Interreg Alpine Space

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ALPHA

A1.4
Alpha co_2 decarbonisation tool

Technical documentation

ALPHA

Advancing 5th-Generation District Heating and Cooling Networks in Alpine Space

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Introduction

The **technical documentation** provides essential information for the ongoing operation and future upgrades of the tool. Its purpose is to ensure that administrators have the necessary guidance to manage the tool effectively over the long term.

The manual is structured into the following sections:

- Documentation of data sources (including formulas): Lists all formulas and calculations used in each module. Administrators can review these to understand the basis of the calculations and, if necessary, check and revise the content in the future.
- Common troubleshooting solutions: Provides basic solutions for common issues that may arise during operation.
- Instructions for debugging and issue resolution: Outlines practical steps for debugging and resolving errors.

Module 1: Individual system vs Shared district heating and cooling network

A. Usage Consumption and Q_delivered

Usage consumption

Usage consumption is the final consumption of energy by the consumer by usage in kWh/year.

$$Usage\ consumption\ in\ kWh/year\ = Surface \times Energy\ Label\ \times Breakdown\ of\ energy\ consumption\ by\ usage$$

Different usages are Heating, Domestic Hot Water and Cooling.

Q_delivered

Q_delivered is the sum of final consumption of energy by the consumer in kWh/year. It can be considered as “the demand”.

$$ConsumptionQdelivered = \sum Usages\ consumptions$$

$$BranchQdelivered = \sum BranchConsumptionsQdelivered$$

$$NetworkQdelivered = \sum BranchesQdelivered$$

Fossil and Biogenic emissions

Equipment Fossil and Biogenic Emissions (kg CO_2e)

$$Fossil\ emissions\ of\ an\ equiment\ =\ Consumption\ in\ kWh \times Fossil\ emission\ factor\ of\ the\ energy\ used$$

Emission factor: kg CO_2/kWh input, varies by fuel/technology. (see database)

$$Biogenic\ emissions\ of\ an\ equiment\ =\ Consumption\ in\ kWh \times Biogenic\ emission\ factor\ of\ the\ energy\ used$$

(Reported Separately - Only applies to biomass, biogas, biofuels, etc.)

Biomass systems are assumed fully biogenic (Fossil emissions = 0)

Factors1GJ = 277.78 kWh

B. For a new network in Module 1

$$\boxed{Fossil\ emissions\ of\ a\ new\ network\ equipment\ =\ \frac{Consumption\ in\ kWh}{Equipment\ efficiency} \times Fossil\ emission\ factor\ of\ the\ energy\ used}$$

If the energy used is renewable/self-produced, e.g. solar panels, emission factor = 0.

For a Heat Pump, the emission factor used is the national grid electricity inputs.

The efficiency and the emission factor for each equipment have been inserted by the user into the database.

Module 2: Network Assessment

A. Branch GHG emissions

The emissions of a branch are the addition of the emissions of branch equipment, plus the share of the emissions of the equipment of central of production according to the share of the Branch_Q_delivered in Network_Q_delivered.

$$Branch\ GHG\ emissions = \sum Branch\ equipment\ fossil\ emissions + \left(\frac{BranchQdelivered}{NetworkQdelivered} \times \sum Production\ equipment\ fossil\ emissions\right)$$

B. Network GHG emissions

$$Network\ GHG\ emissions = \sum Branches\ GHG\ emissions$$

C. Network real efficiency

$$Network\ real\ efficiency = \frac{\sum NetworkQdelivered}{\sum Branches\ equipment\ consumptions\ in\ kWh + \sum Production\ equipment\ consumptions\ in\ kWh}$$

D. Network theoretical efficiency

Typical theoretical efficiencies have been determined from sources such as Waermpreise and Deutsche Umwelthilfe.

The following efficiencies have been defined:

Network theorical efficiency	
Generation	Efficiency
3GDHC	80-85%
4GDHC	85-90%
5GDHC	90-95%

Module 3: Decarbonisation actions

For Network:

Current Network GHG Emissions	Inserts the result from Objective 2
Future Network GHG Emissions	Current Network GHG Emissions - Total avoided GHG emissions (in kgCO2e)
Total avoided GHG emissions (in kgCO2e)	Sum of avoided GHG emissions from all selected actions
Total avoided GHG emissions (in %)	[(Future network GHG emissions - Current network GHG emissions) / Current network GHG emissions] *100
Total gains in energy efficiency (in %)	sum(Action A energy efficiency gains * Scope Action A + …+ Action n energy efficiency gains * Scope Action n)

For Individual System:

Current Individual System GHG Emissions	Inserts the result from Objective 1 – Individual System
Future Individual System GHG Emissions	Current Individual System GHG Emissions - Total avoided GHG emissions (in kgCO2e)
Total avoided GHG emissions (in kgCO2e)	Sum of avoided GHG emissions from all selected

	actions
Total avoided GHG emissions (in %)	[(Future Individual System GHG emissions - Current Individual System GHG emissions) / Current Individual System GHG emissions] *100
Total gains in energy efficiency (in %)	sum(Action A energy efficiency gains * Scope Action A + …+ Action n energy efficiency gains * Scope Action n)

Common Troubleshooting Solutions

This tool is designed to be user-friendly and robust; however, certain actions or misuses could result in unexpected behaviour or erroneous results. Below are common troubleshooting solutions to address frequently encountered issues and maintain the integrity of the tool's functionality.

- Ensure that macros are enabled upon opening the file. The tool is in .xlsm format, and macros must be activated via the yellow security banner to allow full functionality.
- If dropdown menus are not working as expected, check for potential deactivation of data validation due to incorrect pasting or changes in dependent fields. Avoid pasting data directly into the grey cells (user input areas), as this will overwrite data validation rules and may cause errors in automated calculations. Instead, type the data manually or use "Paste Values" to preserve validation.
- In case of a #REF! or #VALUE! error appearing in calculated cells, verify that no linked cells or ranges have been deleted, renamed, or moved improperly. The tool is designed to incorporate all possible outcomes based on the values filled in in the "Database" tab.

Instructions for Debugging and Resolving Issues

In the event that the tool does not function as expected, users can follow these frequently used debugging instructions to identify and resolve issues. These guidelines are intended to minimise disruptions and ensure smooth operation without compromising the tool's structure.

- Enable macros

Always confirm that macros are enabled when opening the file. Without this, user-friendly functionalities including the welcoming message and the button-based navigation will not be operational.

- Check input areas

Ensure user inputs are only entered in the grey-coloured cells. If errors occur, check for invalid entries or if data validation has been accidentally removed. Reapply data validation manually.

- Inspect overwritten formulas

If any calculated cells (marked in green) are showing incorrect or static values, reapply the original formulas by retrieving them from an older version or backup copy. In case they are overwritten by mistake, re-enter the original formula manually to restore the calculation.

- Review named ranges and table structures

Avoid renaming any fields or headers that are linked to green cells. If structural changes are needed, drag and drop instead of cutting/pasting or renaming.

- Check the “Database” section’s calculations

Do not edit the automated calculations in the second half of the "Database" tab. These are back-end operations that populate other tabs. If these cells show errors, confirm that none of the referenced ranges were modified or deleted.

- Use “Undo” or revert to backup

If an action leads to an error and cannot be reversed (e.g., deletion of a tab), use the Excel "Undo" feature (Ctrl + Z), or restore the most recent working version of the file from an older version or backup copy.