inventory tab has three important areas: the **first (1)** is the space for creating substages within the same assessment; the **second (2)** is the space for inputs; and the **third (3)** is the space for the outputs.



The **substages (1)** are created under each stage and represent the facilities to be evaluated. For example: if users want to calculate the emissions for two different water abstraction facilities, they should add 2 substages under "Abstraction" stage, naming them individually.

When defining substages for pumping stations:

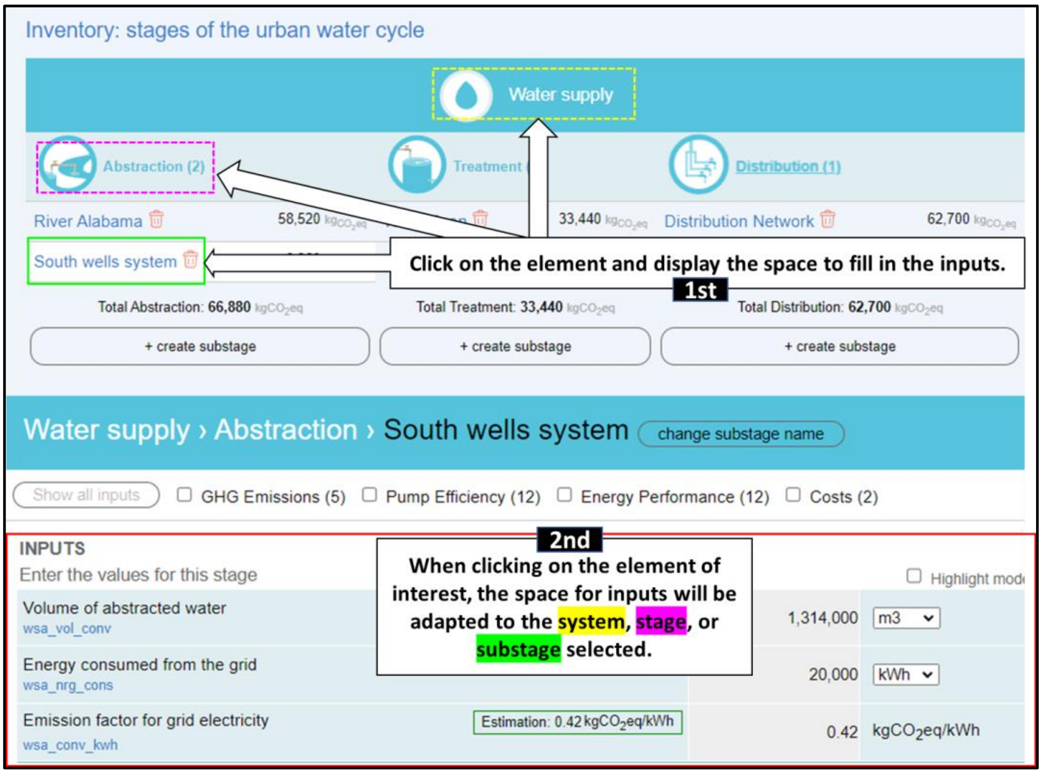
When having multiple water pumping stations or areas for the same or different water distribution systems, the best criteria to consider and define substages would be:

1. Adapt your subtages according to data available and objectives of the assessment. For example, if the objective is to analyze the electromechanical efficiency of each pump separately, substage for each pump can be created. If the objective is to calculate the total emissions for the pumping station, just add one substage.

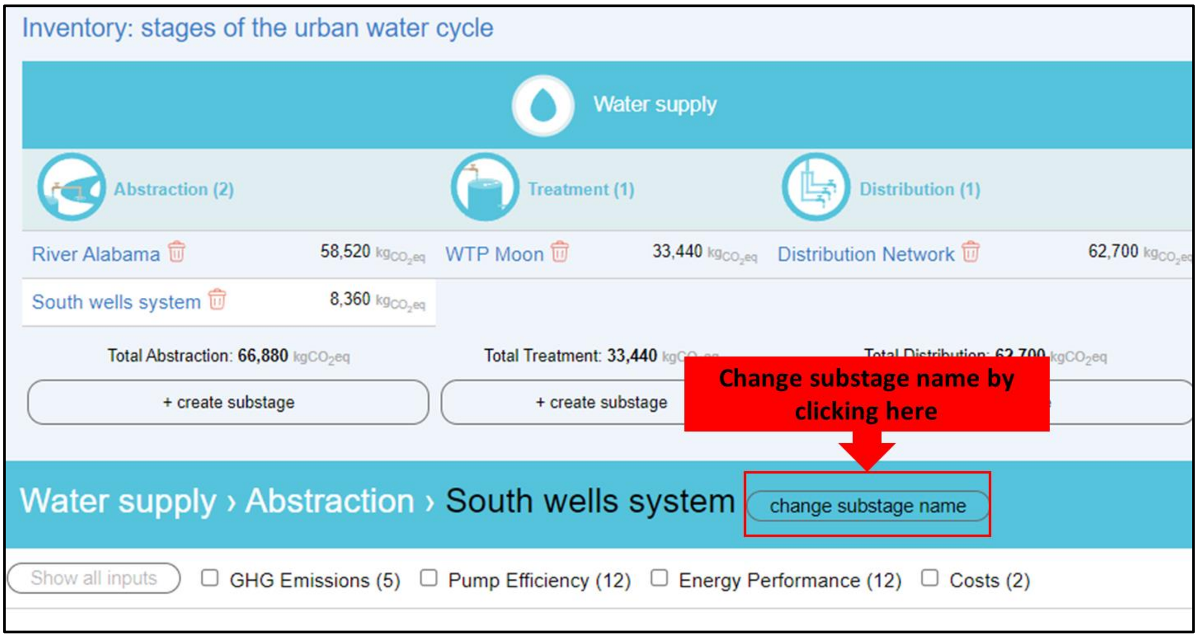
2. Make sure that you are not duplicating sources of emissions when considering pumping stations or volumes of water.

To create a substage, the user should click on “**+ create substage**”.

The **"Inputs" section (2)** is where the user must fill in the data of the selected system, stage, or substage. Each of these elements has a specific input area. To access them, click on the element you want to fill in the data.



If the user selects a substage, it will be possible to modify the name inside the input section. The names of the substages could be the names of the assessed facilities.

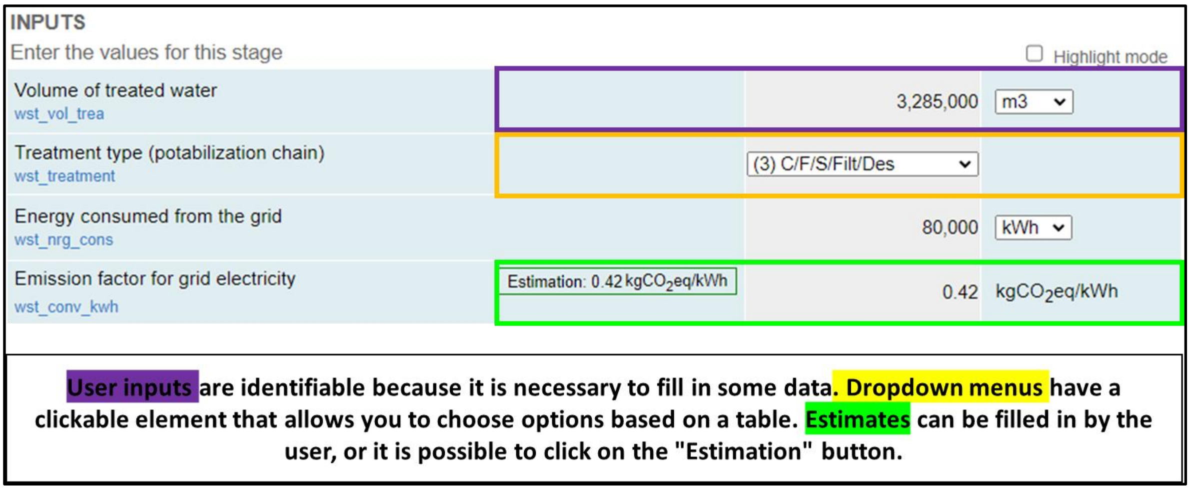


The process of creating substages and renaming them is done in the same way for all the stages of the urban water cycle.

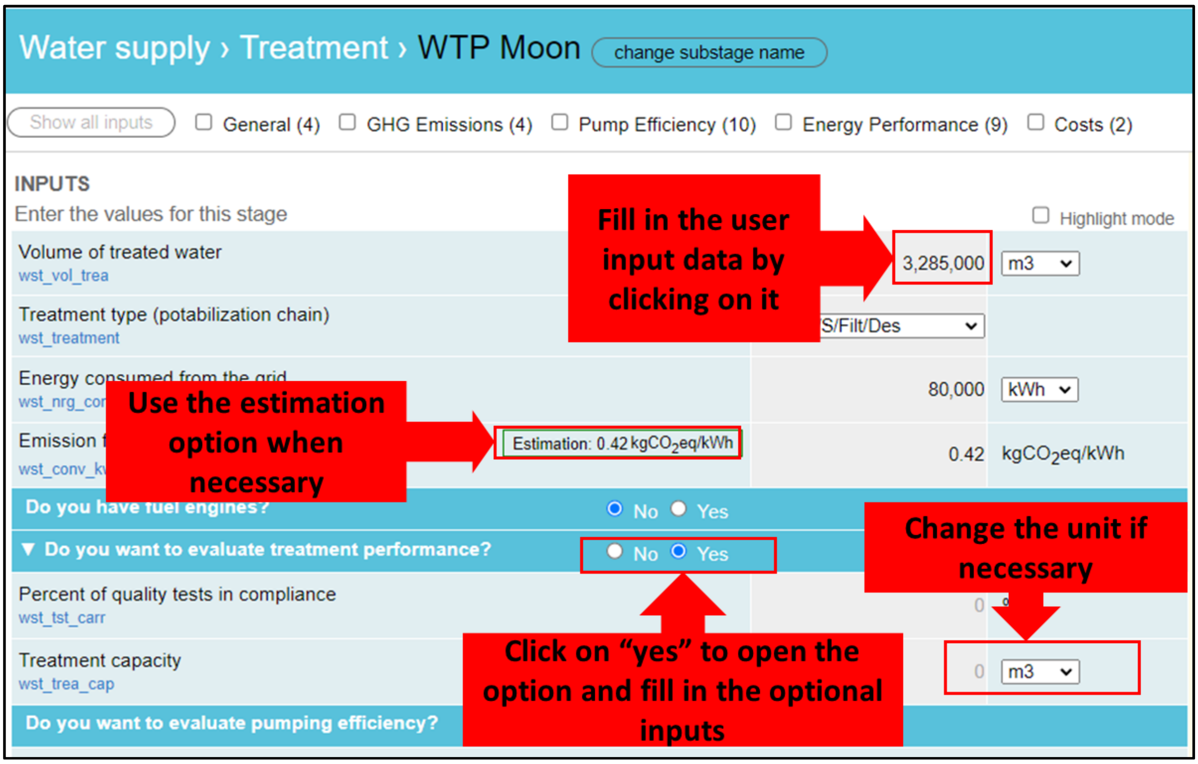
Once an Input Section is opened, the user will find three types[8] of inputs:

- **User input**: Input activity data that <u>must</u> be filled in by the user.
- **Estimates**: Input activity data that can be estimated by the tool or filled in by the user. The estimations are based in user input data.
- **Dropdown menus:** Selectable list, based on a reference table.

[8] Access the Methodology Guide to understand how the ECAM tool proposes each estimate and what the sources for the dropdown menus are. From there, you could prefer to use your own data instead of the suggested ones.

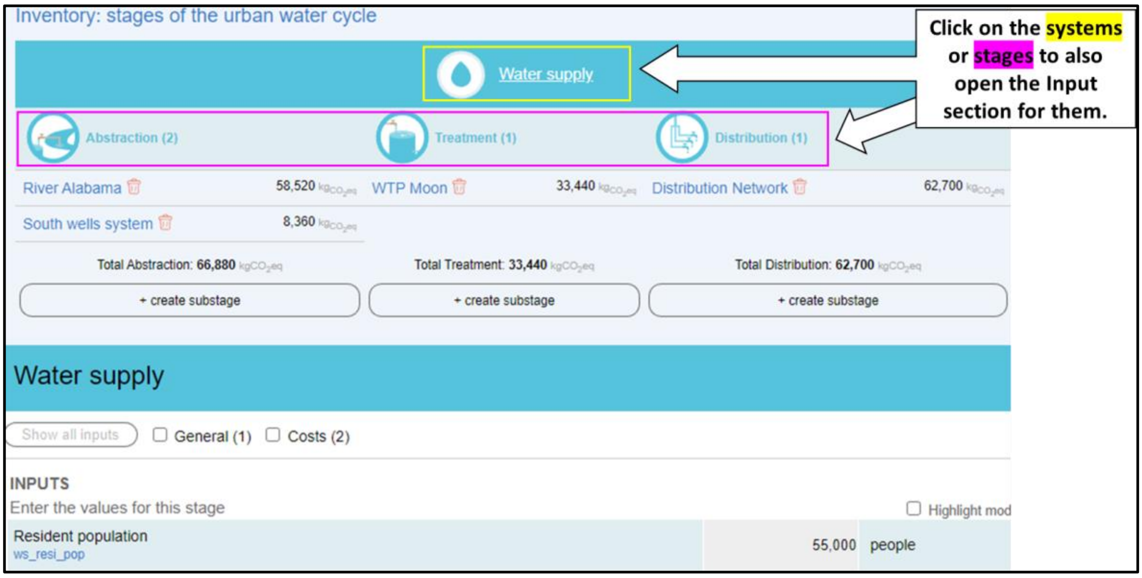


Some input options include additional analysis on Energy performance and Service Level indicators. The user can select these options by clicking on **"Yes"** and then also fill in the available input fields.



It is also possible to open the Inputs section for **systems** and **stages**, just clicking on them, as done with substages.

The information provided as inputs to systems and stages will not be used to calculate GHG Emissions by the tool, but only to calculate Energy performance and Service Level Indicators.

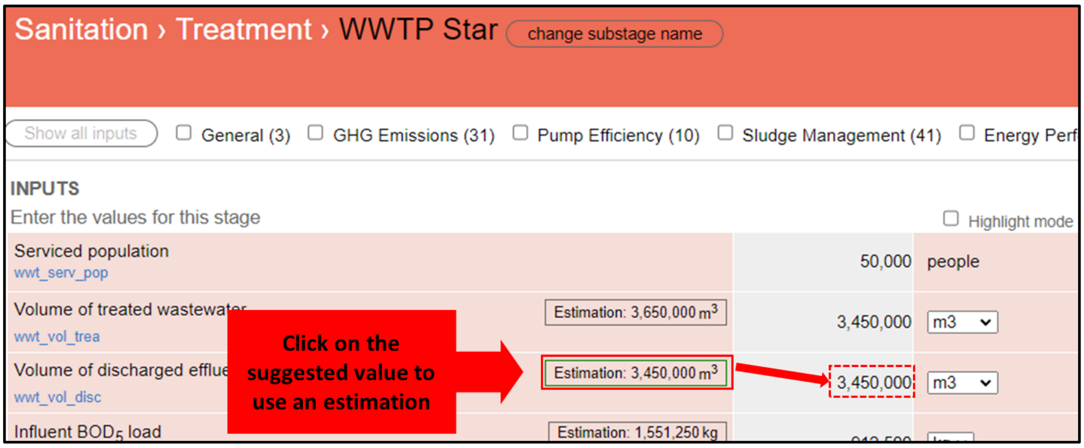


How to use estimates in ECAM

Estimates are an option provided by ECAM to automatically fill some of the input fields. Some of them come directly from the GWP report selected in the configuration tab or from the country specific factors, while others are calculated based on other inputs[9].

The calculated estimates are based on equations from the literature or the IPCC. However, the user can always choose to fill in the Input instead of using the estimation.

The "**Methodology Guide**" support document provides the sources for each of the estimates performed by ECAM.



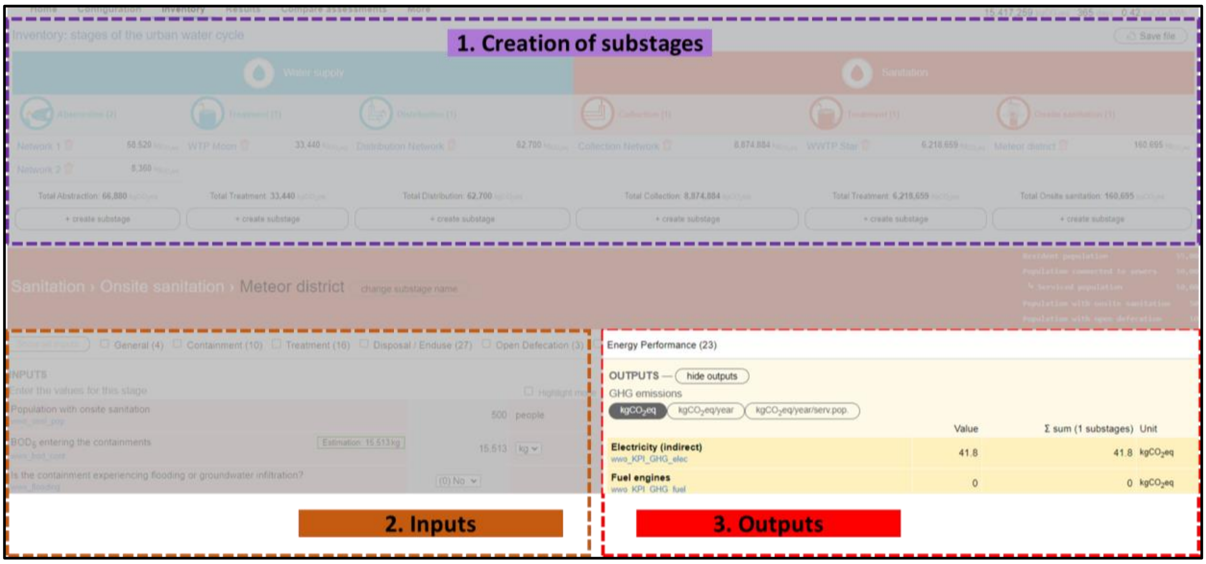
Note that if one of the inputs used by ECAM for estimation is not filled in, the tool will show the value "0" for the estimate. You can click on the estimate code to see which variables it is calculated from.

[9] The sources of each estimate and the formulas used by ECAM to calculate them are covered in the document "Methodology Guide".

Outputs

How to show outputs

The "**outputs**" are the results of the calculations performed by the ECAM tool. The outputs section (3) is on the right side of the inventory tab main page.



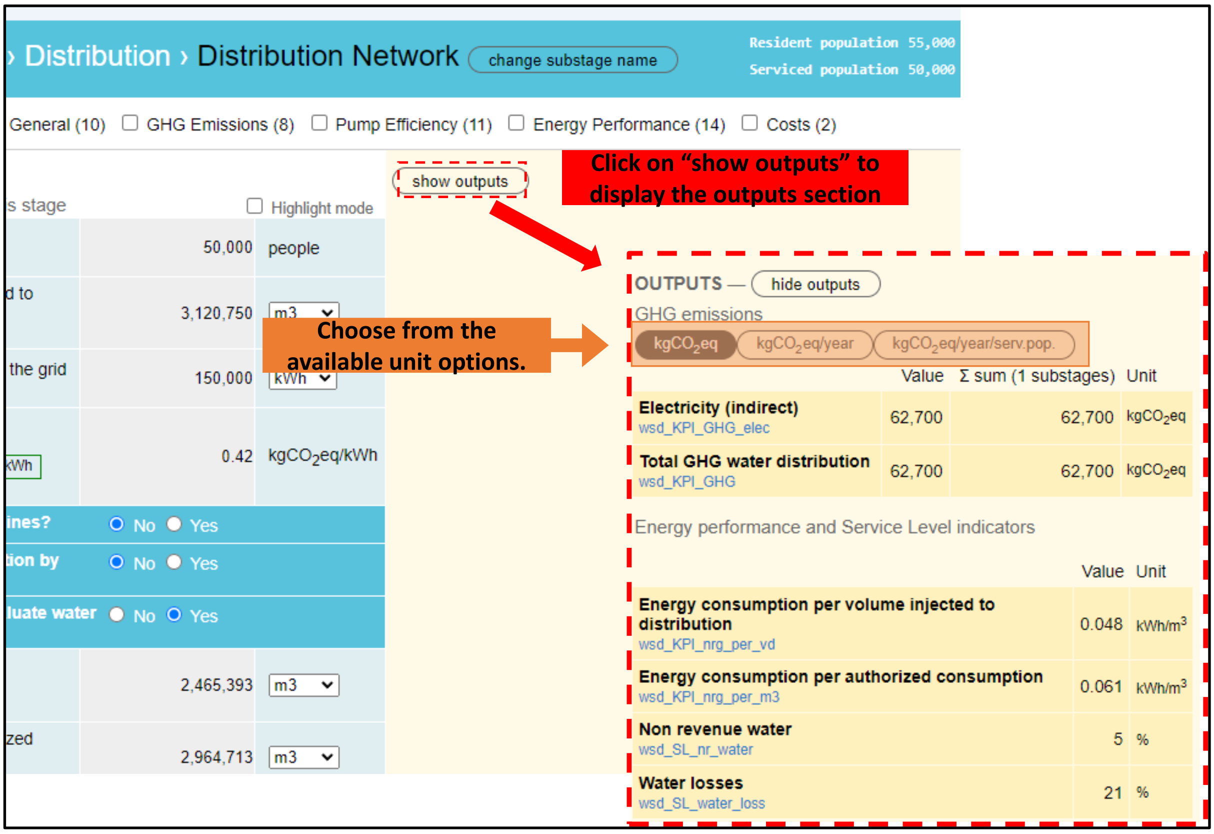
It presents the calculated results in two categories:

- **GHG emissions**, which include all calculations related to the stages.

- **Energy performance and Service level indicators**, which include the optional analysis regarding the operational efficiency of the systems.

To show the outputs, click on the "**Show Outputs**" button. The results will be indicated by type of GHG emission and by type of indicator.

In the Output section it is also possible to modify the units of the results. If the period of assessment is less than 1 year, it is possible to select the unit **$kgCO_{2eq}$/year** to extrapolate the results. However, the user must be aware that this will bring more uncertainty to the generated results.

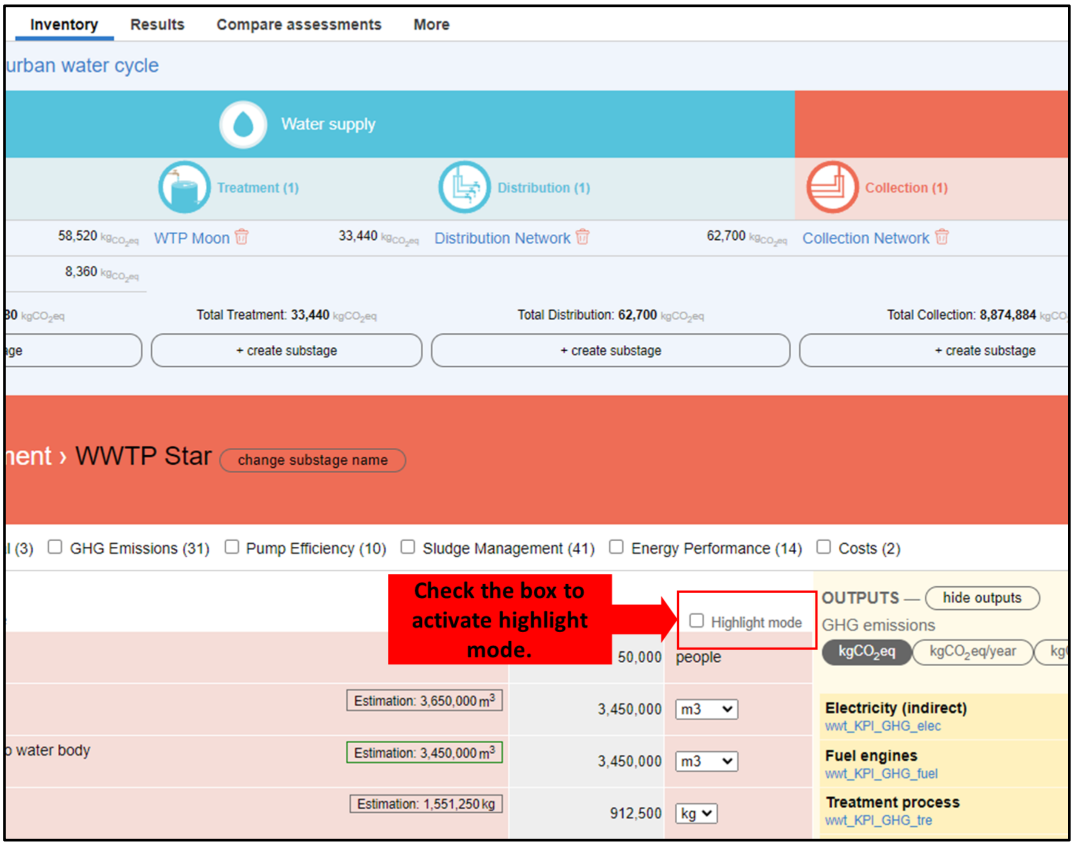


How to traceback a result using the highlight function

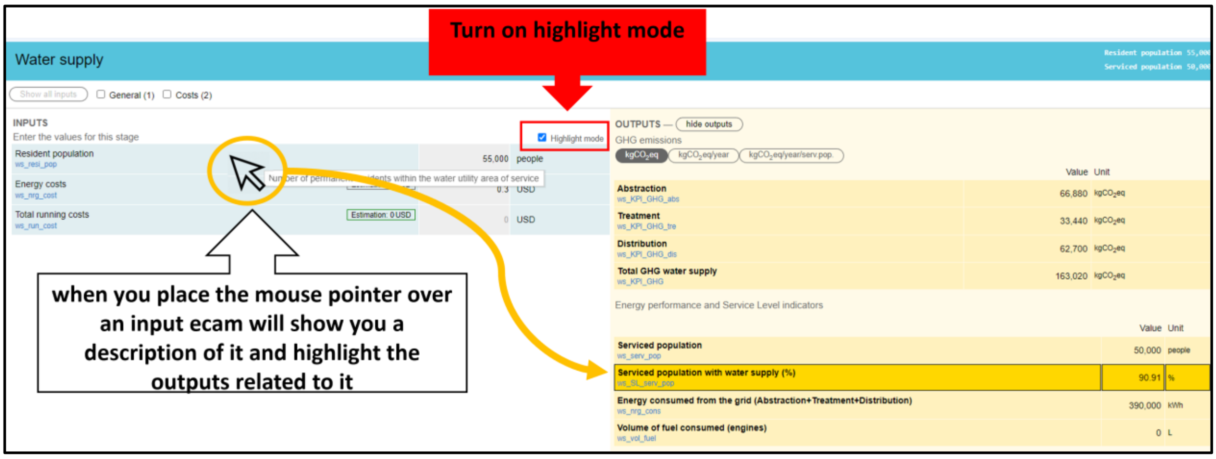
An option to visibilize the filling process by the user and the calculation by the tool is to turn on the **Highlight mode**.

The Highlight Mode displays the relationships between inputs and outputs, which can make it easier for the user to check for errors and where they come from. You can hover the outputs to check which inputs are required to calculate them and vice versa.

To activate this option, enter the "**Inventory**" tab and click on the "**Highlight mode**" option, which is next to the space dedicated to inputs.



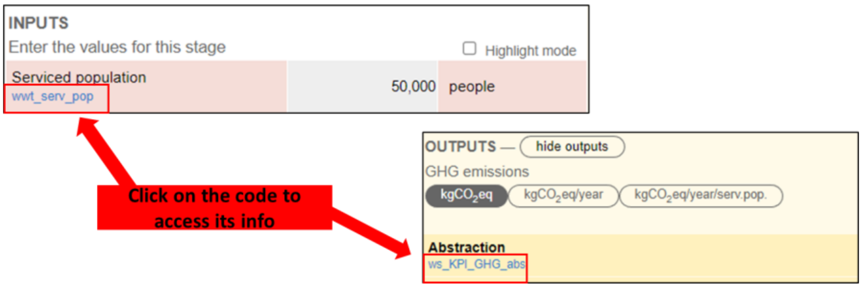
This mode highlights the relationship between codependent inputs and outputs. With the mode on, placing the mouse over an Input will highlight related outputs. The same goes for clicking the mouse pointer over an output, which will highlight the inputs used for its calculation.



How to see formulas, constants, and sources behind the equations

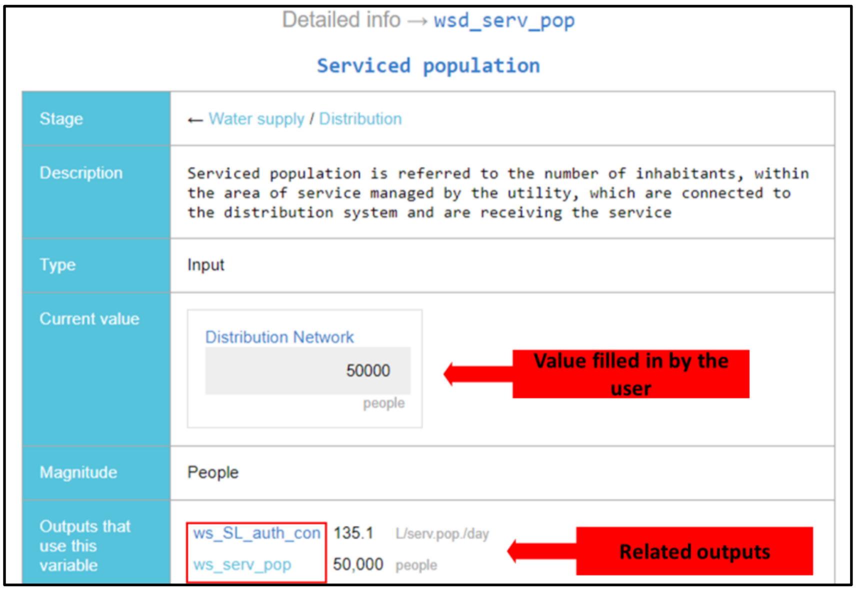
It may be interesting for the user to check the formulas, constants and sources behind an estimate or calculation of an output.

Below the name of each variable there is a **code**, which is unique and represents that variable in the software algorithm. To check the information behind this variable, just click on this code, which will be highlighted in blue.

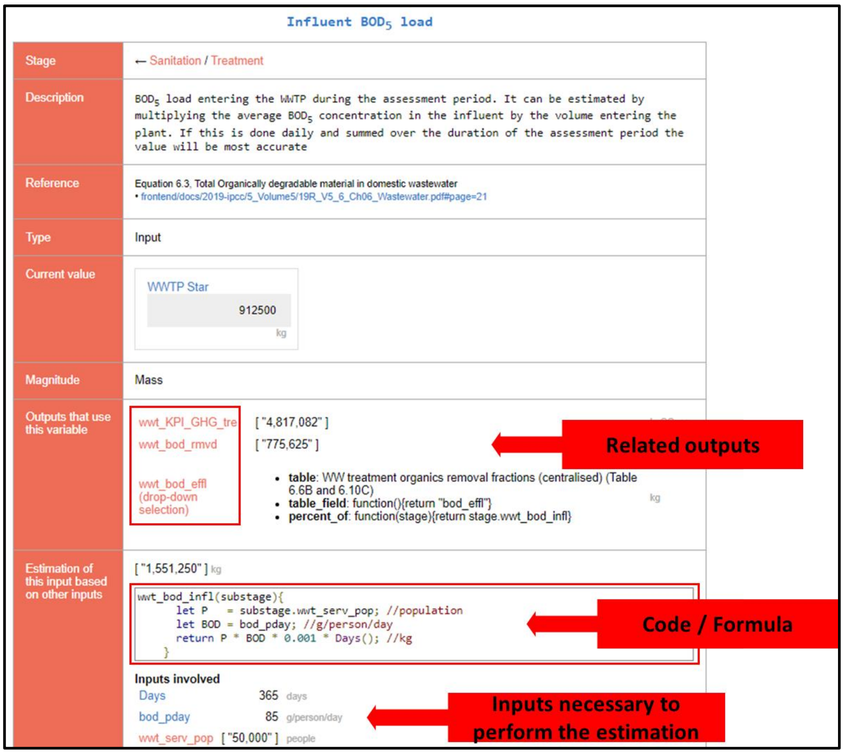


Clicking on the code will take you to a section called "**Detailed info**". The information on this page depends on the type of variable being checked.

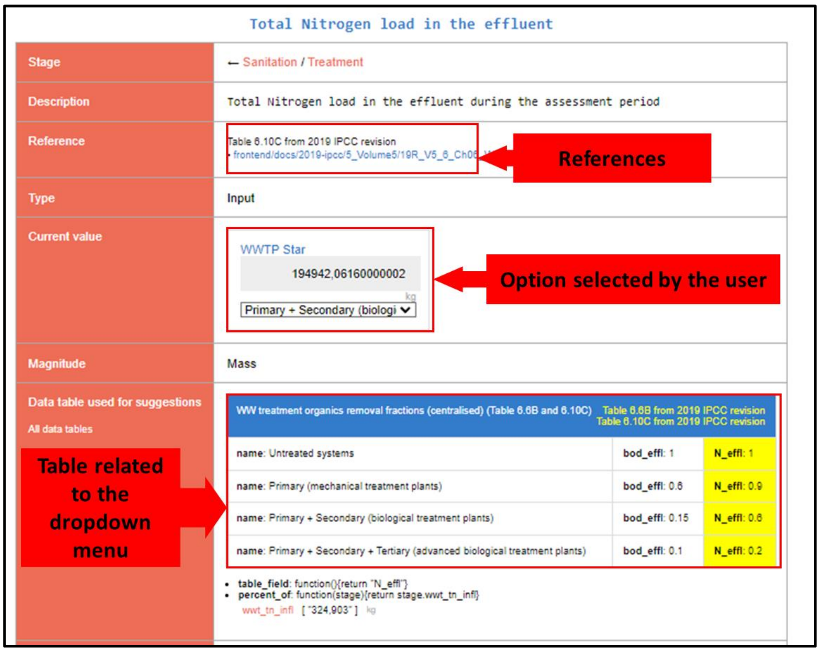
User inputs: the detailed info will show a description for the variable and the outputs that use it for calculation. You can check related outputs detailed infos by clicking on their codes.



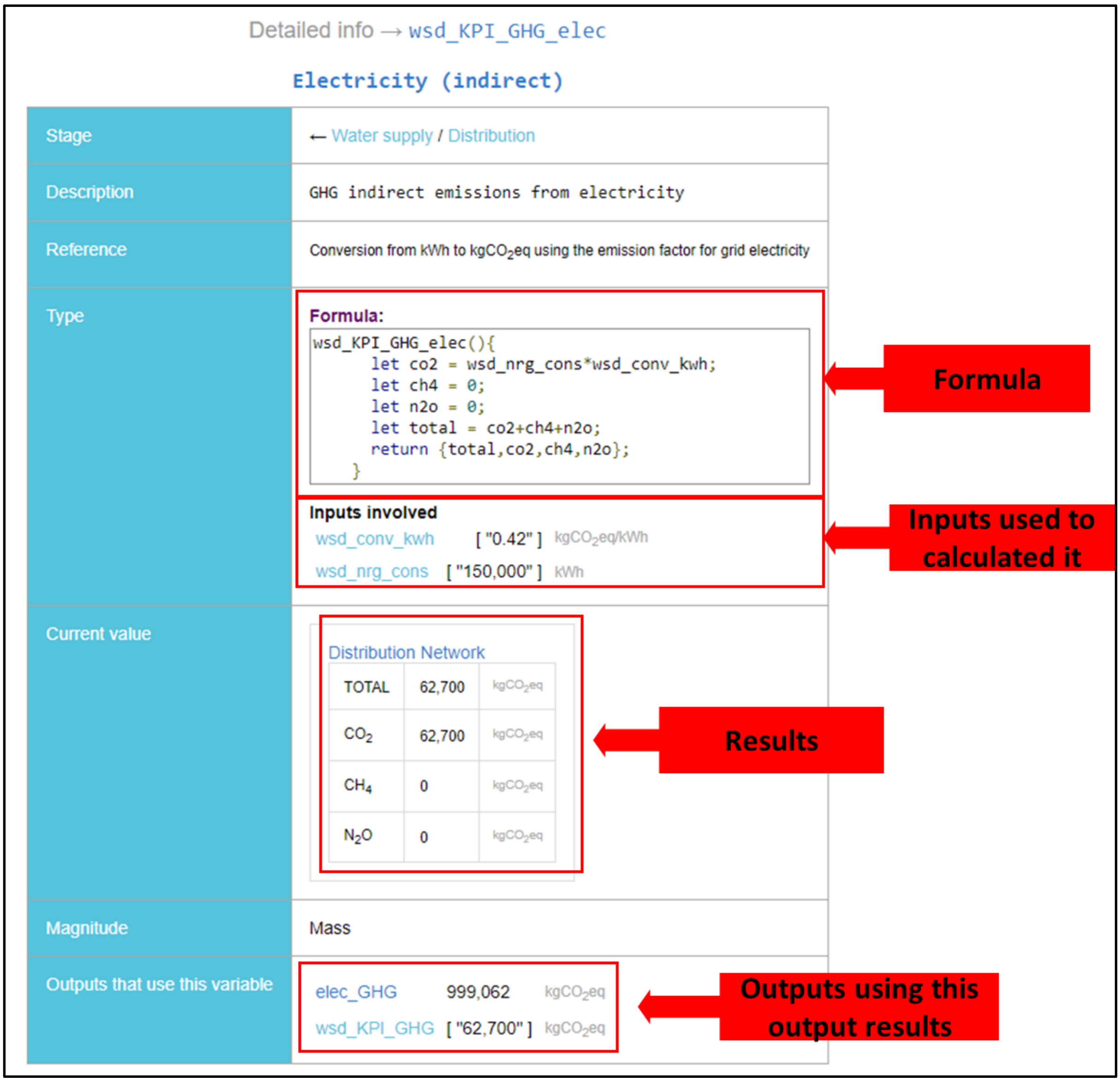
Estimates (inputs): detailed info will additionally show the formula used to estimate the input based on other inputs filled in by the user. You can click on the code of these inputs and go to their detailed info section. You can check related inputs and outputs detailed infos by clicking on their codes.



Dropdown menus (inputs): detailed info will additionally display the table that makes up the menu options, as well as the source it is based on, which can also be consulted at the Methodology Guide support document. You can check related inputs and outputs detailed infos by clicking on their codes.



Outputs: detailed info from outputs will show the formula, the inputs used to calculate the output, the results, references, and other outputs using these results. You can check related inputs and outputs detailed infos by clicking on their codes.


Detailed info → wsd_KPI_GHG_elec
Electricity (indirect)
Stage
← Water supply / Distribution
Description
GHG indirect emissions from electricity
Reference
Conversion from kWh to kgCO2eq using the emission factor for grid electricity
Type
Formula:
wsd_KPI_GHG_elec(){
let co2 = wsd_nrg_cons*wsd_conv_kwh;
let ch4 = 0;
let n2o = 0;
let total = co2+ch4+n2o;
return {total,co2,ch4,n2o};
}
Inputs involved
wsd_conv_kwh ["0.42"] kgCO2eq/kWh
wsd_nrg_cons ["150,000"] kWh
Current value
Distribution Network
TOTAL 62,700 kgCO2eq
CO2 62,700 kgCO2eq
CH4 0 kgCO2eq
N2O 0 kgCO2eq
Magnitude
Mass
Outputs that use this variable
elec_GHG 999,062 kgCO2eq
wsd_KPI_GHG ["62,700"] kgCO2eq
Formula
Inputs used to calculated it
Results
Outputs using this output results

Section 3: Results and assessments

How to show the results

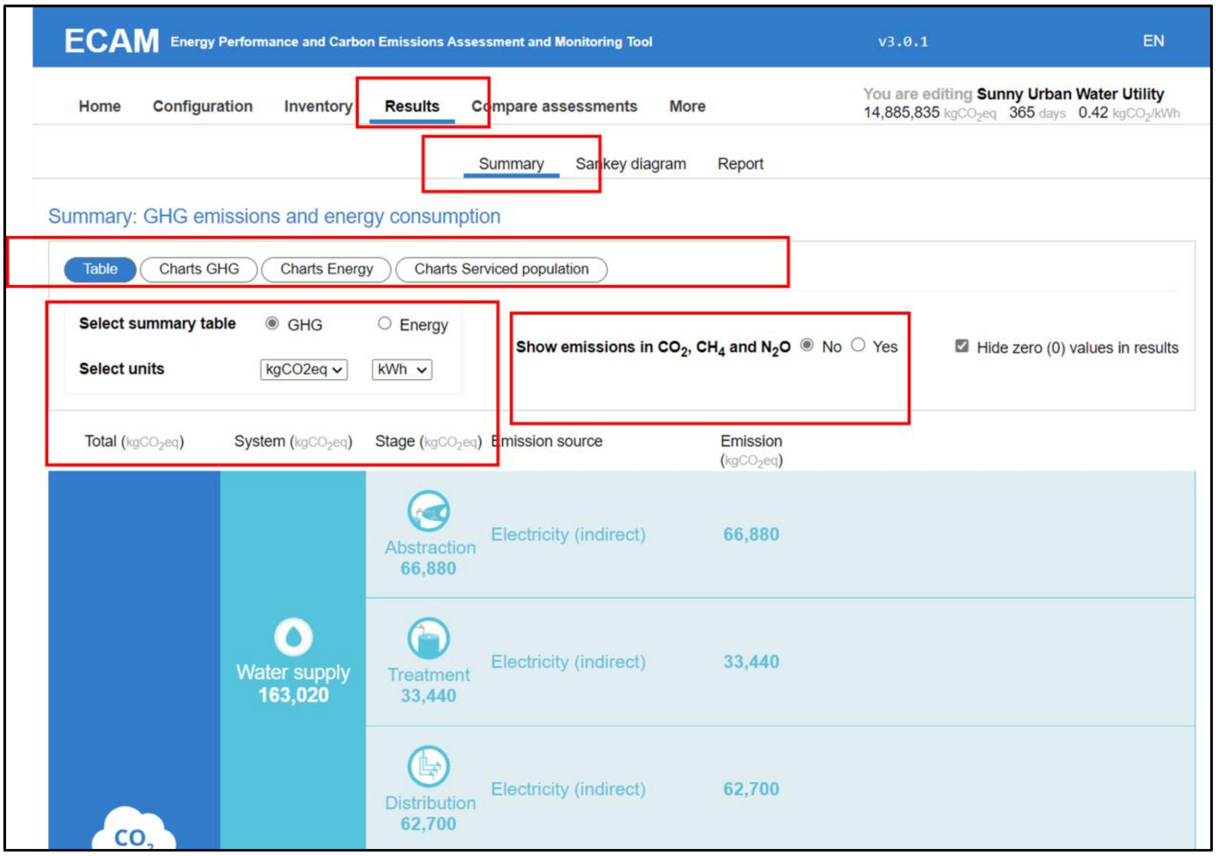
To show the results, the user should click on the "**Results**" tab. There will be sub-tabs to select from: Summary; Sankey diagram; or Report.

Summary

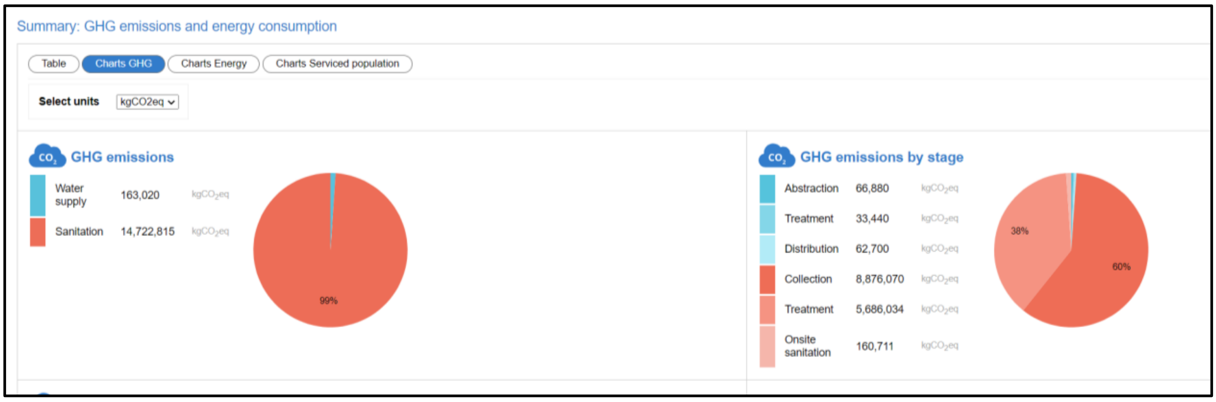
The results are displayed in the Summary sub-tab. In this tab you can select different ways **to display your assessment results**. You can choose between tables, bar charts and pie charts. To do that, just click on the selected option.

When selecting the table option, the user can **present the results** based on the GHG emission or also on the energy consumption in each created substage (when data were provided for such calculation). You can select the unit for both options. The table is intuitive and divided by systems and stages.

The standard for reporting emissions by the IPCC is CO_2 equivalent. However, it may be interesting for the user to display the emissions according to the specific gases. You can do this by selecting the option "**Show emissions in CO_2, CH_4 and N_2O**".

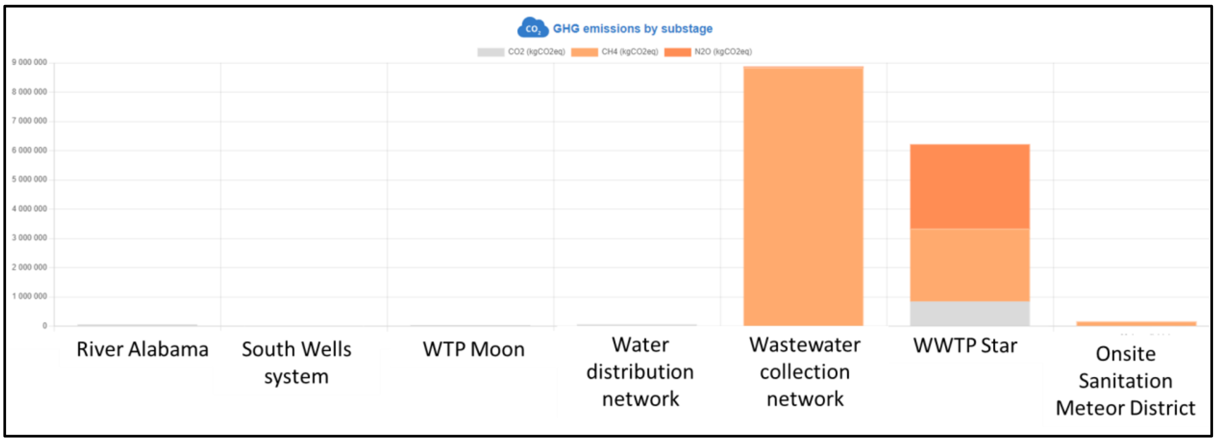


Another option is to **present the results as pie charts**. Graphs are generated by system, by emitted gas, and by stage.



A third option is the **bar charts**, which are just below the pie charts. The bar graphs present the results by substages created within the stages.

Note that bar graphs should be used with caution when substages have very different outputs. In the example below, the emissions from the water system are much lower than those from the sanitation system, which makes it impossible to visually compare water system emissions. If the user is going to present these results, it may be interesting to manually add also the analytical values found for each substage.



Sankey Diagram

Another way to present results is using a **sankey diagram**.

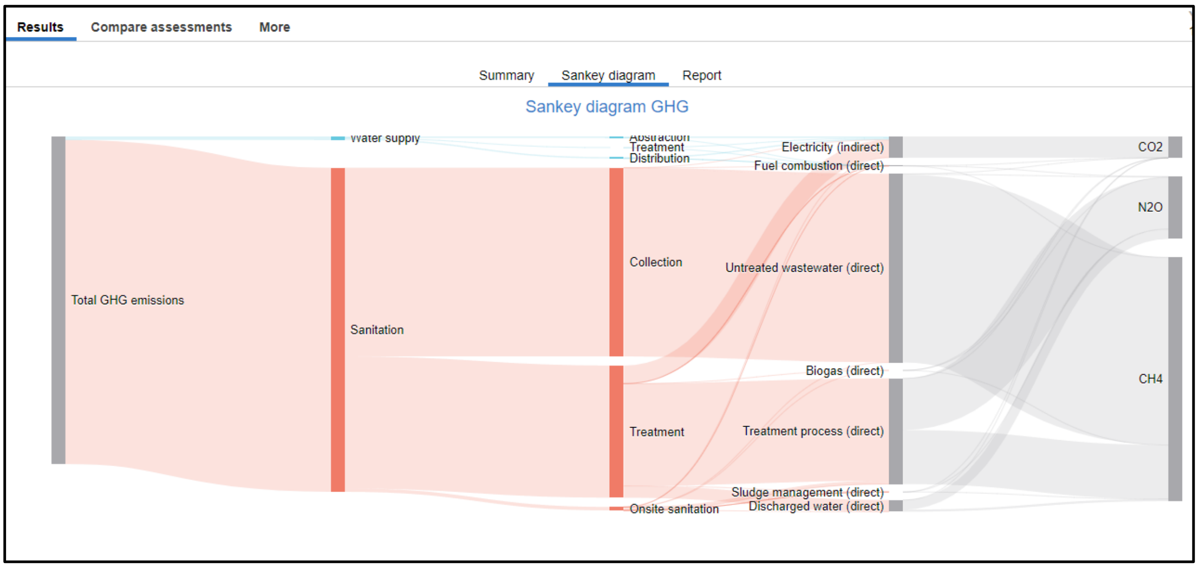
The Sankey Diagram presents the amount of GHG emissions as "flows" following the logic:

- The **greater the thickness**, the **more GHG emissions were generated**.
- **Colored results** refer to **total emissions in CO_2** equivalent.

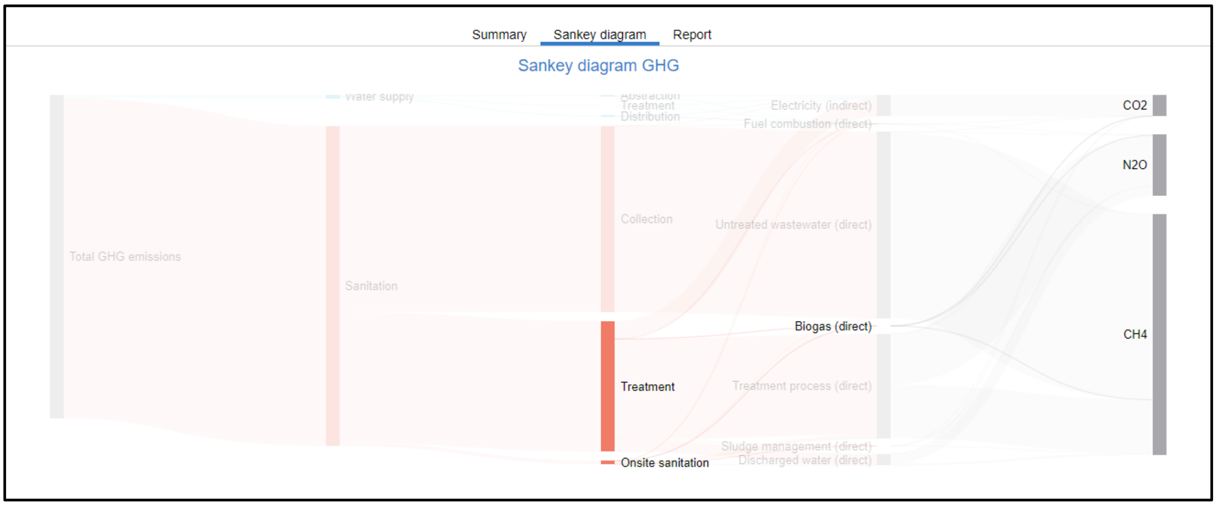
- The **black and white results** are the division of these emissions according to the **specific gases**.

Sankey diagrams allow you to show complex processes visually, with a **focus on a single aspect** that you want to highlight. They also support **multiple viewing levels**, as you can analyze the entire assessment in general, or focus on specific stages or specific emissions, or even on specific gases.

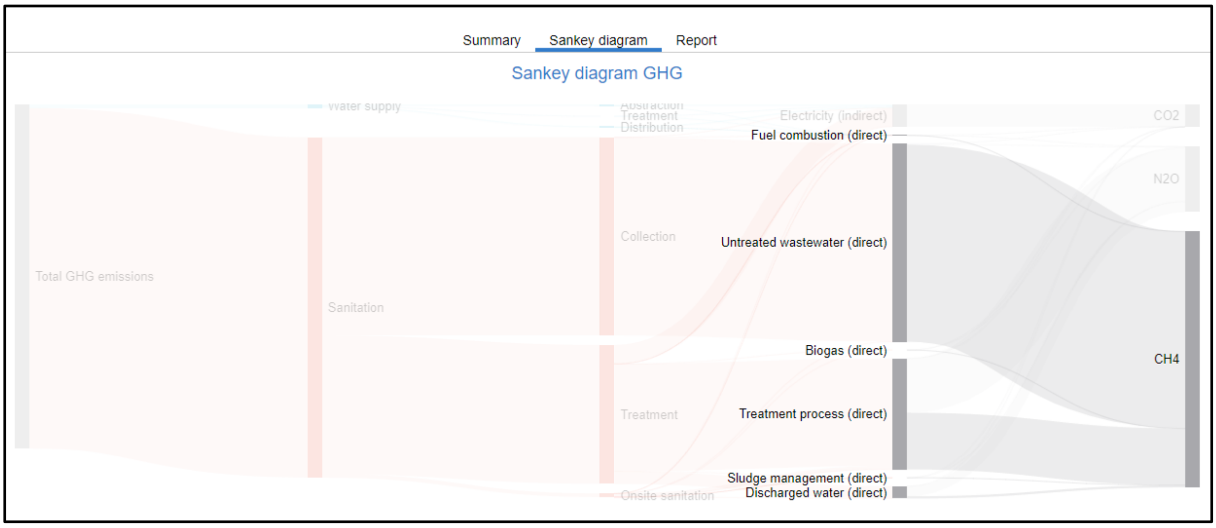
The example below shows the Sankey diagram of an urban water utility. Starting the reading from the left to the right, it is possible to see right away that the **Sanitation system generates much more emissions than the Water Supply system**. Apparently, the **largest** emissions are related to the **wastewater collection** and **wastewater treatment stages**. Remember that the amount is defined by the thickness of the flow, and that colored emissions are in CO_2 equivalent.



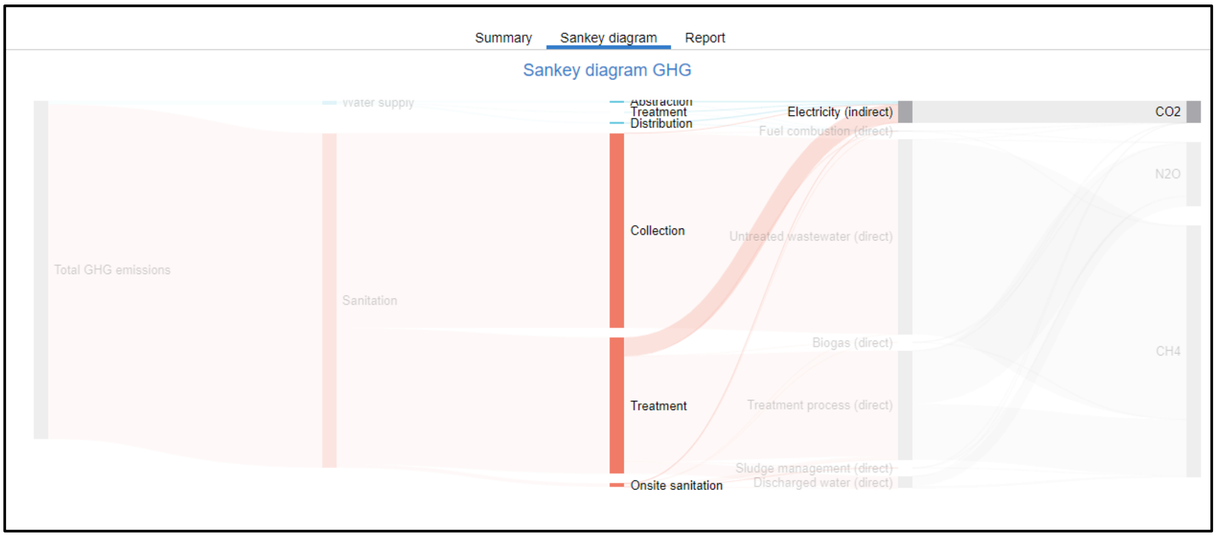
To analyze the diagram in multiple levels, it is necessary to **place the mouse pointer over the name** of which element you want to visualize and check its correlations. For example, by hovering over "**Biogas (direct)**" it is possible to verify that this type of emission comes from the wastewater treatment and onsite sanitation stages, when reading from the right to the left. Additionally, reading from left to right, biogas emissions are generating CO_2, N_2O and CH_4, and it is not possible in this case to differentiate the quantities between them.



In another example, when hovering over CH_4, we observe that most methane emissions come from wastewater collection. From this information, it is possible to search for additional information in other features of the ECAM tool.



As a last example, if we want to analyze emissions related to electricity, we should place the mouse over "**Electricity (indirect)".** It is therefore noted that most of these emissions come from the Wastewater Treatment stage, and that they are exclusively CO_2.



Report

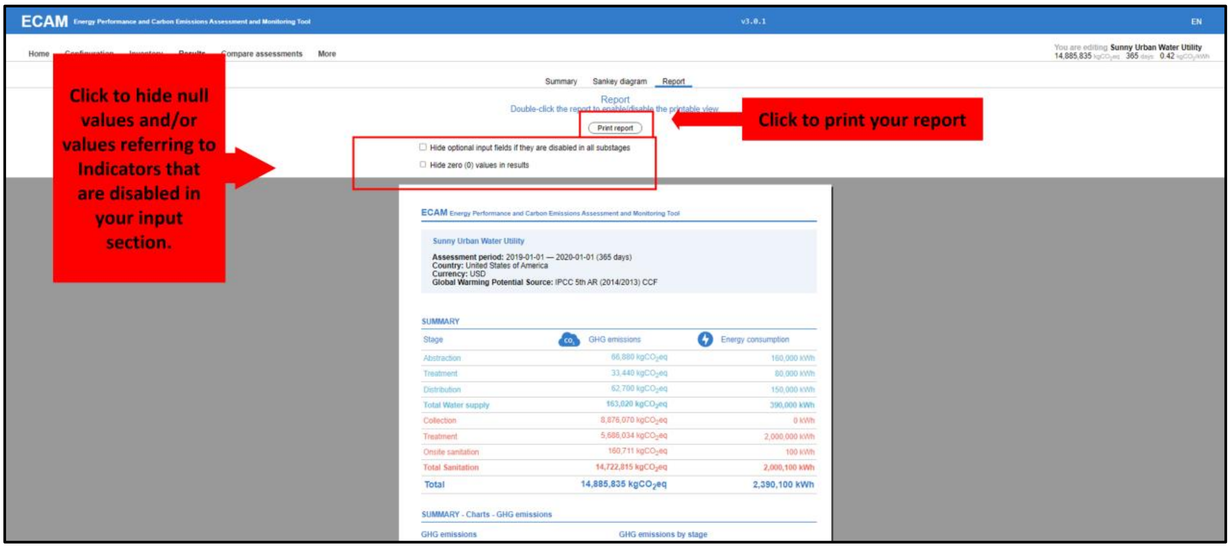
In the Report sub-tab it is possible to access a **summary of all of the charts and diagrams** related to your assessment.

It also displays a **summary of GHG emissions** by systems and stages, as well as **energy consumption** for these elements.

All **inputs** and **outputs** of each created **substage are also shown**, which can be interesting to archive the background referring to your assessment. This way it will be possible to understand the results, look for possible errors, and even ensure that future discrepant results are justified.

There is also the option to hide input fields disabled in substages and to hide results equal to zero (0), which may be interesting to keep your report clearer and shorter.

It is possible to print your report clicking on "**print report**" option and saving it as a pdf.

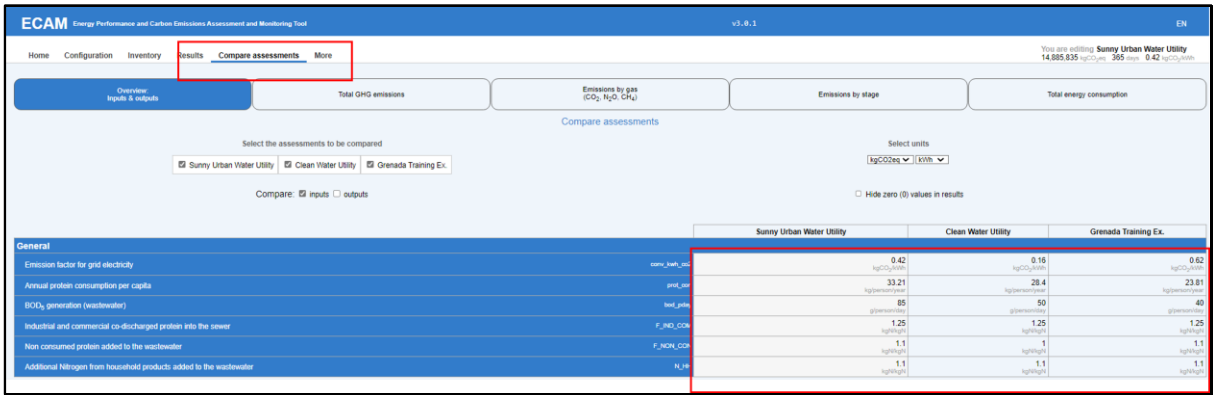


Attention: Remember that this option generates a document for visual presentation only. To save your data, use the **save as JSON option**, as previously explained in topic **Save, Load, and Merge assessments**.

Comparing assessments

When the user is working with more than one assessment, there is an option to compare assessments. This option will generate a table comparing all the outputs and inputs of both assessments.

Select the assessments that you would like to compare with each other. Please note that the order of the selection determines the order of the compared assessments. For example, if you have 3 assessments for the years 2018, 2019 and 2020, you will need to select the assessments in this order. If you select 2019, 2020 and 2018, the order would be different.



You can also display the comparison in the form of bar and line graphs. These options can be accessed in the subtabs.


Overview: Inputs & outputs
Total GHG emissions
Emissions by gas (CO_2, N_2O, CH_4)
Emissions by stage
Total energy consumption
Compare assessments
Select the different options to display bar and line charts
Select the assessments to be compared
Sunny Urban Water Utility
Grenada Training Ex.
Clean Water Utility
Total GHG emissions (kgCO2eq)
45 000 000
40 000 000
35 000 000
30 000 000
25 000 000
20 000 000
15 000 000
10 000 000
5 000 000
0
Sunny Urban Water Utility
Grenada Training Ex.
Clean Water Utility
Variation in respect of previous assessment (%)
Variation of total GHG emissions (%)
200
150
100
50
0
-50

Section 4: Key points when entering data in ECAM

This topic presents some key points that the user should know when entering data in the ECAM tool.

What should I consider when choosing my inventory scope?

Typically, in the urban water sector, emissions are assessed separately and using different tools. The ECAM tool, however, has been developed to facilitate the assessment of systems via a holistic approach, considering all stages of the urban water cycle and the interlinkages between stages. The aim is to maintain the overview on the entire urban water cycle in the analysis, to convey the notion that sub-systems are inter-related.

The choice of which systems will and will not be considered is called **scoping**. A scope of a GHG emissions inventory may include, for example: only one specific WWTP that needs diagnosis; a specific water distribution zone; or a set of systems belonging to the same urban water utility. The decision on which scope to consider should consider:

- The **context of the inventory**, i.e., what is the user's objective of realization, what are the purposes, etc.

- **Organizational boundaries**, that is, the specific characteristics of the utility (geographical location, service municipalities, responsibilities within a shared system, etc.)

- **Operational boundaries**, which refer to deciding which processes to consider (on-site and off-site activities? Just a part of my treatment because I am interested in switching to another technology? Etc.)

Where can I get the data to enter in the ECAM tool?

Filling Input data in the ECAM tool is done in the following ways:

- Data that must be provided directly by the user (user input data), considering inputs for the whole time-period defined.

- Data estimated or suggested by ECAM:
  - Data suggested by the tool based on the selected country and GWP report, which can also be modified by the user.

  - Data calculated through estimations, which can also be modified by the user.

  - Data calculated based on dropdown menus, which are supported by reference literature, and which can also be modified by the user.

Data that must be filled in by the user include those related to population, volume of water/wastewater, energy consumption, among others. Table 2 shows the main user input variables, and from which sources it is possible to obtain them. The user must consider the possible errors associated with each of these sources. Utilities might use standardized sources defined in official documents. (the suggested sources are suggestions, and therefore they do not exclude others that are considered pertinent by the user).

Table 2 - Possible sources for the main User Input variables

Input User Variables	Possible Sources (from top to bottom: most accurate to least accurate)
Resident population	• Most recent census • Project documentation
Serviced population	• Commercial registration • Estimated value based on monitored influent flow (WWTP) • Project documentation
Volume of water and wastewater	• Macrometer data • Operational control • Estimates based on measurements with series failures • Estimates based on instantaneous point measurements • Estimates from water balance
Energy consumed from the grid	• Energy bills • Operational log from the control panel • Estimates based on equipment operating hours • Extrapolated values based on the operation of pumps with frequency inverters
Volume of fuel consumed	• Operational control • Purchase receipts
Number of serviced connections	• Commercial registration • Project documentation

The support document "**Methodology Guide**" presents the equations and data tables for each of the ECAM suggestions and estimates. But it is also possible to enter your own values (Table 3).

Table 3 - Possible sources for the main Estimates

Input ECAM estimates/suggestions	Possible Sources (from top to bottom: most accurate to least accurate)
Emission factor for grid electricity	• Official country-specific factors, defined by local methodology • Updated data from the International Financial Institutions (IFI) Dataset of Default Grid Factors[10] • ECAM suggestions
BOD_5 and Nitrogen influent loads	• Monitoring Protocol • ECAM estimates • Project documentation (influent and effluent)
BOD_5 and Nitrogen effluent loads	• Monitoring Protocol • ECAM estimates • Estimate in accordance with the treatment process adopted (effluent)
Biogas produced	• Monitoring Protocol • Operational control • Estimates based on instantaneous point measurements • ECAM estimates

[10] The ECAM tool suggests the IFI data released in its last update, 2020. However, this data is updated every two years, and is available at: https://www.eib.org/en/publications/eib-project-carbon-footprint-methodologies

Input ECAM estimates/suggestions	Possible Sources (from top to bottom: most accurate to least accurate)
	• Project documentation
Sludge mass	• Operational control • ECAM estimates • Project documentation

Wastewater Treatment stage

In this topic some specifics about the Wastewater Treatment stage will be addressed. They are:

- Information on **choosing wastewater treatment technologies** from the options provided by the ECAM dropdown menus

- Information on **how to calculate an average emission factor** for WWTP with **multi-step technologies <u>without</u> sludge removal**

- Information on **how to calculate an average emission factor** for WWTP **with multi-step technologies <u>with</u> sludge removal**

- Information on **how to calculate an average emission factor** for WWTP **with multi-step technologies <u>with</u> sludge removal and <u>with biogas recollection</u>**

How to choose the best option for the Treatment Technology Dropdown Menus

The dropdown menus are a feature provided by the ECAM tool to facilitate the selection of options based on official guidelines and scientific reference. These sources include the IPCC Guidelines (2006; 2019); traditional literature (Chernicharo, 2015; Von Sperling, 2015); official technical publications (EIB, 2020; FAO, 2022; UNFCC, 2022); and technical-scientific papers (Alegre et al., 2006; Cabrera et al., 2011; Silva; Rosa, 2014). These and other sources are further explored in the supporting document "**Methodology Guide**".

The terms used specifically in the Sanitation Treatment stage dropdown menus are broad, so you may find it difficult to relate them to your operational routine. To facilitate this correlation between the broader terms used by the IPCC for this specific stage and your operational routine, see Table 4.

Table 4 - Types of wastewater treatment technology, categorized according to the level of treatment and the presence (or not) of aeration[11][12]

Primary treatment

- Anaerobic Reactors (depending on the WWTP design)
- Coarse solids reductors
- Grit and oil separators
- Imhoff tanks
- Primary clarifiers
- Screens

Secondary treatment

- Activated Sludge
- Anaerobic Reactors (depending on the WWTP design)
- Biological aerated filters (BAF)
- Constructed Wetlands
- Lagoons
- Membrane bioreactor (MBR)
- Moving bed biofilm reactor (MBBR)
- Packed bed reactor
- Rotating biological contactor (RBC)
- Trickling Filter
- UASB (depending on WWTP design)

Tertiary treatment

- Adsorption
- Air and steam stripping
- Coagulation/Flocculation
- Ion exchange
- Membrane processes
- Oxidation (chemical, wet air, supercritical water)
- Tertiary Filtration

Centralised, aerobic, treatment plant

- Activated sludge
- Aerated Lagoons
- Aeration Basin
- Biological aerated filters (BAF)
- Biological Trickling filters
- Fixed Bed Bioreactors (FBBR)
- Membrane bioreactor (MBR)
- Moving bed biofilm reactor (MBBR)
- Oxidation ditches
- Packed bed reactor
- Rotating biological contactor (RBC)

Anaerobic reactor

- Anaerobic Baffled Reactor (ABR)
- Anaerobic contact reactor
- Anaerobic filter
- CSTR
- Down flow fixed-film reactor
- Expanded-bed process
- UASB
- Upflow packed bed reactor

Choosing the correct option from the dropdown menus will ensure that the correct GHG emissions are accounted for. In this regard, note that:

- Primary level treatment generates mostly CO_2 emissions, while secondary and tertiary treatment may also generate N_2O and CH_4 emissions.

- Aerobic treatments generate mostly N_2O and CO_2, while anaerobic treatments generate mostly CH_4 and CO_2.

[11] Lagoons are also referred as "Ponds".
[12] "Preliminary" and "primary" treatment technologies are both shown as primary in this table, as the base references to the dropdown menus do so.

- Regardless of the technology selected, remember that the generation of GHG in a WWTP also depends on how the facility is being operated. The dropdown menu values are based on data tables which are results from an average of case studies, and therefore may not represent your reality[13].

How to choose an emission factor for treatment if my WWTP has two or more core technologies

According to the IPCC (2019), the calculation of GHG emissions in wastewater treatment processes is given by Equation 1.

Equation 1 – Calculating CH_4 and N_2O emissions in a wastewater treatment process[14]

$$CH4_{WWTP,\ emissions} = (BOD_{inf,\ load} - BOD_{sludge}) \cdot EF_{CH4,\ treatment}$$

$$N2O_{WWTP,\ emissions} = TN_{inf,\ load} \cdot EF_{N2O,\ treatment}$$

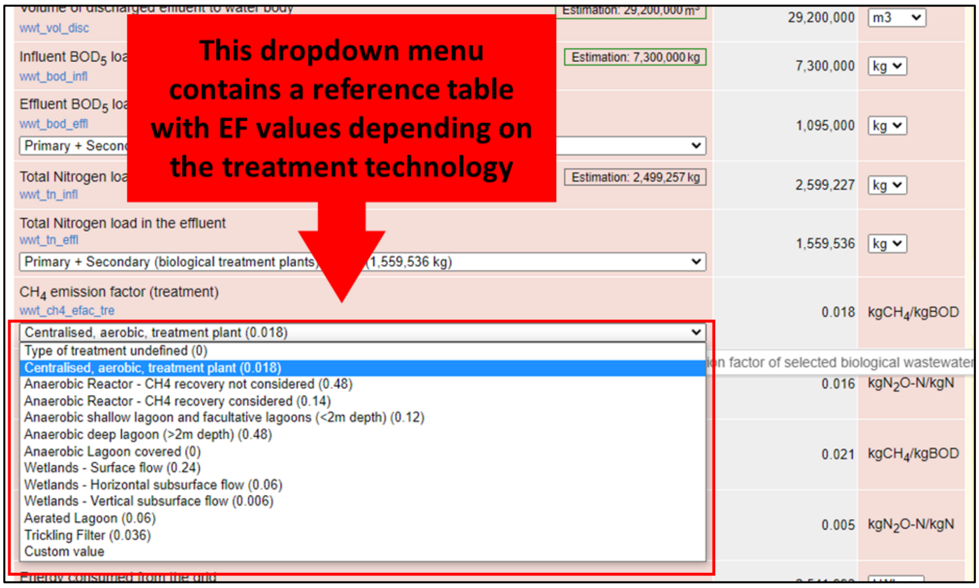
Where:

$CH_{4emissions}$	Total of CH_4 emissions in a wastewater treatment process [$kgCH_4$/year]
$N_2O_{emissions}$	Total of N_2O emissions in a wastewater treatment process [kgN_2O-N/year]
$BOD_{inf,\ load}$	Influent BOD load [$kgBOD_5$/year]
$BOD_{inf,\ load}$	BOD removed as sludge [$kgBOD_5$/year]
$EF_{CH4,\ treatment}$	Methane emission factor for wastewater treatment [$kgCH_4/kgBOD_5$]
$TN_{inf,\ load}$	Influent Total Nitrogen load [kg N/year]
$EF_{N2O,\ treatment}$	Nitrous oxide emission factor for wastewater treatment [kgN_2O-N/kgN]

But in ECAM it is not necessary to perform this calculation manually. To calculate emissions from wastewater treatment, the user must fill in the input data and **select the CH_4/N_2O treatment emission factors**.

In the tool, you can select this emission factor from several options available in a dropdown menu by choosing your WWTP core technology, as shown below.

[13] Further discussion in the Methodology Guide.
[14] For didactic reasons, the equations here are simplified. For additional considerations, see the IPCC Guidelines (2019).



This procedure is quite simple for users who are evaluating **only one specific core technology**. When choosing the CH_4 emission factor, for example:

- In the case of a treatment based on an anaerobic lagoon, choose the option "Anaerobic deep lagoon (EF = 0.48)";
- Or in the case of a treatment based on an extended aeration (activated sludge) reactor, choose the option "Centralised aerobic treatment plant (EF = 0.018).

But in the case of **more than one treatment technology** (eg. Anaerobic lagoon followed by a Facultative Lagoon), the procedure requires additional steps. It is therefore suggested that the user calculates an **average emission factor** for these combinations of technologies.

Equation 2 was developed by applying Equation 1 (provided by the IPCC) to each of the WWTP's core technologies. Equation 2 can be used to calculate the **average emission factor** for both CH_4 and N_2O emissions.

The Equation 2 is developed by equating steps 1 and 2 defined below.

Equation 2 - Calculating average emission factors for WWTP with more than one core technology

$$Emissions_{treatment} = (Load_{1st\,tech} - Sludge_{1st\,tech}) \cdot EF_{1st\,tech} + (Load_{2nd\,tech} - Sludge_{2nd\,tech}) \cdot EF_{2nd\,tech} \quad \text{(step 1)[15]}$$

$$Emissions_{treatment} = (Load_{1st\,tech} - Sludge_{1st\,tech} - Sludge_{2nd\,tech}) \cdot EF_{average} \quad \text{(step 2)[16]}$$

$$EF_{average^{17}} = \frac{(Load_{1st\,tech} - Sludge_{1st\,tech}) \cdot EF_{1st\,tech} + (Load_{2nd\,tech} - Sludge_{2nd\,tech}) \cdot EF_{2nd\,tech}}{Load_{1st\,tech} - Sludge_{1st\,tech} - Sludge_{2nd\,tech}}$$

Where:

$Emissions_{treatment}$	Total of CH_4 or N_2O emissions considering two WWTP core technologies [$kgCH_4$/year or kgN_2O-N/year]
$Load_{1st\,tech}$	BOD or Total Nitrogen load influent to the 1_{st} technology [kg BOD_5/year or kg N/year]
$Load_{2nd\,tech}$	BOD or Total Nitrogen load influent to the 2_{nd} technology [kg BOD_5/year or kg N/year]
$EF_{1st\,tech}$	Emission factor – 1st technology [$kgCH_4/kgBOD_5$ or kgN_2O-N/kgN]
$EF_{2nd\,tech}$	Emission factor – 2nd technology [$kgCH_4/kgBOD_5$ or kgN_2O-N/kgN]
$EF_{average}$	Average emission factor [$kgCH_4/kgBOD_5$ or kgN_2O-N/kgN]
$Sludge_{1st\,tech}$	BOD removed as sludge – 1st technology [$kgBOD_5$/year] ("= 0" when calculating average N_2O emission factors)
$Sludge_{2nd\,tech}$	BOD removed as sludge – 2nd technology [$kgBOD_5$/year] ("= 0" when calculating average N_2O emission factors)

Note that the ECAM also calculates the BOD removed as sludge, although the users can calculate this value with their own data.

If there is no significant frequency of sludge removal on any of the WWTP core technologies, the users can use a simplified equation.

Equation 3 is a simplification of Equation 2, for which the users should only know the individual emission factors of each technology (provided by ECAM) and their wastewater treatment efficiencies.

[15] "step 1" is a variation of Equation 1, considering the sum of emissions in each of the core technologies.
[16] "step 2" is a second variation of Equation 1. In this case, a blackbox boundary condition model is assumed.
[17] The equation considers two core technologies (eg. Anaerobic lagoon + Facultative lagoon). In the case of three or more, just add identical variables for the additional technologies.

Equation 3 - Calculating average emission factors for WWTP with more than one core technology (without sludge removal)

$$EF_{CH4,average} = EF_{CH4,1st\ tech} + (1 - \eta_{BOD,\ 1st\ tech}) \cdot EF_{CH4,2nd\ tech}$$

$$EF_{N2O,average} = EF_{N2O,1st\ tech} + (1 - \eta_{N,\ 1st\ tech}) \cdot EF_{N2O,2nd\ tech}$$

Where:

$EF_{CH4,\ average}$	Average methane emission factor [kgCH_4/kgBOD]
$EF_{CH4,\ 1st\ tech}$	Methane emission factor – 1st technology [kgCH_4/kgBOD_5]
$EF_{CH4,\ 2nd\ tech}$	Methane emission factor – 2nd technology [kgCH_4/kgBOD_5]
$\eta_{BOD,\ 1st\ tech}$	BOD_5 removal efficiency in the 1st technology [%]
$EF_{N2O,\ average}$	Average nitrous oxide emission factor [kgN_2O-N/kgN]
$EF_{N2O,\ 1st\ tech}$	Nitrous Oxide emission factor – 1st technology [kgN_2O-N/kgN]
$EF_{N2O,\ 2nd\ tech}$	Nitrous Oxide emission factor – 2nd technology [kgN_2O-N/kgN]
$\eta_{N,\ 1st\ tech}$	Total Nitrogen removal efficiency in the 1st technology [%]

In case the user does not know exactly the treatment efficiencies of the WWTP core technologies, we suggest the adoption of EF values from Table 5, which were calculated based on reference literature.

Table 5 - Suggested emission factors for WWTP with more than one core technology, without sludge removal

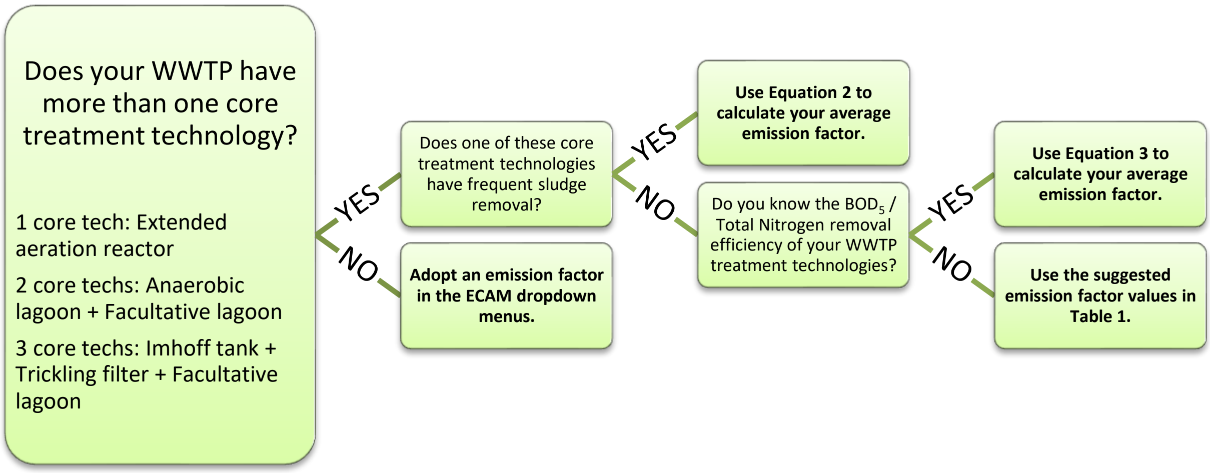
Treatment technology	Eficiency Removal in the first technology (% of removal)				Emission Factor ($kgCH_4/kgBOD_5$ or kgN_2O-N/kgN)					
	BOD_5		N_{total}		1st technology		2nd technology		Average	
	Literature [1]	Adopted	Literature[1]	Adopted	EF_{CH4}	EF_{N2O}	EF_{CH4}	EF_{N2O}	EF_{CH4}	EF_{N2O}
Facultative lagoon	75 – 85 %	80%	< 60 %	20%	0.120	0.016	-	-	**0.120**	**0.016**
Anaerobic lagoon (no biogas recolected) + Facultative lagoon	- [2]	50%	- [2]	20%	0.480	0.000	0.120	0.016	**0.540**	**0.013**
Anaerobic lagoon (biogas recolected) + Facultative lagoon	- [2]	50%	- [2]	20%	0.140	0.000	0.120	0.016	**0.200**	**0.013**
Imhoff tank (no biogas recolected) + facultative lagoon	- [2]	60%	- [2]	20%	0.480	0.000	0.120	0.016	**0.528**	**0.013**
Imhoff tank (biogas recolected) + facultative lagoon	- [2]	60%	- [2]	20%	0.140	0.000	0.120	0.016	**0.188**	**0.013**
Imhoff tank (no biogas recolected)	- [2]	60%	- [2]	20%	0.480	0.000	-	-	**0.480**	**0.000**
Imhoff tank (biogas recolected)	- [2]	60%	- [2]	20%	0.140	0.000	-	-	**0.140**	**0.000**
Aerated lagoon	75 – 85 %	80%	< 30 %	20%	0.060	0.016	-	-	**0.060**	**0.016**
Anaerobic lagoon (no biogas recolected) + Aerated lagoon	- [2]	50%	- [2]	20%	0.480	0.000	0.060	0.016	**0.510**	**0.013**
Anaerobic lagoon (biogas recolected) + Aerated lagoon	- [2]	50%	- [2]	20%	0.140	0.000	0.060	0.016	**0.170**	**0.013**
UASB (no biogas recolected) + Aerated Lagoon	60 – 75 %	70%	< 60 %	20%	0.480	0.000	0.060	0.016	**0.498**	**0.013**
UASB (biogas recolected) + Aerated Lagoon	60 – 75 %	70%	< 60 %	20%	0.140	0.000	0.060	0.016	**0.158**	**0.013**
UASB + trickling filter	60 – 75 %	70%	60 – 75 %	20%	0.480	0.000	0.036	0.016	[3]	**0.013**
Anaerobic lagoon + trickling filter	- 2	50%	- [2]	20%	0.480	0.000	0.036	0.016	[3]	**0.013**
UASB + Anaerobic Filter	60 – 75 %	70%	< 60 %	20%	0.480	0.000	0.480	0.000	**0.624**	**0.000**
Primary clarifier + Digester/Imhoff tank + Trickling filter	- [2]	60%	- [2]	20%	0.480	0.000	0.036	0.016	[3]	**0.013**
Extended aeration	90 – 97 %	90%	< 60 %	40%	0.018	0.016	-	-	**0.018**	**0.016**

1) According to Sperling (2005).

2) Adopted based on similarity with the other processes.

3) For these combinations of technologies, the user must calculate an average methane EF from Equation 2 since there is frequent removal of sludge.

To facilitate the decision process on which equation or table to adopt, use the following decision tree:



How to choose an emission factor for discharge (using Tiers)

In the IPCC (2006; 2019), a tier represents a level of **methodological complexity**. Usually, three tiers are mentioned in IPCC. Tier 1 is the basic method, Tier 2 intermediate and Tier 3 most demanding in terms of complexity and data requirements. Tiers 2 and 3 are sometimes referred to as higher tier methods and are generally considered to be more accurate.

In practice with the ECAM tool, the Tier concept will be used for the **selection of emission factors used to calculate wastewater discharge emissions**, which are generated in the Wastewater Collection, Treatment, and Onsite Sanitation stages. In this case, "Tier" can be understood as "**Level of Information**" related to:

1. **Level of activity data** that make up the equation for which the emission factor will be applied.

2. **Level of information** that the utility has **about the water body** where the discharge is taking place.

Table 6 presents the Tier options to be chosen when selecting the wastewater discharge EF, based on the activity data and water body level of information. To select the tier of the first column, **all requirements** of the columns in the corresponding row must be met.

Once the users have defined the Tier in which their wastewater discharge data is located, it is possible to select the emission factor within the options in the dropdown menu.

For example, if the user is in a dropdown menu for the definition of a CH_4 emission factor for wastewater discharge in the Treatment Stage, with the following data:

- The utility does not have effluent BOD load data, and therefore is using ECAM estimations (Tier 1).

- The utility knows that the discharge is carried out over a specific river (Tier 2).

In the example above, not all conditions were met to select the Tier 2 option (it would be necessary to have a more precise BOD load data), and therefore the Tier 1 option is selected in the dropdown menu. The exercises in this User Manual will address in practice this selection.

Table 6 - Choosing Wastewater Discharge emission factors based on Tiers (Level of Information)

	Level of Information	
Chosen Tier	**When defining CH_4 emission factors for wastewater discharge:**	**When defining N_2O emission factors for wastewater discharge:**
Tier 1 Methodologically, the data is scaled from a particular source, which will not respond to local changes. No information about the water body is known.	**Effluent BOD_5 load:** Defined from ECAM estimates, that is, based on the extrapolation of a series of studies carried out. **Water body:** There is no need for the utility to know which type of water body the wastewater is discharged.	**Effluent Total Nitrogen load:** Defined from ECAM estimates, that is, based on the extrapolation of a series of studies carried out. **Water body:** There is no need for the utility to know which type of water body the wastewater is discharged nor if this body is impacted by nutrients or it is in hypoxic conditions.
Tier 2 Methodologically, the data are scaled from country-specific calculations or from local monitoring. No information about the water body is known.	**Effluent BOD_5 load:** Defined based on country-specific studies or on local monitoring by the utility (in this second case, the utility must consider uncertainties such as gaps in data sets). **Water body:** The utility must know to what type of water body is discharged the wastewater, i.e., if it is a river, estuary, lake, etc.	Not applicable, because the selection of the N_2O emission factors do not include a Tier 2.
Tier 3 Methodologically, the data are scaled from country-specific calculations or local monitoring. The necessary information about the water body is known.	Not applicable, because the selection of the CH_4 emission factors do not include a Tier 3.	**Effluent Total Nitrogen load:** Defined based on country-specific studies or on local monitoring by the utility (in this second case, the utility must consider uncertainties such as gaps in data sets). **Water body:** The utility must know the water body and know if it is impacted by nutrients and/or in hypoxic conditions.

Section 5: Case Scenario examples

This topic presents practical examples of using the ECAM tool to calculate GHG emissions in the Urban Water Sector. The solution of these cases is provided step-by-step using screenshots.

This topic is a preparation for practicing the exercises in the next topic.

Calculate emissions from a water pumping facility in the Abstraction Stage

The management of the Urban Water Utility "Hope" is thinking about which mitigation measures should be prioritized this year.

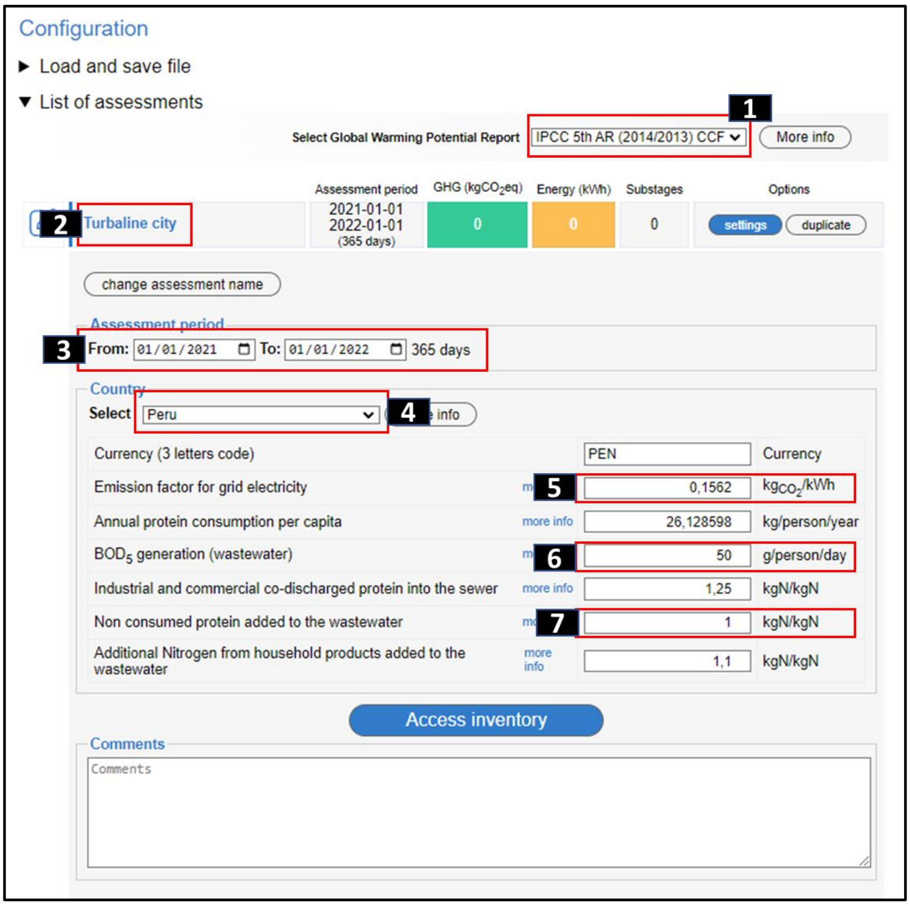
To gather more information, the manager asked the team to account for emissions from the water pumping facility used for ABSTRACTION in the hypothetical city of Turbalina, in Peru. After consulting their database, the technicians found the following information:

- The pumping system consumed **4,150,000 kWh/year** from the grid.
- The backup power supply system for the pumps is made up of two gasoline engines. These motors operated a few days throughout the year due to network failure or scheduled maintenance. In total, **52,000 liters of gasoline** were consumed in the year.

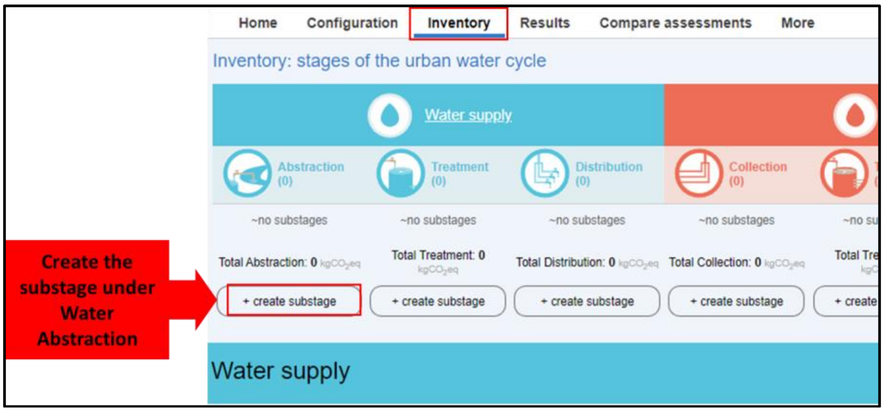
Now, in ECAM we are going to estimate the emissions related to **electricity (indirect)** and **fuel engines**.

To do the calculations, let's prepare the ECAM Configuration tab:

1. Select **the most recent IPCC GWP Report**, since there are no requirements for using older versions.
2. Choose the **name of your assessment**.
3. Choose the **evaluation period from 01/01/2021 to 01/01/2022**.
4. Choose "**Peru**" as your country.
5. Change the **electricity emission factor** to **0.1562 kg CO_{2eq}/kWh**, since we have this information from official institutions.
6. Change the **BOD_5 generation factor** for wastewater to **50 g per person per day**, since we have this information from official institutions.
7. Change the value of the **non consumed protein added to wastewater factor to 1**, since we have this information from official institutions.



As a next step, let's access the inventory. Then click on "create substage" under Abstraction, which is what we'd like to assess.

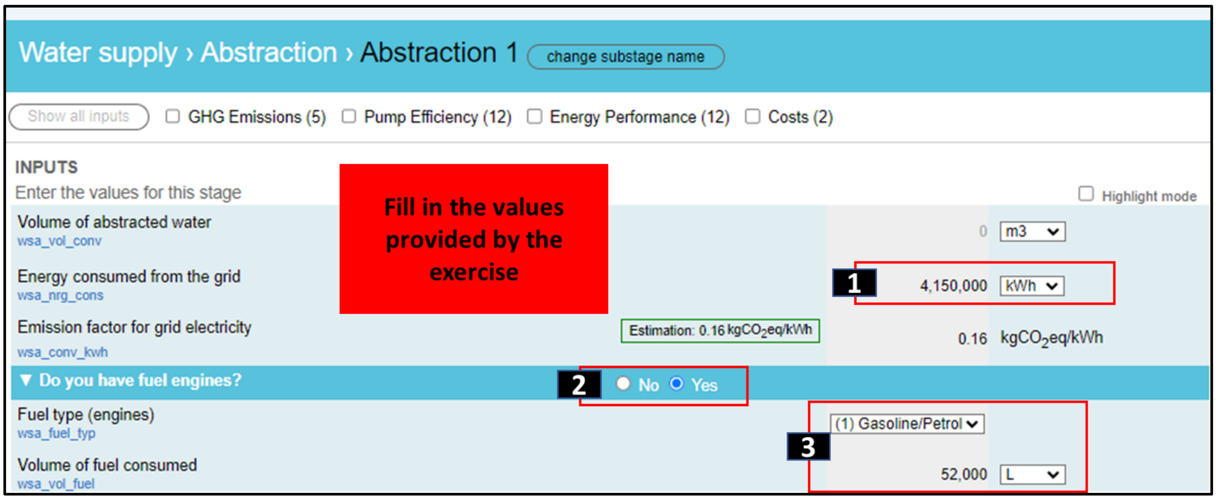


We will need to fill in the data we have to estimate the emissions.

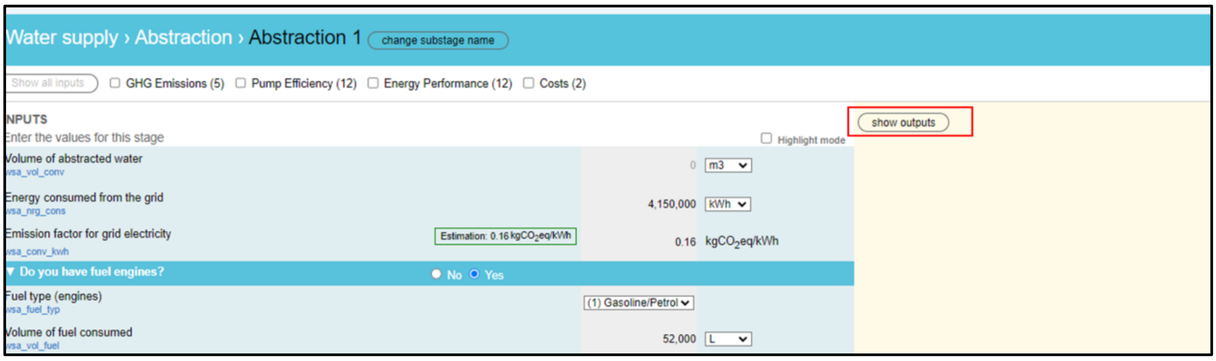
1. Fill in the energy consumption from the grid for the whole year. The Emission factor for grid electricity was defined in the general factors section.

2. Activate the option to calculate emissions for onsite fuel engines.

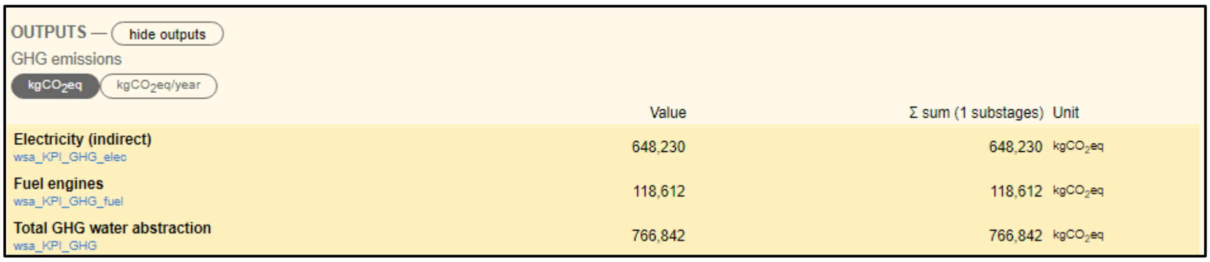
3. Fill in the information about onsite fuel consumption. Remember to choose the type of fuel, which in this case is Gasoline.



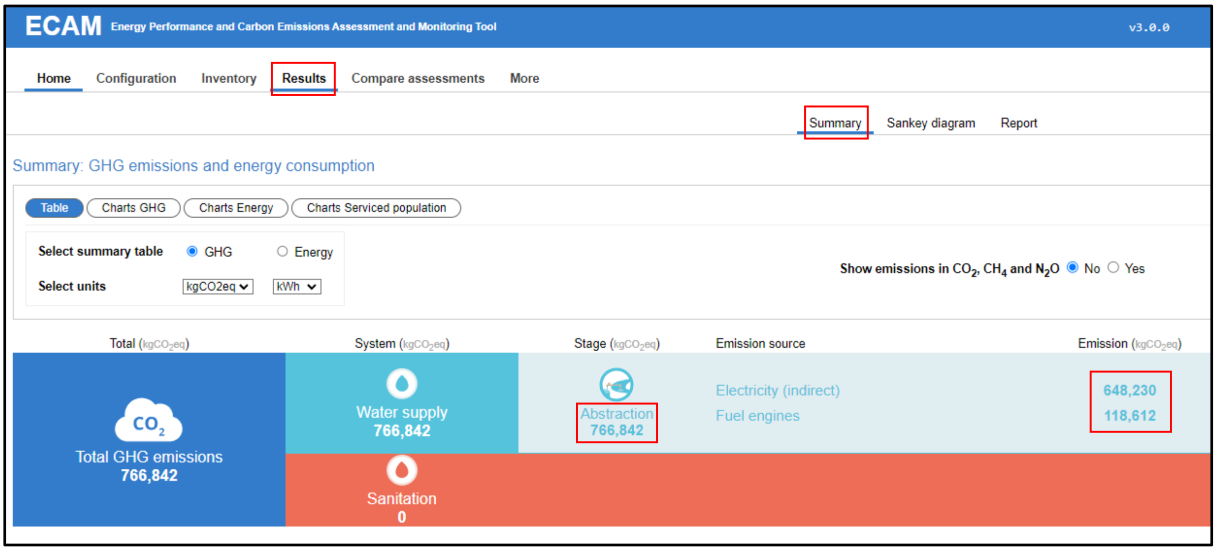
The resulting GHG emissions can be checked in the Outputs section. Click on "show outputs".



The Outputs section shows the results of the requested calculations. In the image below, we can see the result for the emissions referring to **Electricity from the grid (648,230 kg CO_{2eq})**, **Fuel Engines (118,612 CO_{2eq})**, and **Total Emissions in Water Abstraction (766,842 CO_{2eq})**.



The same results could be inspected in the "Results - Summary" tab.



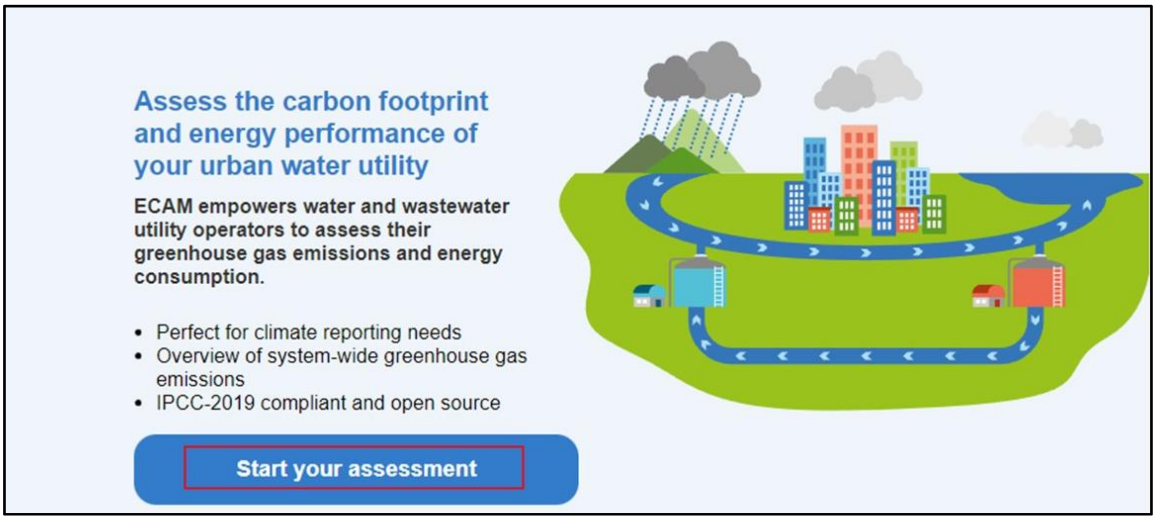
Calculate emissions from a WWTP

In this case, the proposal is to calculate the **total GHG emissions of a WWTP** composed by a **facultative lagoon**.

Relevant information about the process includes:

- The population serviced by the wastewater treatment system is **100,000 people**.
- The WWTP electricity consumption is entirely from the grid, with a total of **30,000 kWh** in 2021.
- We will **not consider removing sludge** from processes.
- The treated effluent is **discharged into a river**.

First, start your assessment, or create a new one under the Configuration tab.



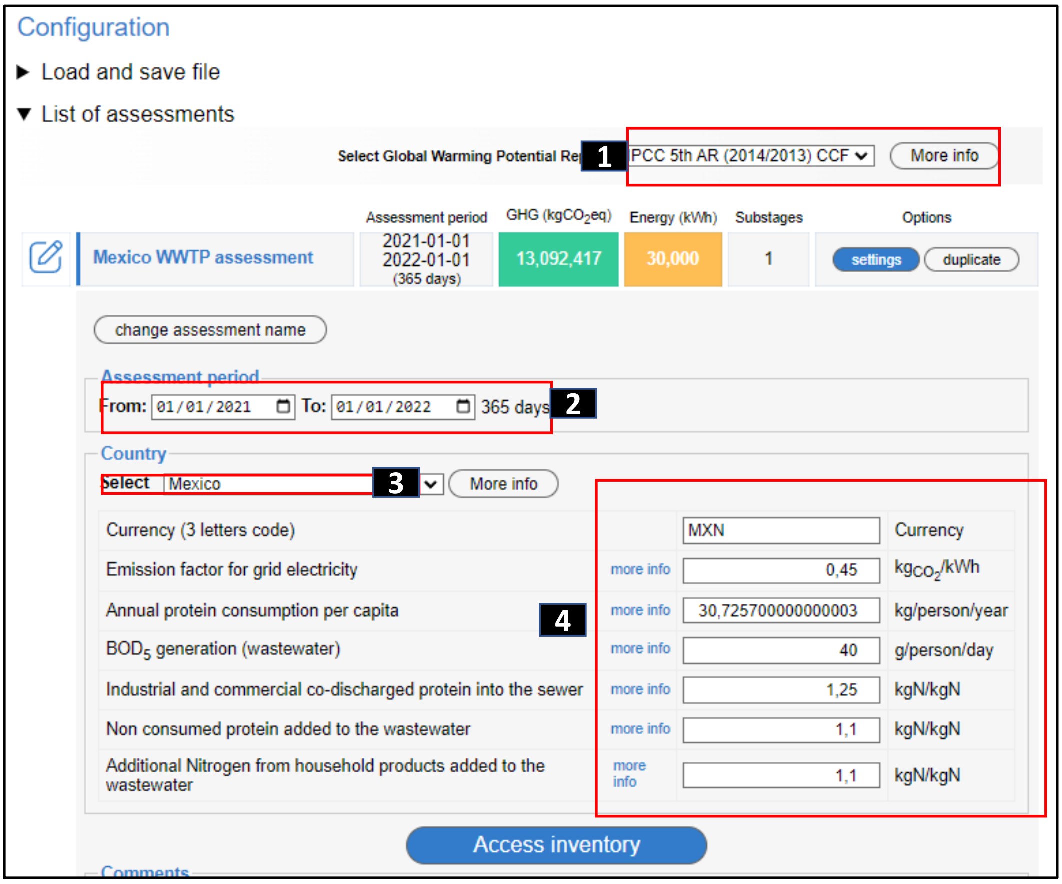
Now you will need to prepare the Configuration tab considering the following information:

1. Let's use the GWP Report IPCC 5th AR CCF.

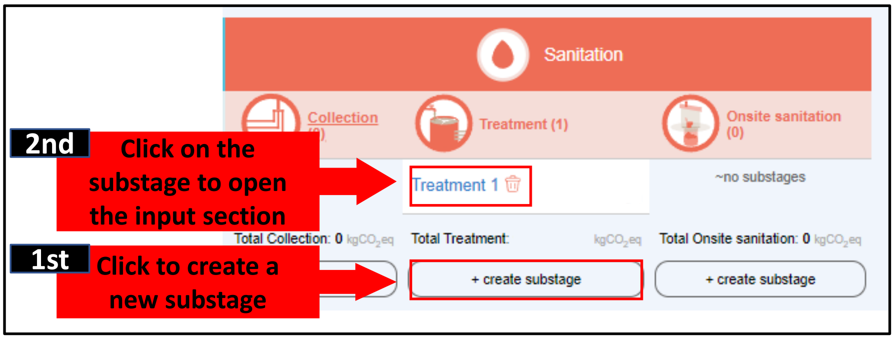
2. The assessment period will be the full year of 2021.

3. The assessment will take place at a facility in Mexico.

4. For the general factors, we will keep the values suggested by ECAM, since we don´t have local or official factors to replace them.



The next step will be to create a substage within the Wastewater Treatment stage.



Now you must fill in the Input Section according to the data provided by the exercise.

1. The population serviced by the wastewater treatment system is **100,000 people**.

2. When filling in the serviced population, ECAM will suggest some **estimates** for the inputs (**green squares**). These values are also calculated based on the general factors selected in the Configuration tab (for example, from the BOD generated per capita it is possible to calculate the Load of Influent BOD to the WWTP[18]). **To use estimates, click on the suggested value**.

[18] Check more about that in the Methodology Guide.

3. We do not have information about the BOD load in the effluent (there is no monitoring in the WWTP). It would be possible to calculate it from the efficiency of our process, but we are not sure about this data either. In this sense, we are going to use the **dropdown menu** offered by ECAM, selecting the technology we have. The lagoon is a primary + secondary process. **The software also calculates the value in kg/year**.

4. If you don't have WWTP affluent monitoring data, you should also use estimation for the Nitrogen load in the influent. **To use estimates, click on the suggested value**.

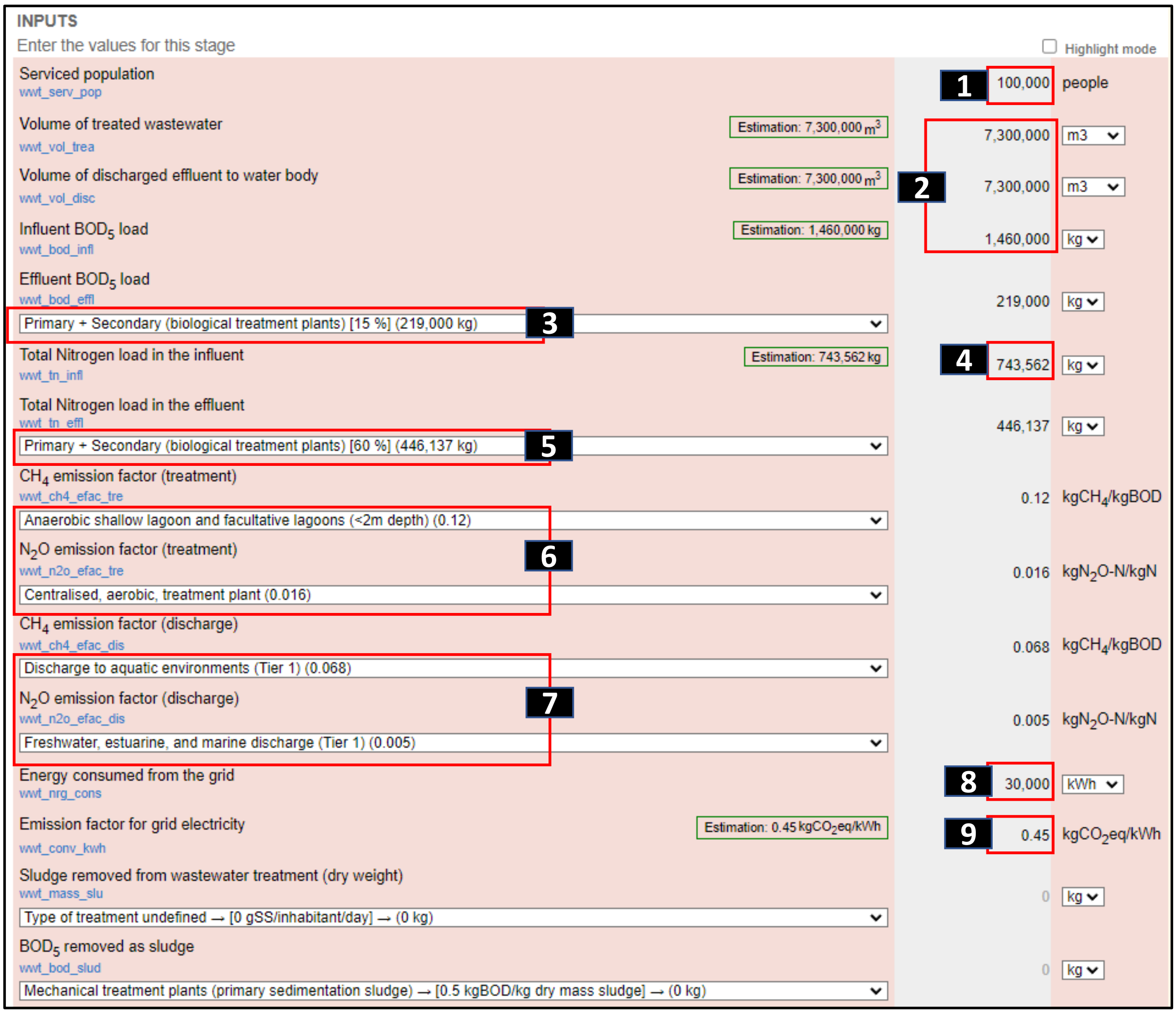
5. Like step 3, we can calculate the Total Nitrogen load in the effluent from the dropdown menu. **Select the "primary + secondary process" option**.

6. Considering the technological composition of the treatment process (facultative lagoon), choose the right options in the dropdown menus. A facultative lagoon is also an aerobic treatment.

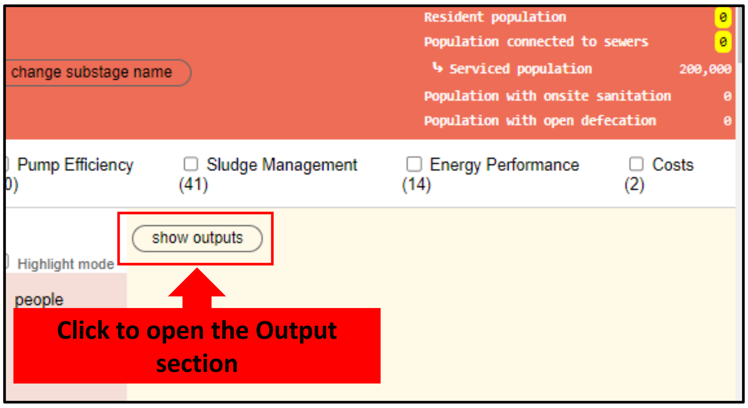
7. The discharge emission factor is defined based on the type of discharge and the level of information that we have:
    - For CH_4 emission factor (discharge):
        - We have information about the water body of discharge, we know it is a specific river (Level 2).
        - The BOD load data used are estimated by ECAM from the efficiency of our process, also based on an influent BOD estimate (Level 1).
        - Based on this, **choose the factor 0.068**.
    - For the N_2O emission factor (discharge):
        - There is information about the water body, but there is no measurement of nutrients (Level 2).
        - Based on this, **choose the factor 0.005**.

8. The WWTP electricity consumption is entirely from the grid, with a total of **30,000 kWh** in 2021.

9. The emissions factor for grid electricity comes from the General factors in the Configuration tab.



The Outputs section shows the results of the calculations.



In the image below, we can see the result for the emissions referring to **Total GHG wastewater treatment (11,901,057 kg CO_{2eq})**.

OUTPUTS — hide outputs

GHG emissions

kgCO$_2$eq | kgCO$_2$eq/year | kgCO$_2$eq/year/serv.pop.

	Value	Σ sum (1 substages)	Unit
Electricity (indirect) wwt_KPI_GHG_elec	13,500	13,500	kgCO$_2$eq
Treatment process wwt_KPI_GHG_tre	10,336,631	10,336,631	kgCO$_2$eq
Biogas (anaerobic digestion of sludge) wwt_KPI_GHG_biog	0	0	kgCO$_2$eq
Fuel (digester) wwt_KPI_GHG_dig_fuel	0	0	kgCO$_2$eq
Sludge management wwt_KPI_GHG_slu	0	0	kgCO$_2$eq
Discharged water wwt_KPI_GHG_disc	1,550,926	1,550,926	kgCO$_2$eq
Total GHG wastewater treatment wwt_KPI_GHG	11,901,057	11,901,057	kgCO$_2$eq

Sludge Anaerobic Digester vs Landfilling

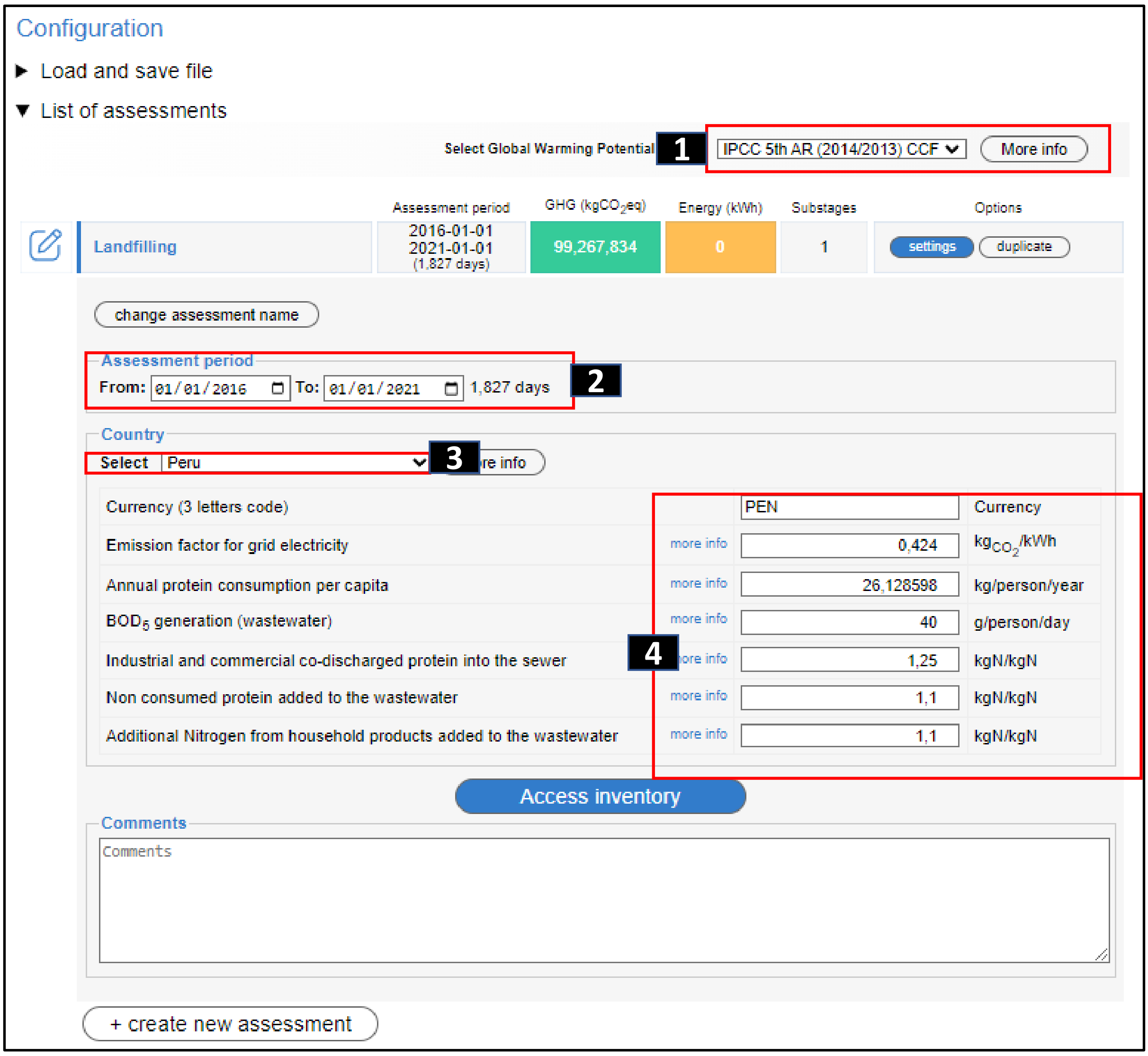
This case presents a proposal for calculating avoided GHG emissions in recent years, coinsidering that a utility makes a switch from **Landfilling** sludge to **Anaerobic Digestion** at the Wastewater Treatment Plant.

We will consider:

- The analysis will be between **01/01/2016 to 01/01/2021**.
- The amount of sludge produced during this entire period was **23,675 tons in dry weight**. This data was obtained by operational monitoring.

Start by performing the General Setup on the Configuration tab:

1. Let's use the GWP Report IPCC 5th AR CCF.
2. Select the entire evaluation period.
3. Select the country where the facility is located, which is Peru.
4. There is no local data for the general factors, so we will use the ECAM suggestions based on the IPCC.



Landfill

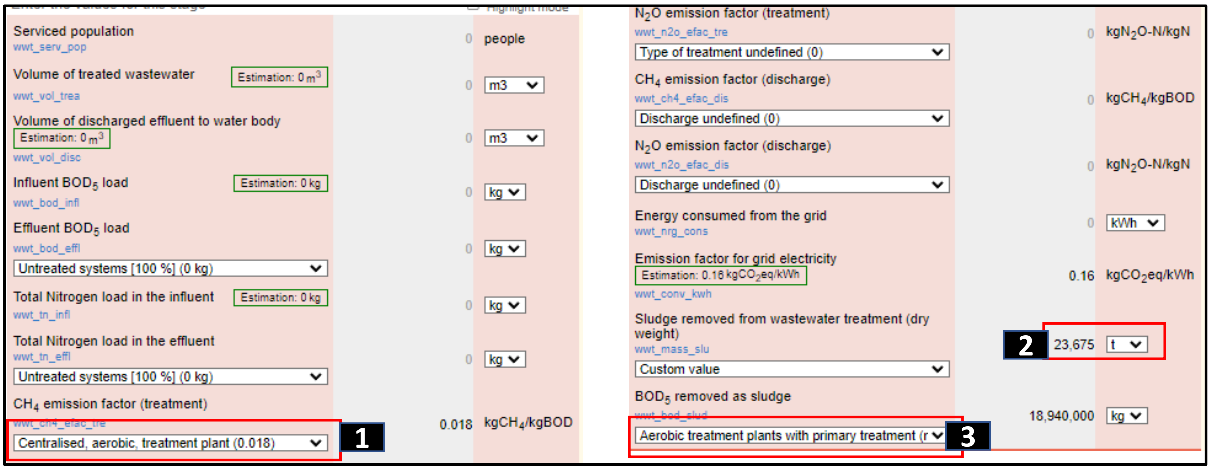
First, we are going to generate an assessment (scenario) considering that **there is no anaerobic sludge digester**. For this, it is also important to indicate the methane emission factor of the wastewater treatment, because a reduction in the organic load due to the removal of BOD_5 must be considered.

In this case, the sludge management will consider that undigested sludge is sent to a sanitary landfill, where there is no recovery or burning of biogas, which is emitted directly into the atmosphere.

Initially you must:

1. Fill in the CH_4 emission factor from wastewater treatment.
2. Fill in the amount of sludge produced in the WWTP (dry weight).

3. Select the option “aerobic treatment plants with primary treatment (mixed primary and secondary sludge, untreated or treated aerobically).



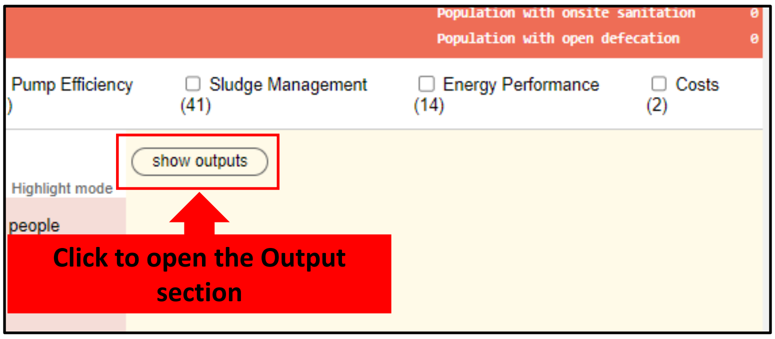
Then, in the question “**Evaluate sludge management?”** choose “Yes”, and in the question “**Is sludge sent to landfilling**?” choose “Yes”.

1. Enter the same amount of sludge generated in the field “sludge sent to a landfill (dry weight)”

2. Choose the “Non-digested” option in “Total Volatile Solids (%)” and “N content of sludge (% dry weight)”.

3. In "Methane correction for anaerobically managed landfills", select "Sanitary Landfill" option.

The Outputs section shows the results of the requested calculations.



In the image below, we can see the result for the emissions referring to **Total GHG wastewater treatment (99,267,834 kg CO_{2eq})**.

Sludge management wwt_KPI_GHG_slu	110,859,114	110,859,114	$kgCO_2eq$
Discharged water wwt_KPI_GHG_disc	0	0	$kgCO_2eq$
Total GHG wastewater treatment wwt_KPI_GHG	99,267,834	99,267,834	$kgCO_2eq$

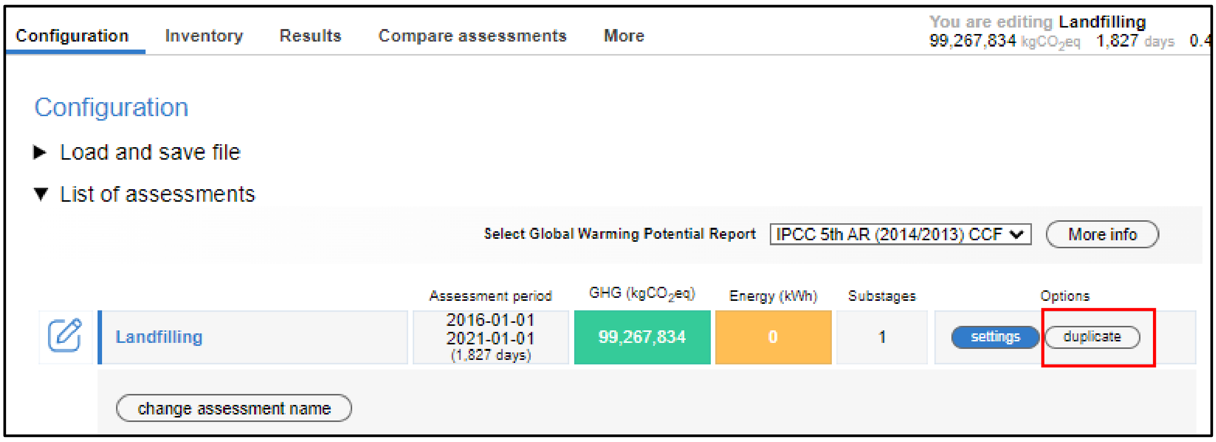
Sludge Digester

Additional information about the Sludge Digester include:

- The amount of sludge sent to the landfill is reduced by treatment in the anaerobic digester. According to the operational reports we can assume a reduction of the total solids of **26.24%.** Therefore, we are now going to consider sending only **17,464 tons of digested sludge** to the landfill instead of the 23,675 tons in the previous assessment/scenario.

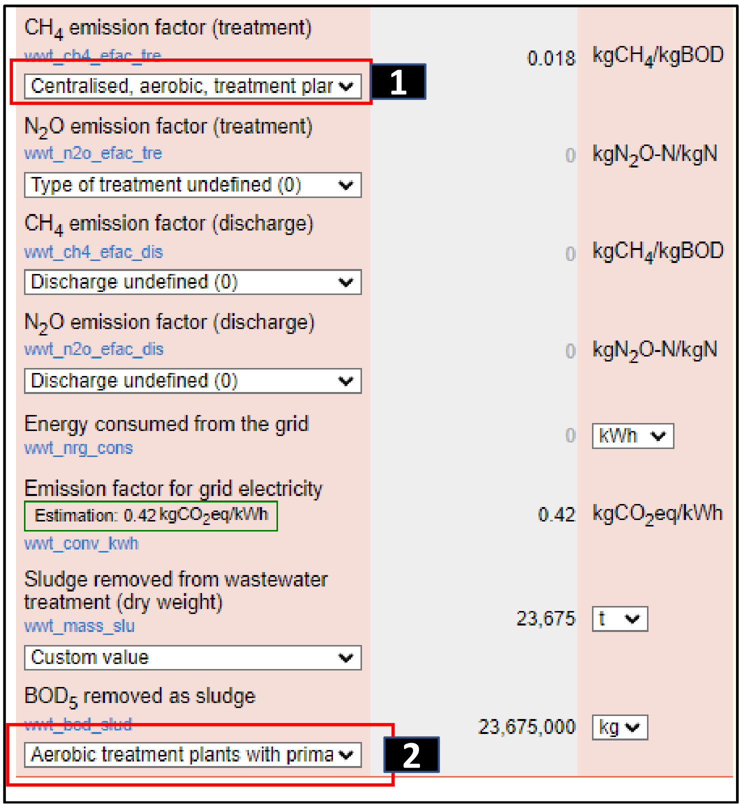
- Since the anaerobic sludge digester produces biogas with a **methane concentration** of **67%**, we also need to determine the GHG emissions from losses to the atmosphere. We can assume a biogas production **of 5,819,342 Nm^3**, at normal conditions (N) of pressure (P = 1 atm.) and temperature (T = 0°C), during the 5 years; and that 98% of the production is burned and 2% is lost or released into the atmosphere.

To make the comparison, we are going to duplicate the evaluation/scenario (without anaerobic digester) generated above.



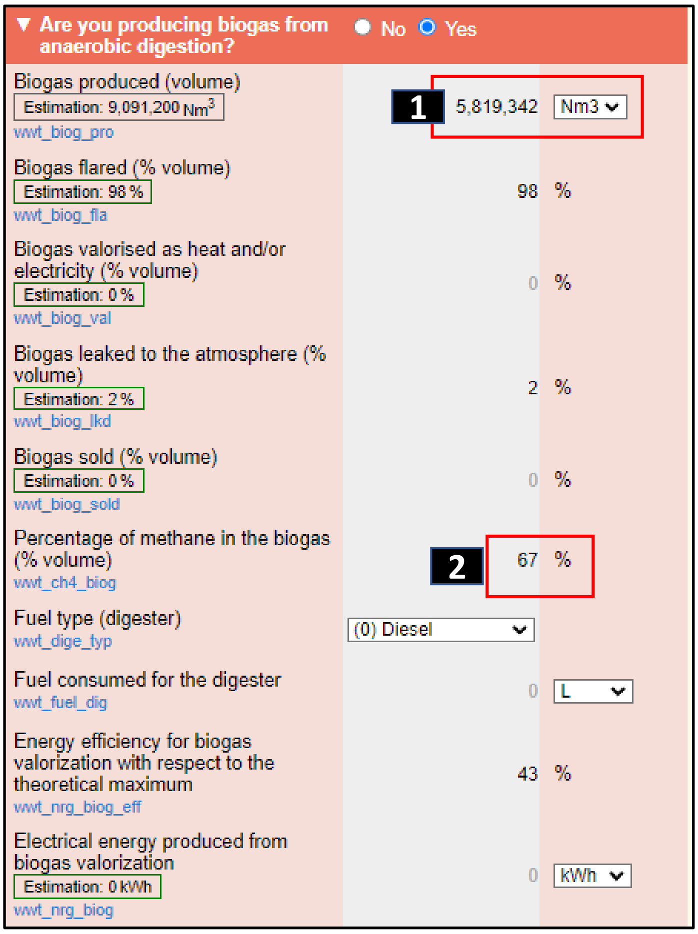
1. Keep the methane emission factor from the wastewater treatment and the amount of sludge produced in the WWTP (dry weight).

2. Change the BOD_5 removed as sludge to "aerobic treatment plants with primary treatment and anaerobic digestion of sludge (mixed primary and secondary sludge, treated anaerobically)".

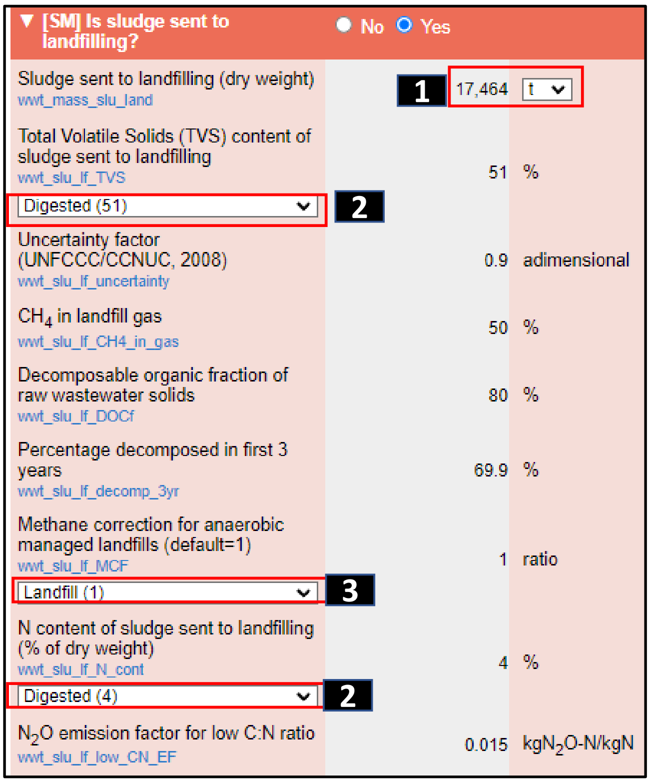


1. In relation to biogas production, fill in the amount of **5,819,342 Nm^3** for the 5 years.

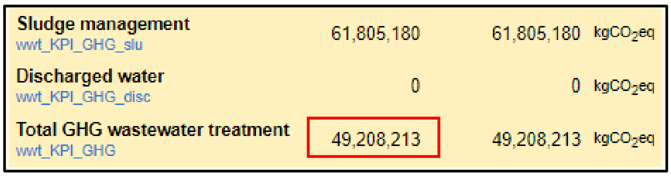
2. Keep the percentages of biogas burned, biogas released into the atmosphere and change the percentage of methane in the biogas to 67%.



1. Enter the new amount of digested sludge in the "sludge sent to landfilling (dry weight)" field
2. Choose the "Digested" option in "Total Volatile Solids (% dry weight)" and "N content".
3. In the "Methane correction for anaerobically managed landfills" field, select the "Landfill" option.



The emission results can also be displayed at the Output Section. In the image below, we can see the result for the emissions referring to **Total GHG wastewater treatment (49,208,213 kg CO_{2eq})**.



As a conclusion, we know that without an anaerobic sludge digester, the sludge management system generated 99,267,834 $kgCO_{2eq}$. With the implementation of the anaerobic sludge digester, the system generates 49,208,213 $kgCO_{2eq}$. **There is a reduction of 50,059,621 $kgCO_{2eq}$.**

Section 6: Putting into practice: proposed case exercises

Calculate emissions from a water pumping facility in the Distribution Stage

The management of an Urban Water Utility in Guatemala saw your results obtained on the emissions from the Water Abstraction (refer to *Calculate emissions from a water pumping facility in the Abstraction Stage*) stage when you were working at the Water Utility "Hope".

There is now also interest in assessing the GHG emissions from the **Water Distribution stage** pumping system located in another city: the **Memory City, in Guatemala**.

Types of emissions that will be considered in this exercise:

- ➢ Electricity (indirect).
- ➢ Fuel Engines.

After consulting the database, the technicians found the following information:

- The pump system consumed **1,500,000 kWh/year** from the grid**.**
- The backup power supply system for the distribution pumps is made up of **onsite diesel engines**. These engines operated a few days throughout the year due to grid failures or scheduled maintenance. In total, **20,000 liters of diesel** were consumed in 2021.

Start by performing the General Setup on the Configuration tab:

5. Select the entire year of 2021 as the evaluation period.
6. Let's use the GWP Report IPCC 5th AR CCF.
7. Select the country where the facility is located.
8. There is no local data for the general factors, so we will use the ECAM suggestions based on the IPCC.

Answer the following questions:

A. How much GHGs are generated in **Electricity (indirect)**, **Fuel engines**, and **Total GHG water distribution** in CO_{2eq}?

B. The utility would also like to know how many **kg of CO equivalent** are generated **per year by each inhabitant** served by the distribution system. This result will be used for benchmarking with other utilities. The population serviced is 50,000 inhab.

Calculate emissions from a WWTP

In this exercise, the proposal is to calculate the **GHG emissions of a WWTP** that uses a process composed of an **anaerobic lagoon** followed by a **facultative lagoon** in the treatment of wastewater.

Types of emissions that will be considered in this exercise:

- ➢ Emissions from Electricity (indirect).
- ➢ Emissions from Treatment.
- ➢ Emissions from Discharged Water.

Relevant information about the process includes:

- The population serviced by the wastewater treatment system is **200,000 people**.
- The WWTP electricity consumption is entirely from the grid, with a total of **140,000 kWh** in 2021.
- Considering the technological composition of the treatment process (anaerobic + facultative lagoons) a methane emission factor of **0.540 kgCH_4/kgBOD** should be assumed. The average nitrous oxide emission factor for the treatment is **0.013 kgN_2O-N/kgN**. Check the topic "**How to choose an emission factor for treatment if my WWTP has two or more core** technologies" to understand this choice.
- We will **not consider removing sludge** from processes.
- The treated effluent is **discharged into a river**.

Start by performing the General Setup on the Configuration tab:

1. Let's use the GWP Report IPCC 5th AR CCF.
2. The assessment period will be the full year of 2021.
3. The assessment will take place at a facility in the United States.
4. In the USA around 50% of the food waste is disposed of in sewers through the sinks, so the Non consumed protein added to the wastewater is higher. Let's consider a value of 1.13, according to IPCC table 6.10A (Volume 5, 2009).
5. For the other General factors, we will keep the values suggested by ECAM, since we don´t have local or official factors to replace them.

Answer the following questions:

A. How much is the **total GHG emissions** generated in the Wastewater Treatment Stage (**treatment + discharge + electricity**)?

B. How much is the GHG emission of the Wastewater Treatment Stage **per serviced population** (**treatment + discharge + electricity**)?

C. Which of the considered gases - **carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)** - generate **the most significant GHG emissions** and how much is their **corresponding emission** in CO_{2eq} (treatment + discharge + electricity)?

Conduct a complete assessment of an Urban Water Utility

The Urban Water Utility "Visionary Water (VW)" is preparing an inventory of greenhouse gas emissions from the systems it operates, which include water and sanitation facilities. VW must therefore assess its main sources of GHG emissions.

Types of emissions that will be considered in this exercise:

- Water Abstraction, Treatment, and Distribution:
  - Emissions from Electricity (indirect) and Fuel engines.
- Sanitation Collection:
  - Emissions from Discharge to water body (untreated)
- Sanitation Treatment:
  - Emissions from Electricity (indirect).
  - Emissions from Treatment process and from Discharged water.
  - Emissions from Biogas (anaerobic digestion of sludge)

Relevant information was accessed in the urban water utility database. They were organized according to each stage of the ECAM tool:

- Water Abstraction:
  - The system is composed of pumps and equipment transporting water from a river using energy from the grid. In the year 2019, the system consumed **3,200,000 kWh** of electrical energy. The backup power supply system consists of **gasoline engines** and consumed **65,000 liters** in the year 2019.
- Water Treatment:
  - The drinking water treatment system consumed **850,000 kWh** of electrical energy from the grid in the year 2019. The backup system is also composed of gasoline engines and consumed **10,000 liters** in the same year.
- Water Distribution:
  - The system is composed of boosters that supply additional pressure when necessary. It consumed 3,800,000 kWh in the year 2019. The backup power supply system consists of **diesel engines** and consumed **22,000 liters** in the year 2019.
- Sanitation Collection:
  - The population connected to the sewer system is **150,000 people**.
  - VW wants to include in the scope the emissions related to the **Discharge to water body (untreated)**, since part of the collection system is not yet connected to a wastewater treatment plant. **15% of the volume of collected wastewater** is not yet being treated and is being discharged into water bodies about which the utility has no information.

    - The sanitation collection system is **100% gravitational.** Electricity consumption will not be considered.

- Sanitation Treatment:

    - **85% of the 150,000 people** connected to the sewer system **are being serviced** by the WWTP.

    - The **technology** adopted at the WWTP is activated sludge, a **centralized aerobic treatment system composed of primary + secondary treatment**.

    - The WWTP electricity consumption is entirely from the grid, with a total of **4,100,000 kWh** in 2019.

    - The treated wastewater is discharged to River Melbourne.

    - The operational control shows that the system **produced 3,000 tonnes of sludge (dry weight) in 2019**.

    - The sludge is treated anaerobically in a **sludge digester** that produces biogas with **65%** metered (measured) **methane concentration**, where **98% of the production is flared** and approximately **2% is lost or released to the atmosphere**. The digested sludge is sent to landfilling.

    - Sludge emissions that occur OUTSIDE of the WWTP, ie, those related to the final disposal of the digested sludge, will not be considered. This decision refers to the scope defined by the utility.

Start by performing the General Setup on the Configuration tab:

1. Let's use the GWP Report IPCC 5th AR CCF.

2. The assessment period will be the full year of 2019.

3. The assessment will take place in Australia.

4. For the General factors, we will keep the values suggested by ECAM, since we don´t have local or official factors to replace them.

Answer the following questions:

A. How much GHG emissions are generated for each of the emissions requested by the exercise (CO_{2eq})?

Water Abstraction	Electricity (indirect)	
	Fuel engines	
Water Treatment	Electricity (indirect)	
	Fuel engines	
Water Distribution	Electricity (indirect)	
	Fuel engines	
Sanitation Collection	Discharge to water body (untreated)	
Sanitation Treatment	Electricity (indirect)	
	Treatment process	
	Biogas (anaerobic digestion of sludge)	
	Discharged water	

B. Is the greater consumption of electrical energy associated with the Utility's Water supply or Sanitation systems? Rank the stages according to the highest energy consumption (in CO_{2eq}) in the reference year.

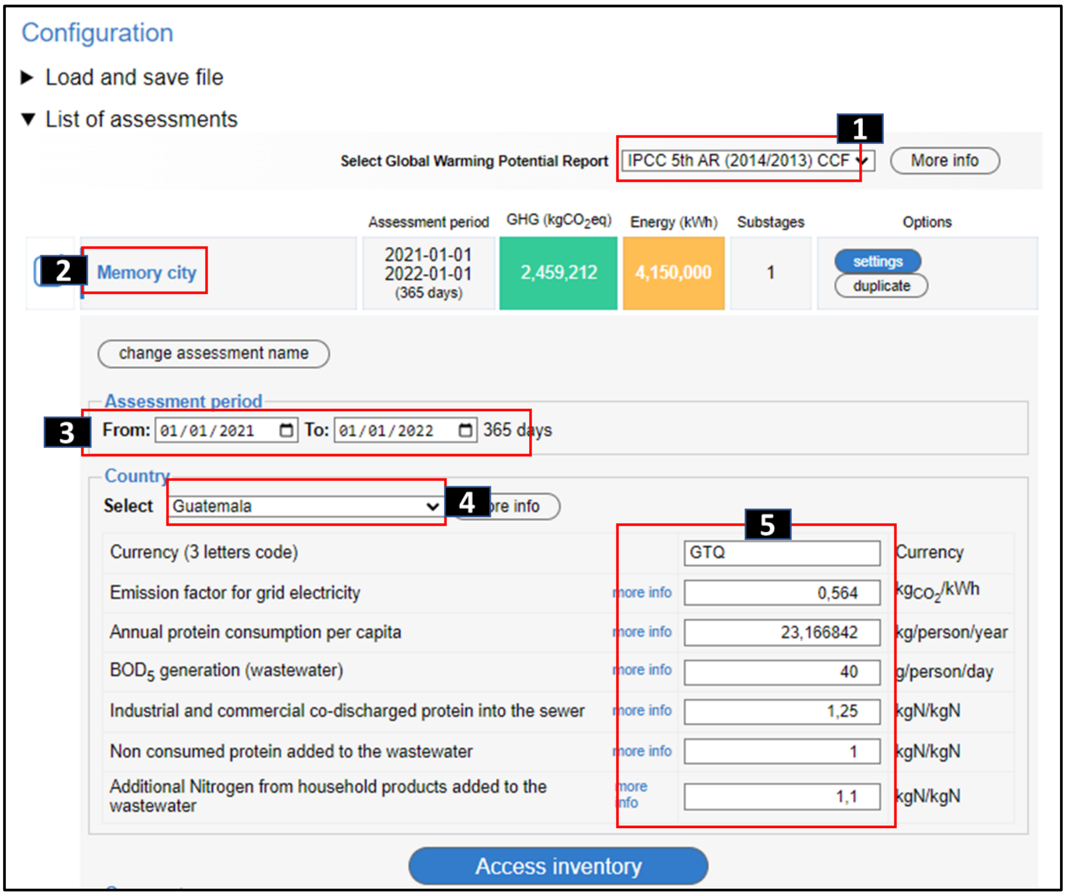
C. Which gas has the greatest absolute representation of emissions for the utility (in CO_{2eq})? And which gas has the highest unitary generation and in which stage (in CO_{2eq})?

Results for the proposed exercises

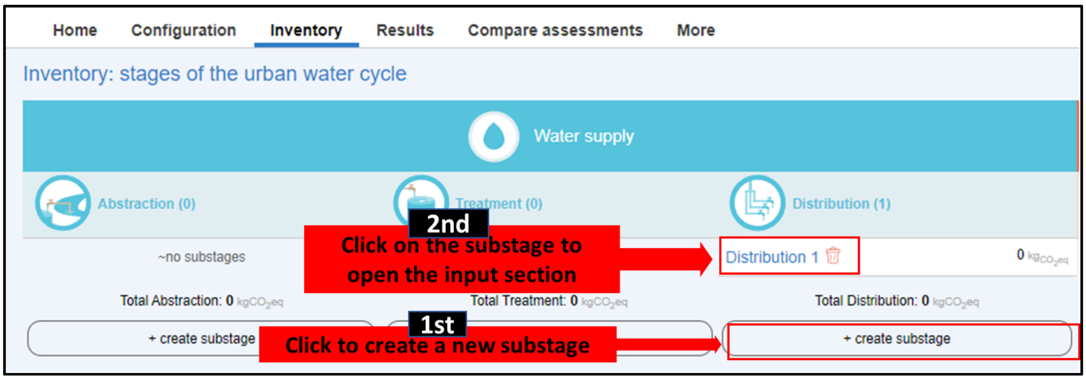
Calculate emissions from a water pumping facility in the Distribution Stage

The first thing to do is to prepare the Configuration tab according to the specifications.

1. Select the GWP Report IPCC 5th AR CCF.
2. Select the name of your assessment.
3. Select the assessment period to consider the full complete year of 2021. Remember to choose it from the 1st of January to the 1st of January.
4. Select the country where the facility is located (Guatemala)
5. There is no local data for the general factors, so we will use the ECAM suggestions.



As a next step, let's access the Inventory tab and create a substage in the Distribution stage.

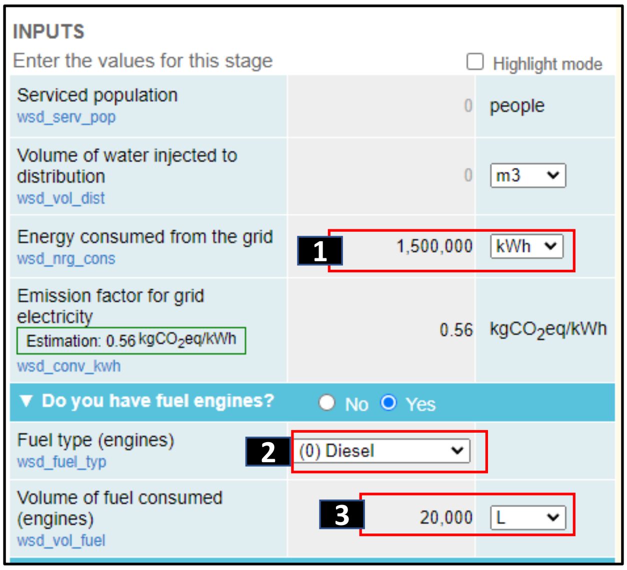


Within the created substage, it will be necessary to fill in the information:

1. The pump system consumed **1,500,000 kWh/year from the grid.**

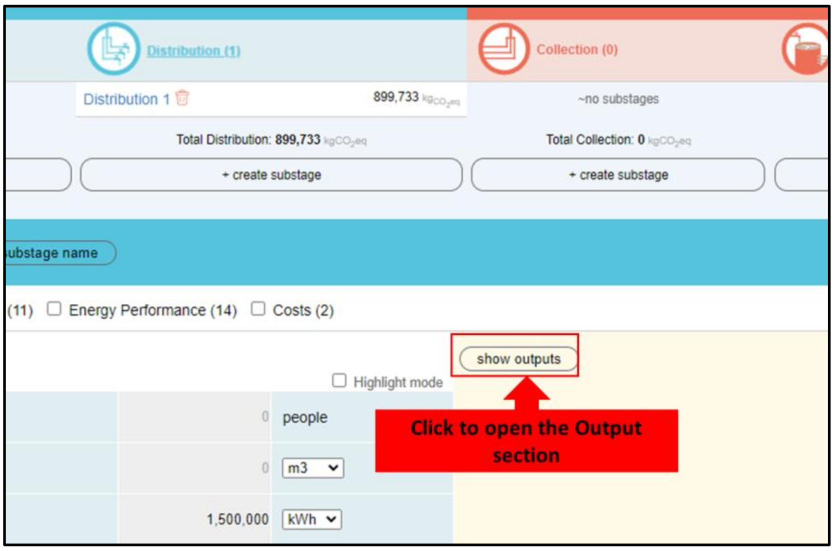
2. The backup power supply system for the distribution pumps is made up of **onsite diesel engines**.

3. These engines operated a few days throughout the year due to grid failures or scheduled maintenance. In total, **20,000 liters of diesel** were consumed in 2021.



Now answer the following questions.

A. How much GHGs are generated in **Electricity (indirect)**, **Fuel engines**, and **Total GHG water distribution** in CO_{2eq}?



The Outputs section shows the results of the requested calculations. In the image below, we can see the result for the emissions referring to **Electricity from the grid (846,000 kg CO_{2eq})**, **Fuel Engines 53,733 CO_{2eq})**, and **Total Emissions in Water Abstraction (899,733 CO_{2eq})**.

OUTPUTS — hide outputs

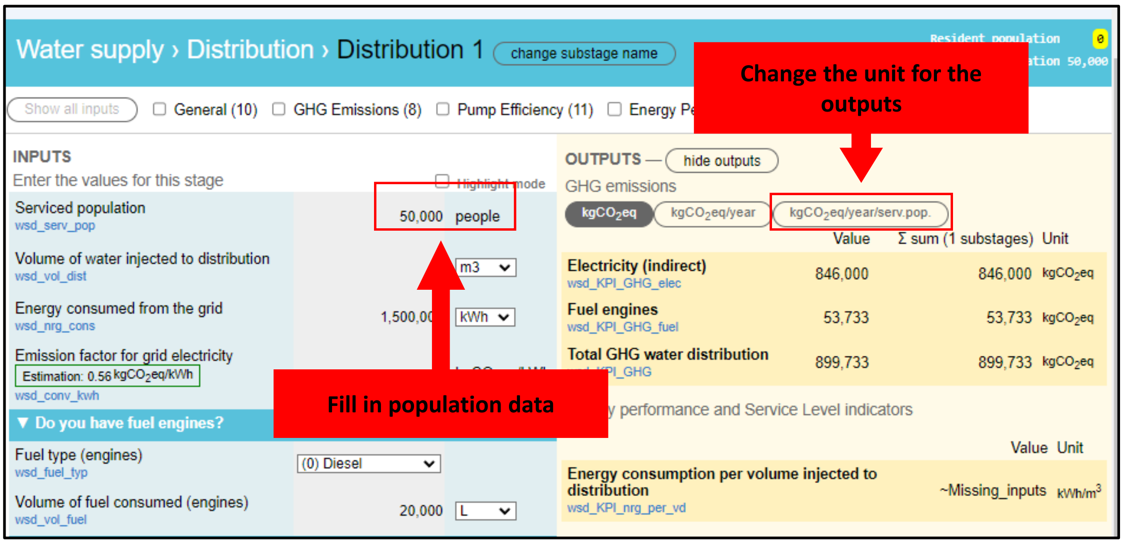
GHG emissions

kgCO$_2$eq | kgCO$_2$eq/year | kgCO$_2$eq/year/serv.pop.

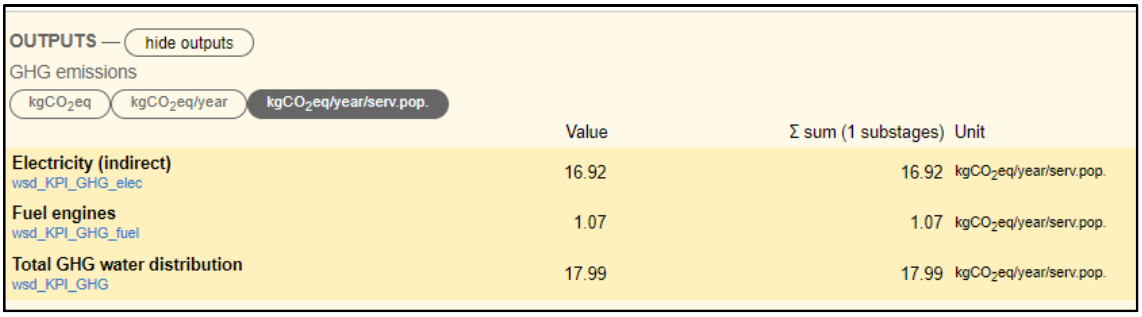
	Value	Σ sum (1 substages)	Unit
Electricity (indirect) wsd_KPI_GHG_elec	846,000	846,000	kgCO$_2$eq
Fuel engines wsd_KPI_GHG_fuel	53,733	53,733	kgCO$_2$eq
Total GHG water distribution wsd_KPI_GHG	899,733	899,733	kgCO$_2$eq

B. The utility would also like to know how many **kg of CO equivalent** are generated **per year by each inhabitant** served by the distribution system. This result will be used for benchmarking with other utilities. The population serviced is 50,000 inhab.

Fill in the population data and change the unit shown in the Output section.



Once you have changed the units, you can check the updated results in the Outputs section. In the image below, we can see the result for the emissions (**$kgCO_{2eq}$/year/serv.pop)** referring to **Electricity from the grid (16.92)**, **Fuel Engines (1.07)**, and **Total Emissions in Water Abstraction (17.99)**.



Calculate emissions from a WWTP

In this exercise, the proposal was to calculate the **GHG emissions of a WWTP** that uses a process composed of an **anaerobic lagoon** followed by a **facultative lagoon** in the treatment of wastewater.

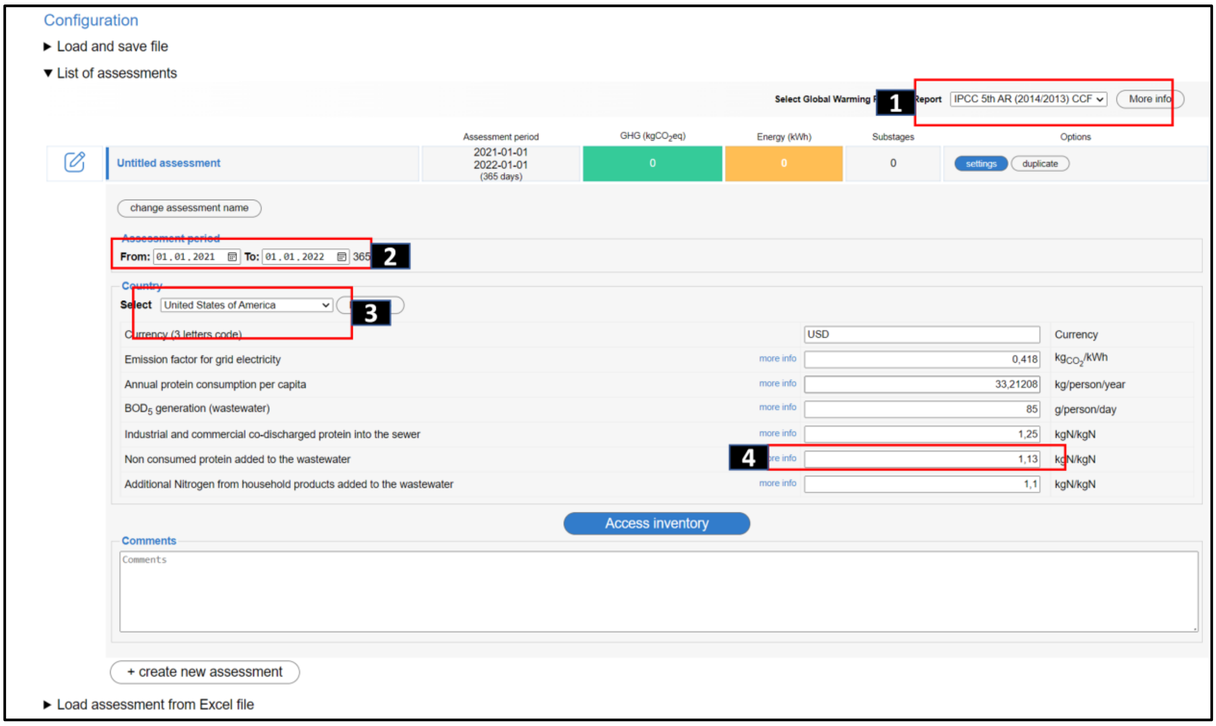
First, start your assessment, or create a new one under the Configuration tab.

Now you will need to prepare the Configuration tab considering the following information:

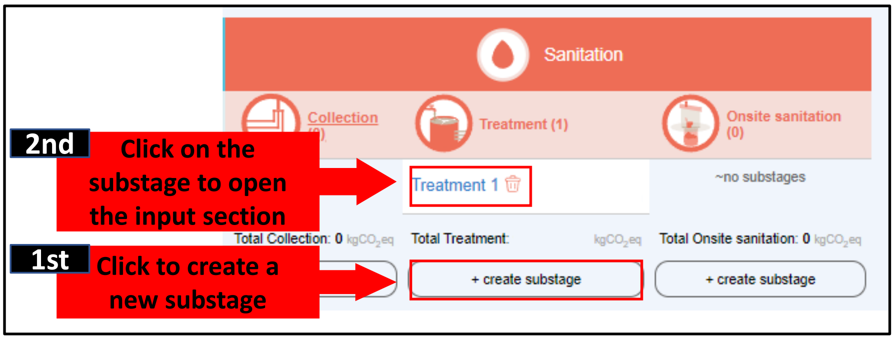
1. Let's use the GWP Report IPCC 5th AR CCF.
2. The assessment period will be the full year of 2021.
3. The assessment will take place at a facility in the United States.

4. In the USA around 50% of the food waste is disposed of in sewers through the sinks, so the Non consumed protein added to the wastewater is higher. Let's consider a value of 1.13, according to IPCC table 6.10A (Volume 5, 2009).

5. For the other General factors, we will keep the values suggested by ECAM, since we don´t have local or official factors to replace them.



The next step will be to create a substage within the Wastewater Treatment stage.



Now you must fill in the Input Section according to the data provided by the exercise.

1. The population serviced by the wastewater treatment system is **200,000 people**.

2. When filling in the serviced population, ECAM will suggest some **estimates** for the inputs (**green squares**). These values are also calculated based on the General Factors selected in the

Configuration tab (for example, from the BOD generated per capita it is possible to calculate the Load of Influent BOD to the WWTP[19]). **To use estimates, click on the suggested value**.

3. We do not have information about the BOD load in the effluent (there is no monitoring in the WWTP). It would be possible to calculate it from the efficiency of our process, but we are not sure about this data either. In this sense, we are going to use the **dropdown menu** offered by ECAM, selecting the technology we have. The system of lagoons is a primary + secondary process. **The software also calculates the value in kg/year**.

4. If you don´t have WWTP affluent monitoring data, you should also use estimation for the Nitrogen load in the influent. **To use estimates, click on the suggested value**.

5. Like step 3, we can calculate the Total Nitrogen load in the effluent from the dropdown menu. **Select the "primary + secondary process" option**.

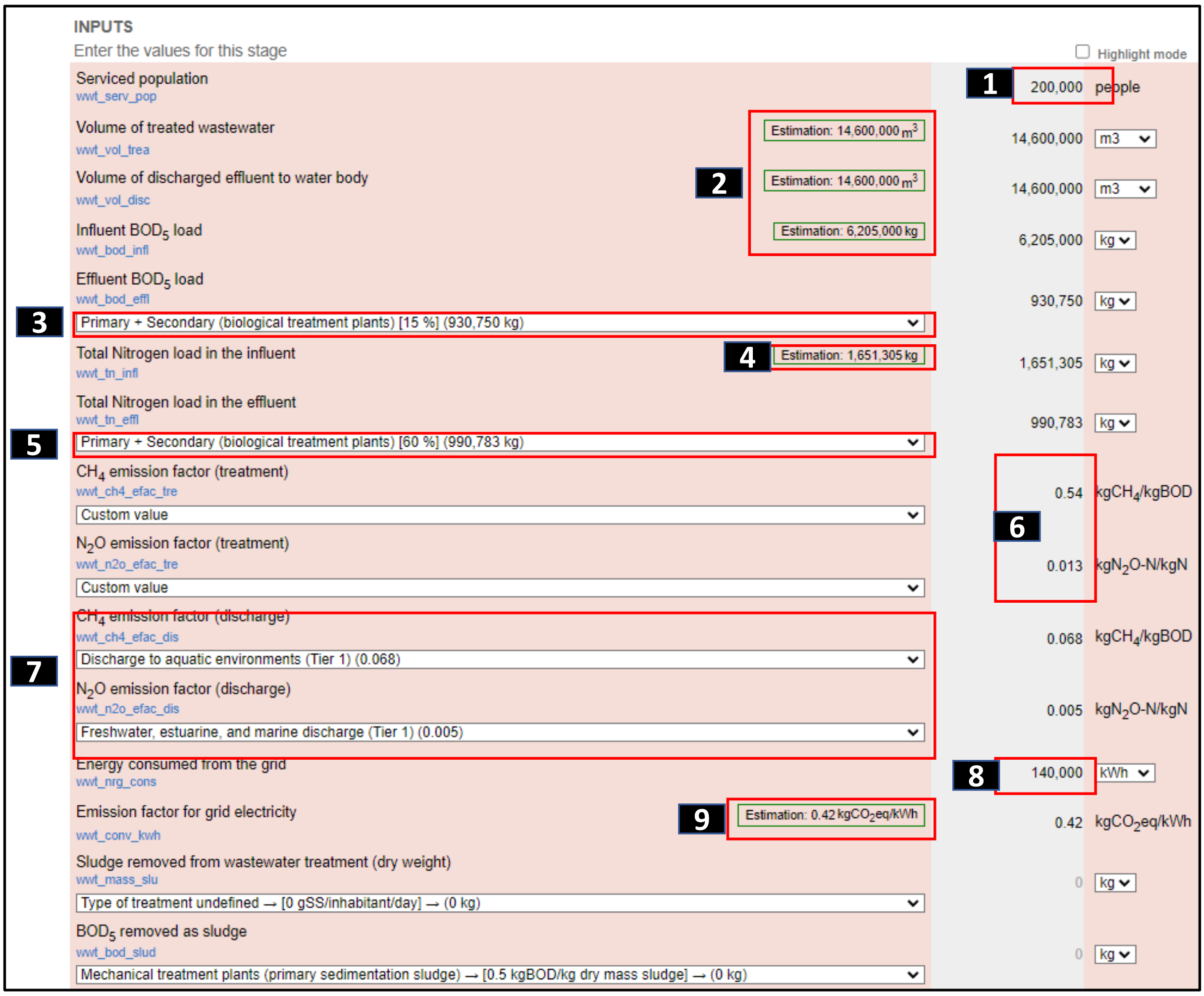
6. Considering the technological composition of the treatment process (anaerobic + facultative lagoons) a methane emission factor of **0.540 kgCH_4/kgBOD** should be assumed. The average nitrous oxide emission factor for the treatment is **0.013 kgN_2O-N/kgN**. Check the topic "**How to choose an emission factor for treatment if my WWTP has two or more core** technologies" to understand this choice. **To choose these factors, you have to fill them in directly.**

7. The discharge emission factor is defined based on the type of discharge and the level of information that we have:
   - For CH_4 emission factor (discharge):
     - We have information about the water body of discharge, we know it is a specific river (Level 2).
     - The BOD load data used are estimated by ECAM from the efficiency of our process, also based on an influent BOD estimate (Level 1).
     - Based on this, **choose the factor 0.068**.
   - For the N_2O emission factor (discharge):
     - There is information about the water body, but there is no measurement of nutrients (Level 2).
     - Based on this, **choose the factor 0.005**.

8. The WWTP electricity consumption is entirely from the grid, with a total of **140,000 kWh** in 2021.

9. The emission factor for grid electricity comes from the General factors in the Configuration tab.

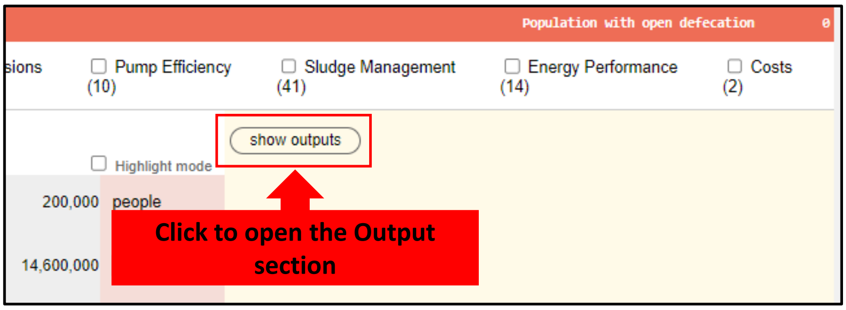
[19] Check more about that in the Methodology Guide.



Now answer the questions:

A. How much is the total GHG emission generated in the Wastewater Treatment Stage (treatment + discharge + electricity)?

The Outputs section shows the results of the requested calculations.



In the image below, we can see the result for the emissions referring to **Total GHG wastewater treatment (128,506,732 kg CO_{2eq})**.

OUTPUTS — hide outputs

GHG emissions

kgCO$_2$eq | kgCO$_2$eq/year | kgCO$_2$eq/year/serv.pop.

	Value	Σ sum (1 substages)	Unit
Electricity (indirect) wwt_KPI_GHG_elec	58,520	58,520	kgCO$_2$eq
Treatment process wwt_KPI_GHG_tre	123,976,471	123,976,471	kgCO$_2$eq
Sludge management wwt_KPI_GHG_slu	0	0	kgCO$_2$eq
Discharged water wwt_KPI_GHG_disc	4,471,741	4,471,741	kgCO$_2$eq
Total GHG wastewater treatment wwt_KPI_GHG	128,506,732	128,506,732	kgCO$_2$eq

B. How much is the GHG emission of the Wastewater Treatment stage per capita (treatment + discharge + electricity)

To answer this question, select the unit kg CO_{2eq}/year/pob.serv. The result is **642.5 kg CO_{2eq}/year/pob.serv**.

OUTPUTS — hide outputs

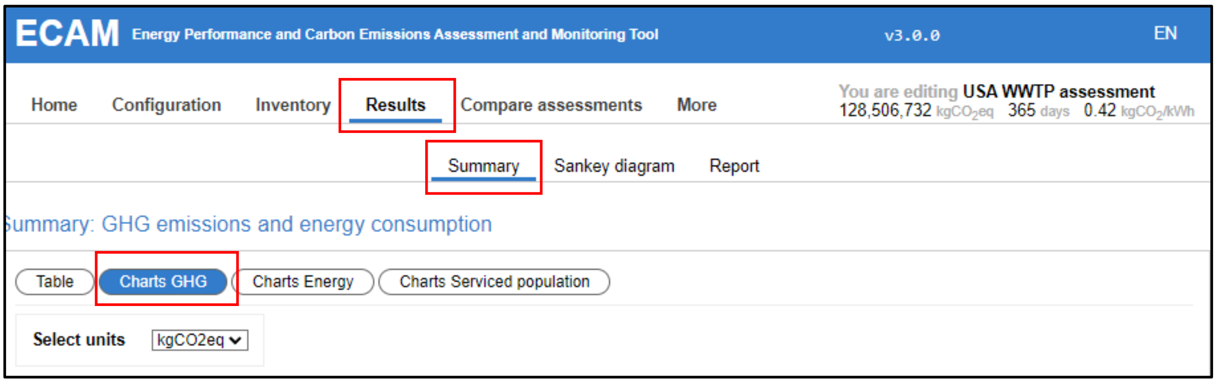
GHG emissions

kgCO$_2$eq | kgCO$_2$eq/year | kgCO$_2$eq/year/serv.pop.

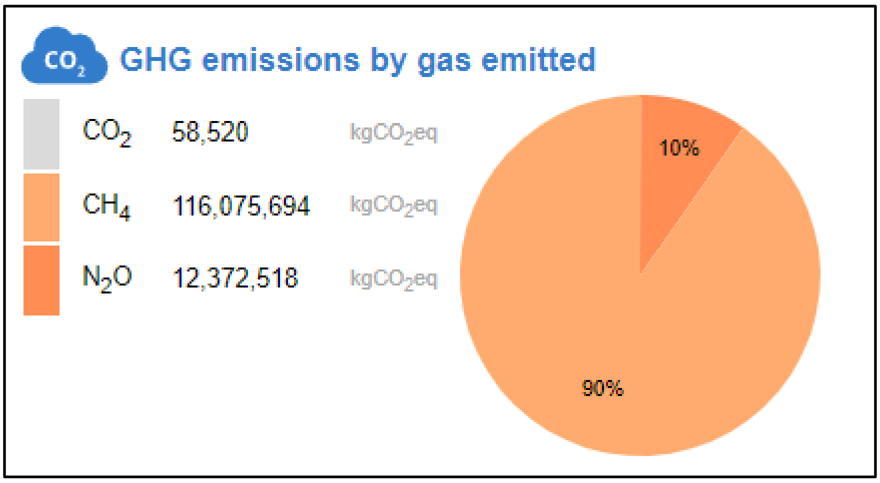
	Value	Σ sum (1 substages)	Unit
Electricity (indirect) wwt_KPI_GHG_elec	0.29	0.29	kgCO$_2$eq/year/serv.pop.
Treatment process wwt_KPI_GHG_tre	619.9	619.9	kgCO$_2$eq/year/serv.pop.
Sludge management wwt_KPI_GHG_slu	0	0	kgCO$_2$eq/year/serv.pop.
Discharged water wwt_KPI_GHG_disc	22.36	22.36	kgCO$_2$eq/year/serv.pop.
Total GHG wastewater treatment wwt_KPI_GHG	642.5	642.5	kgCO$_2$eq/year/serv.pop.

C. Which of the gases considered - carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) - generate the most significant GHG emissions and how much is their corresponding emission in CO_{2eq} (treatment + discharge + electricity)?

To answer this question, click on the tab **Results**, and in **Summary** you should click on "**Charts GHG**".



The third graph will show the emissions by GHG.



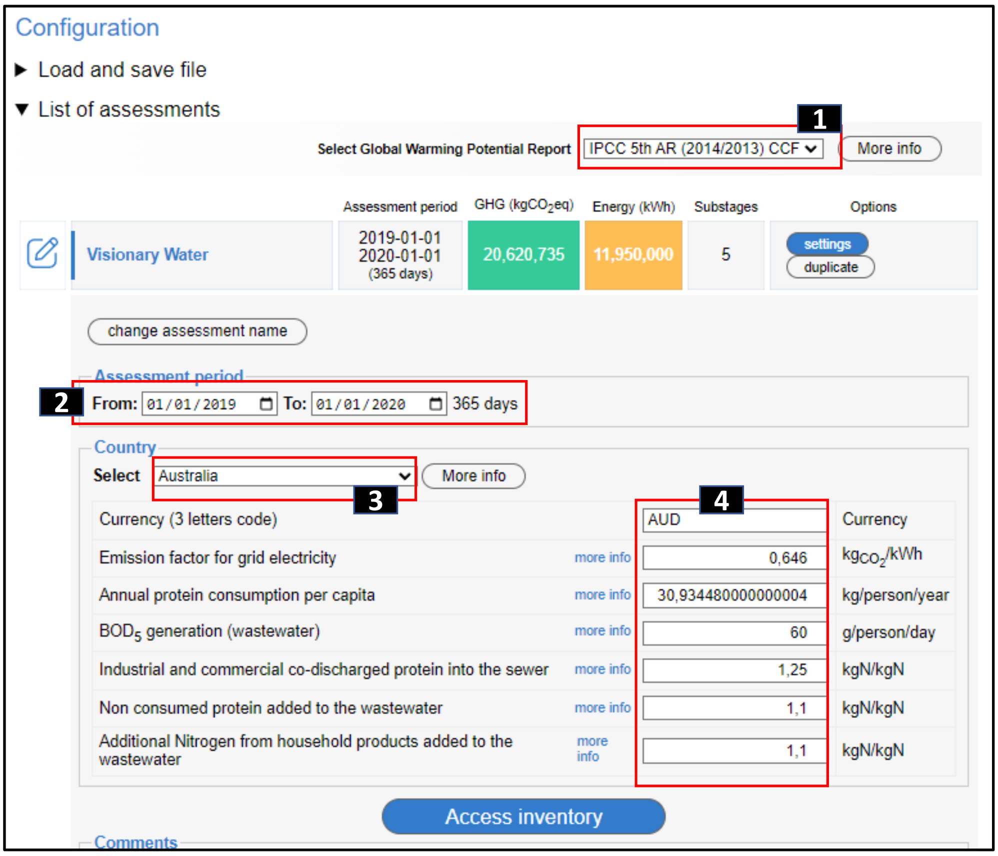
Conduct a complete assessment of an Urban Water Utility

In this exercise, the proposal was to calculate the **GHG emissions of an Urban Water Utility, "Visionary Water (VW)"**, which was preparing an inventory of greenhouse gas emissions from its water and sanitation facilities.

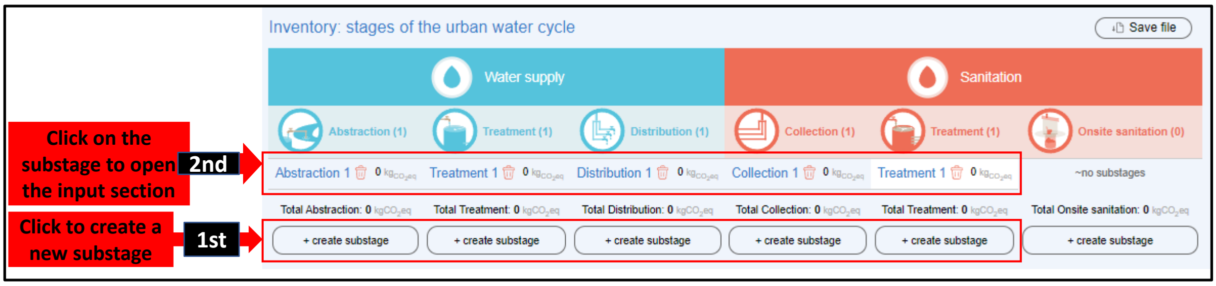
First, start your assessment, or create a new one under the Configuration tab.

Now you will need to prepare the Configuration tab considering the following information:

1. Let's use the GWP Report IPCC 5th AR CCF.
2. The assessment period will be the full year of 2019.
3. The assessment will take place in Australia.
4. For the General factors, we will keep the values suggested by ECAM, since we don´t have local or official factors to replace them.



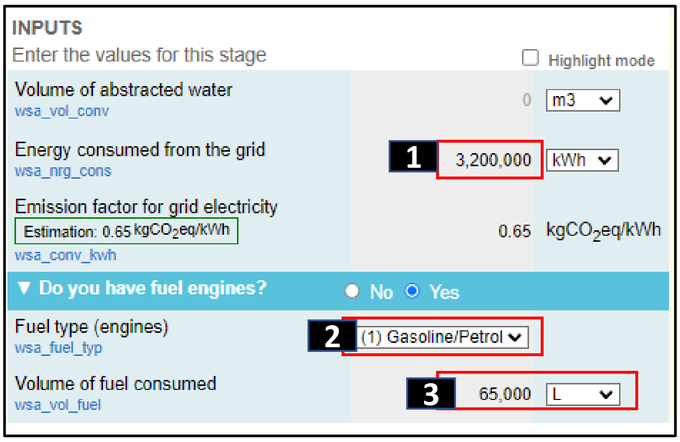
The next step will be to create a substage within each one of the stages (Water Abstraction, Water Distribution, Water Treatment, Sanitation Collection, and Sanitation Treatment).



Now you must fill in the Input Section according to the data provided by the exercise.

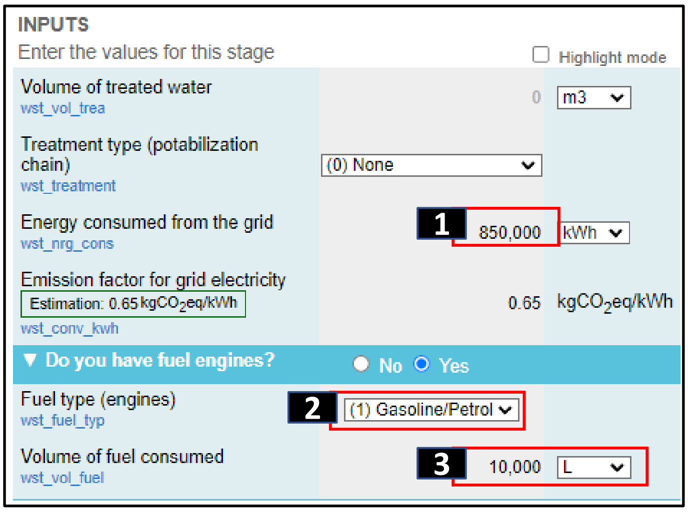
Water Abstraction

1. The energy consumption is **3,200,000 kWh**.
2. The fuel is **gasoline**.
3. Fuel consumption is **65,000 liters.**



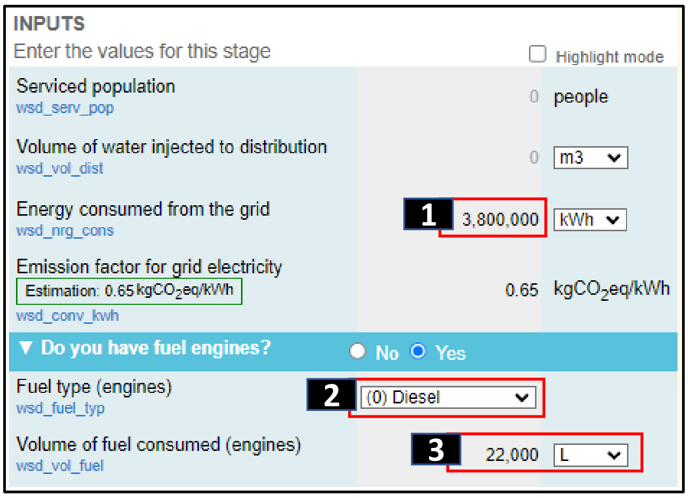
Water Treatment

1. The energy consumption is **850,000 kWh**.
2. The fuel is **gasoline**.
3. Fuel consumption is **10,000 liters.**



Water Distribution

1. The energy consumption is **3,800,000 kWh**.
2. The fuel is **diesel**.
3. Fuel consumption is **22,000 liters.**



Sanitation Collection

1. The Population connected to sewers is **150,000 people.**

2. When filling in the population, ECAM will suggest some **estimates** for the inputs (**green squares**). These values are also calculated based on the General Factors selected in the Configuration tab (for example, from the BOD generated per capita it is possible to calculate the Load of Influent BOD to the WWTP[20]). **To use estimates, click on the suggested value**.

3. Volume of collected wastewater untreated is 15% of our total volume of collected water. 15% of 10,950,000. **Fill in 1,642,500 m^3.**

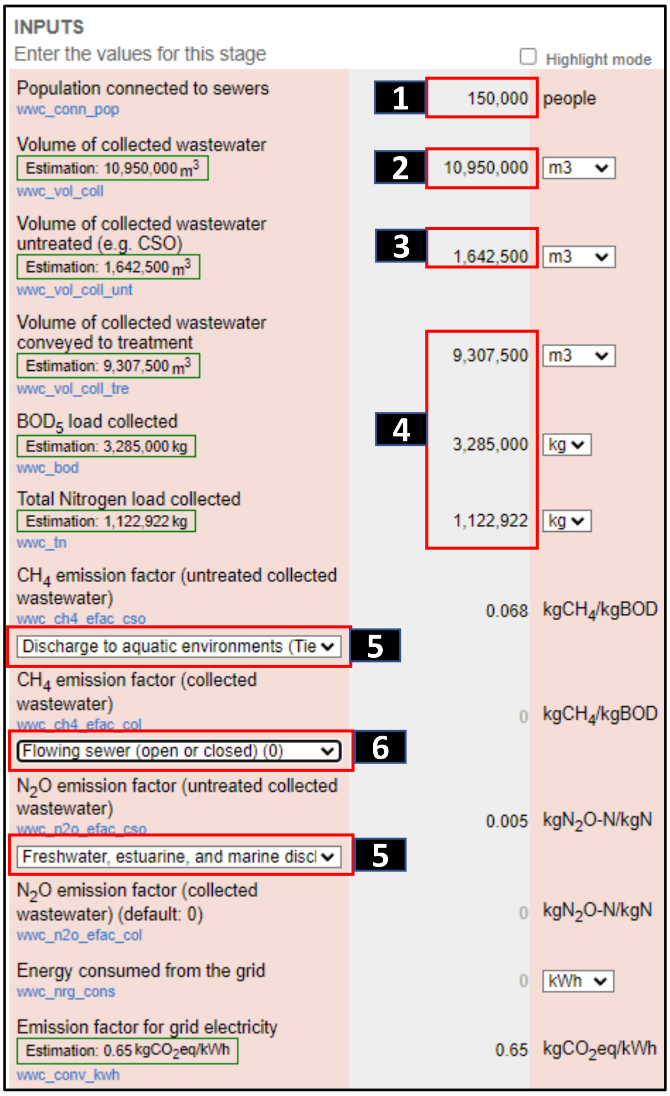
4. Use the estimation tool to calculate the next data.

5. The discharge emission factor is defined based on the type of discharge and the level of information that we have (To recall the criteria of this analysis, access topic "**How to choose an emission factor for discharge (using Tiers)**"

   - For CH_4 emission factor (untreated collected wastewater):
     - We do not have information on the water body of discharge (Level 1)
     - The BOD load data used are estimated by the ECAM from the General Factors (per capita generation averages) (Level 1).
     - Based on this, **choose the factor 0.068**.
   - For the N_2O emission factor (untreated collected wastewater):
     - There is no information about the water body (Level 1).
     - Based on this, **choose the factor 0.005**.

6. **There is no CH_4 emission factor for collected water** since the collection is made by **flowing closed sewers**.

[20] Check more about that in the Methodology Guide.



Sanitation Treatment

1. The population serviced by the wastewater treatment system is 127,500 **people**.

2. When filling in the serviced population, ECAM will suggest some **estimates** for the inputs (**green squares**). These values are also calculated based on the General Factors selected in the Configuration tab (for example, from the BOD generated per capita it is possible to calculate the Load of Influent BOD to the WWTP[21]). **To use estimates, click on the suggested value**.

3. We do not have information about the BOD load in the effluent (there is no monitoring in the WWTP). It would be possible to calculate it from the efficiency of our process, but we are not sure about this data either. In this sense, we are going to use the **dropdown menu** offered by

[21] Check more about that in the Methodology Guide.

ECAM, selecting the technology we have. **Choose the "Primary + Secondary biological treatment plants"**.

4. Since you don´t have Nitrogen influent monitoring data, you should also use estimation for the Nitrogen load in the influent. **To use estimates, click on the suggested value**.

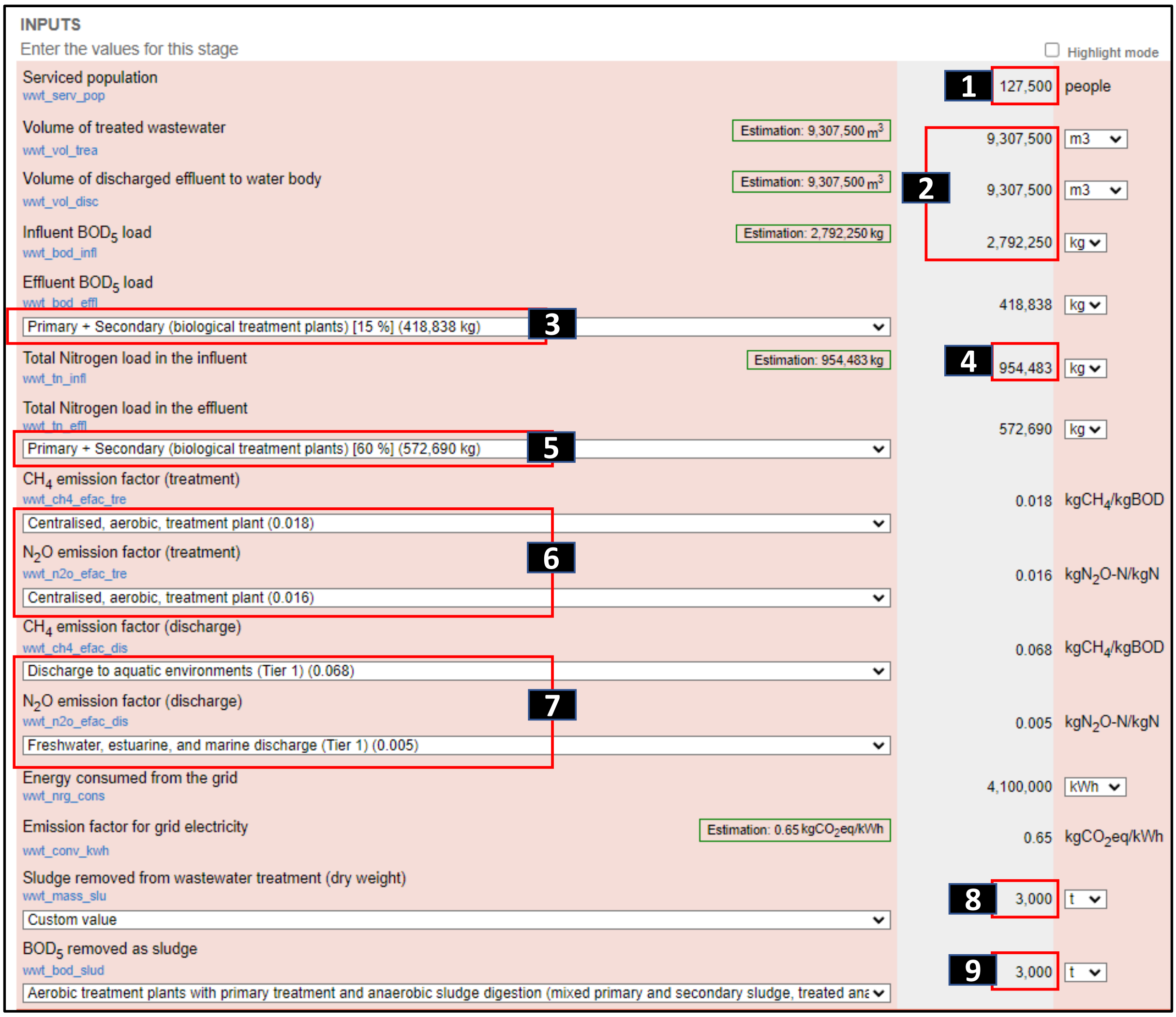
5. Like step 3, we can calculate the Total Nitrogen load in the effluent from the dropdown menu. **Select the " Primary + Secondary biological treatment plants " option**.

6. Choose the centralized aerobic treatment plant option in the dropdown menus since we have activated sludge as our technology.

7. The discharge emission factor is defined based on the type of discharge and the level of information that we have:
    - For CH_4 emission factor (discharge):
        - We have information about the water body of discharge, we know it is a specific river (Level 2).
        - The BOD load data used are estimated by ECAM from the efficiency of our process, also based on an influent BOD estimate (Level 1).
        - Based on this, **choose the factor 0.068**.
    - For the N_2O emission factor (discharge):
        - There is information about the water body, but there is no measurement of nutrients (Level 2).
        - Based on this, **choose the factor 0.005**.

8. We have our own data for sludge removed from the treatment. **Fill in with 3,000 tones**.

9. Since out sludge is digested in an anaerobic digester, **choose the option "Aerobic treatment plants with primary treatment and anaerobic sludge digestion".**

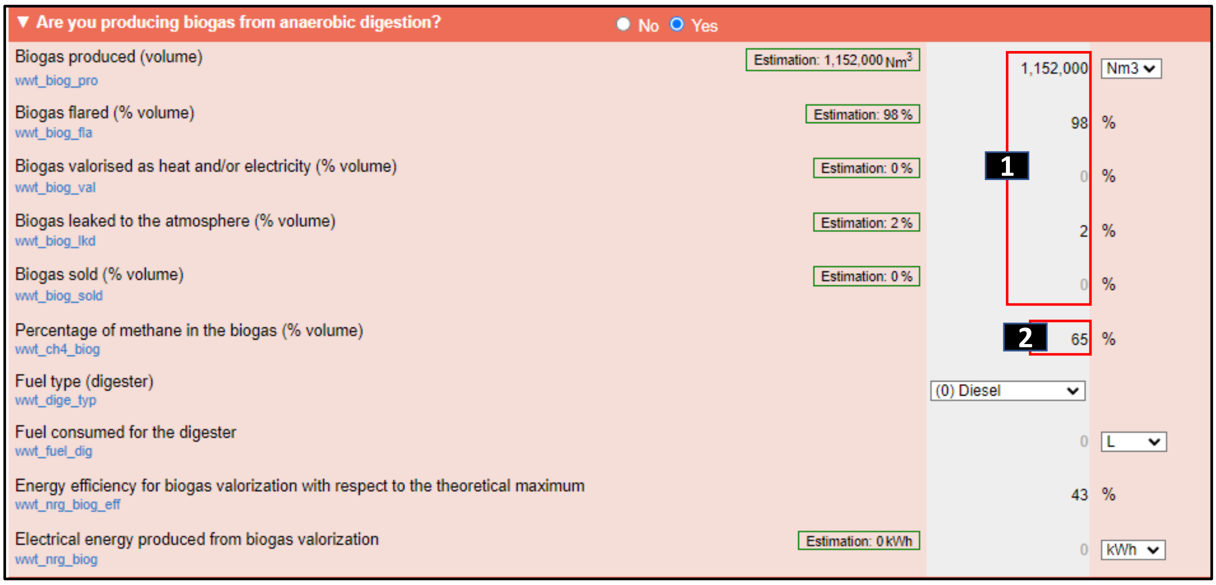


Since we are also accounting for the biogas emissions within the anaerobic digestion, you have to activate the option “Are you producing biogas from anaerobic digestion”.

Once you did that, you have to:

1. Use the estimation option to estimate the production of biogas (**1,152,000 Nm³**). We also know that our case follows the ECAM suggestion when it comes to the percentage of biogas flared (**98%**) and leaked to the atmosphere (**2%**).

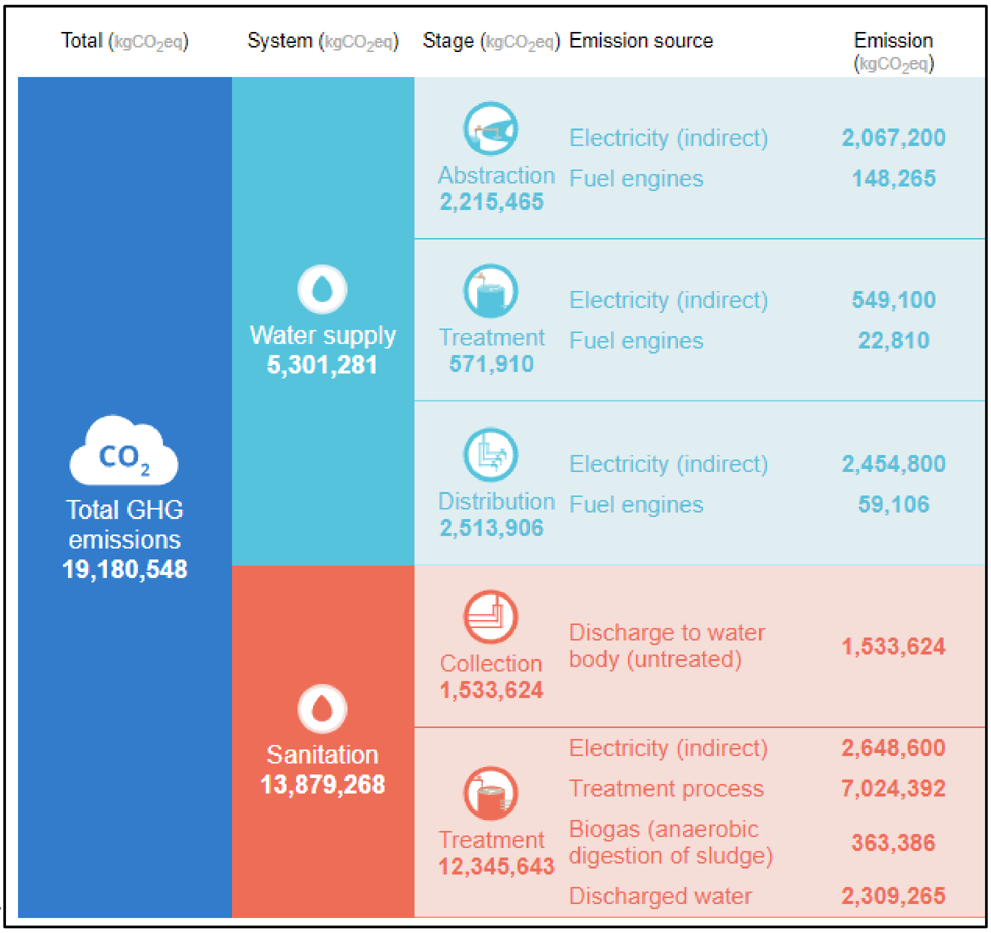
2. Since we monitor ao biogas, we know **it has 65% of methane. Fill in this information**.



Now answer the questions:

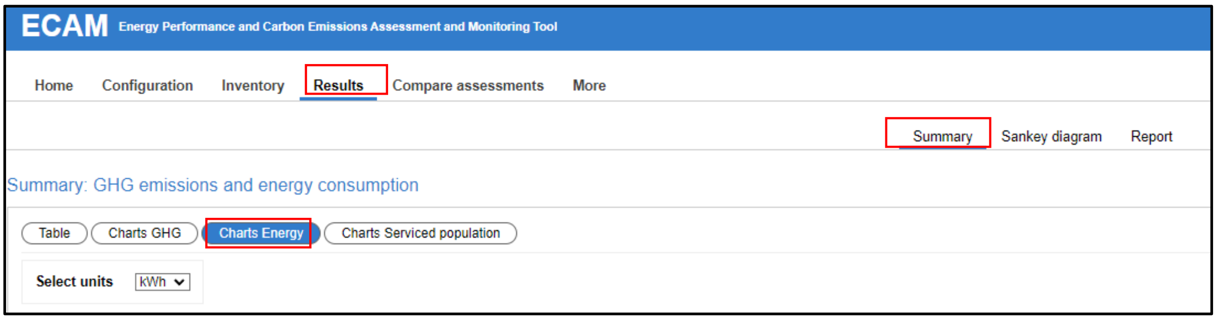
A. How much GHG emissions are generated for each of the emissions requested by the exercise (CO_{2eq})?

The emissions generated by each stage can be displayed in the Results -> Summary -> Table tab.



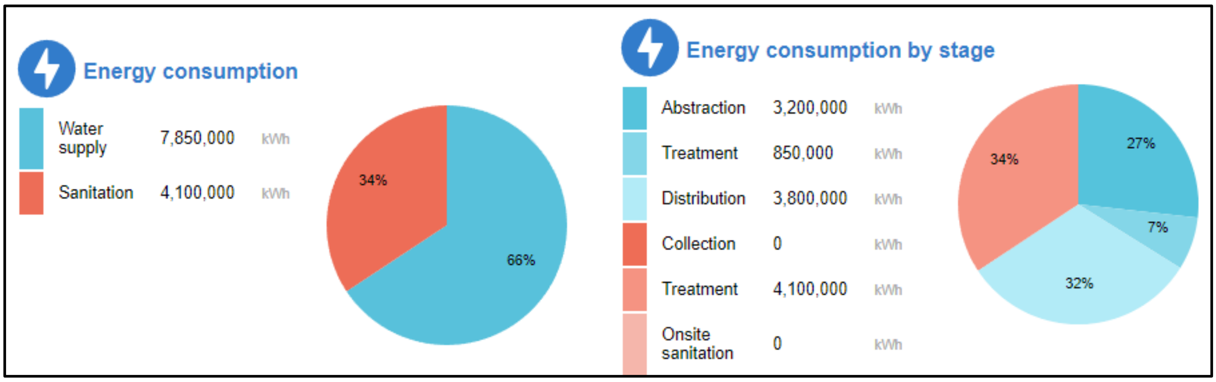
B. Is the greater consumption of electrical energy associated with the Utility's Water supply or Sanitation systems? Rank the stages according to the highest energy consumption (in CO_{2eq}) in the reference year.

You can check data about electricity still in the Results -> Summary tab but choosing to show the Energy Charts.



In the charts we see that the greater consumption of electricity is related to the Water supply (7,850,000 kWh). The rank for energy consumption is: Sanitation treatment > Water Distribution > Water Abstraction > Water treatment.

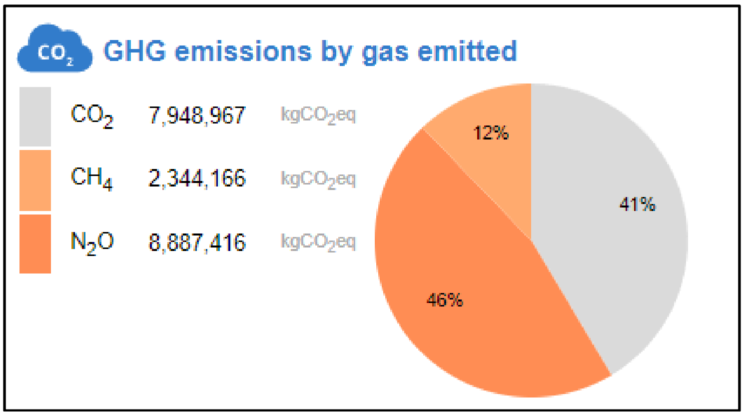
This approach can be interesting to initiate investigations that lead to the prioritization of actions for energy management.



C. Which gas has the greatest absolute representation of emissions for the utility (in CO_{2eq})? And which gas has the highest unitary generation and in which stage (in CO_{2eq})?

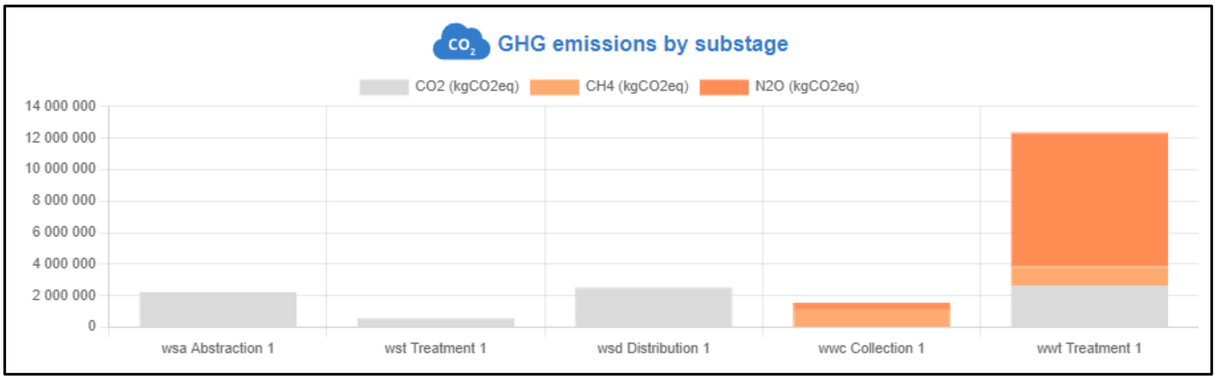
To check information about specific gases, go to the Charts GHG option within the Results -> Summary tab.

The third chart will show information about each specific GHG within the whole assessment. N_2O represents the biggest absolute emission in this case (**8,887,416 kg CO_{2eq}).**



To display the unitary emissions per gas, which is, per gas per stage, access the bar chart below the pie charts.

From this graph it will be possible to see that the largest representative of unitary emission is the N_2O in the Sanitation Treatment Stage ("wwt Treatment 1"). It is interesting to note that N_2O emissions, often less representative when in the unit of the gas itself, become extremely relevant when converted to equivalent CO_2 due to their high Global Warming Potential.



Troubleshooting

What happens if I have negative emissions?

It is important that the users consider the source of their activity data when evaluating the results in the ECAM tool. Negative results could happen when the user uses two different sources for data that compose the same equation.

To traceback a negative result, use highlight mode (topic "**How to traceback a result using the highlight function**").

What happens if I upload data from Excel and they are not recognized by the tool?

The reason for this is because you probably didn't follow the template suggested by the tool. Check more about it in the topic "**How to load data from excel files**".

The *.Json* file that I uploaded is damaged, what do I do?

JSON is a plain text file that can be opened in a text editor. You can easily check it and modify/save it back without any special software.

I want to change the emission factors given in ECAM, how do I change them?

To change an emission factor suggested by the tool, just click on the numerical value, and fill in with your own EF.

Further information about the calculation of emission factors by ECAM is given in the **Methodology Guide**.

Can I rearrange the order of my assessments in ECAM?

You can rearrange the order in which assessments appear in your report when comparing them. To do this, follow the steps outlined in the topic "**Comparing assessments**".

Does ECAM consider leap years?

Yes. The ECAM tool considers leap years, but for this it will be necessary to select the assessment period properly. Check the topic "**How to start and configure a new assessment**".

Where to learn more

ECAM has a series of complementary materials for the use and understanding of the tool. They include:

- **Methodology Guide**: which presents the conceptual framework of the tool, as well as the equations and sources behind the calculations and estimates.

- **E-learning modules**: to learn interactively what was also presented in the User Manual.

- **Tutorial Video Collection**: series of videos on how to use the ECAM tool, organized by topics.

- **Factsheets, cases, and more.** To access, visit the **WaCCliM project webpage**.

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INTERNATIONAL CLIMATE INITIATIVE

On behalf of:

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of the Federal Republic of Germany

Implemented by:

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the international
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