



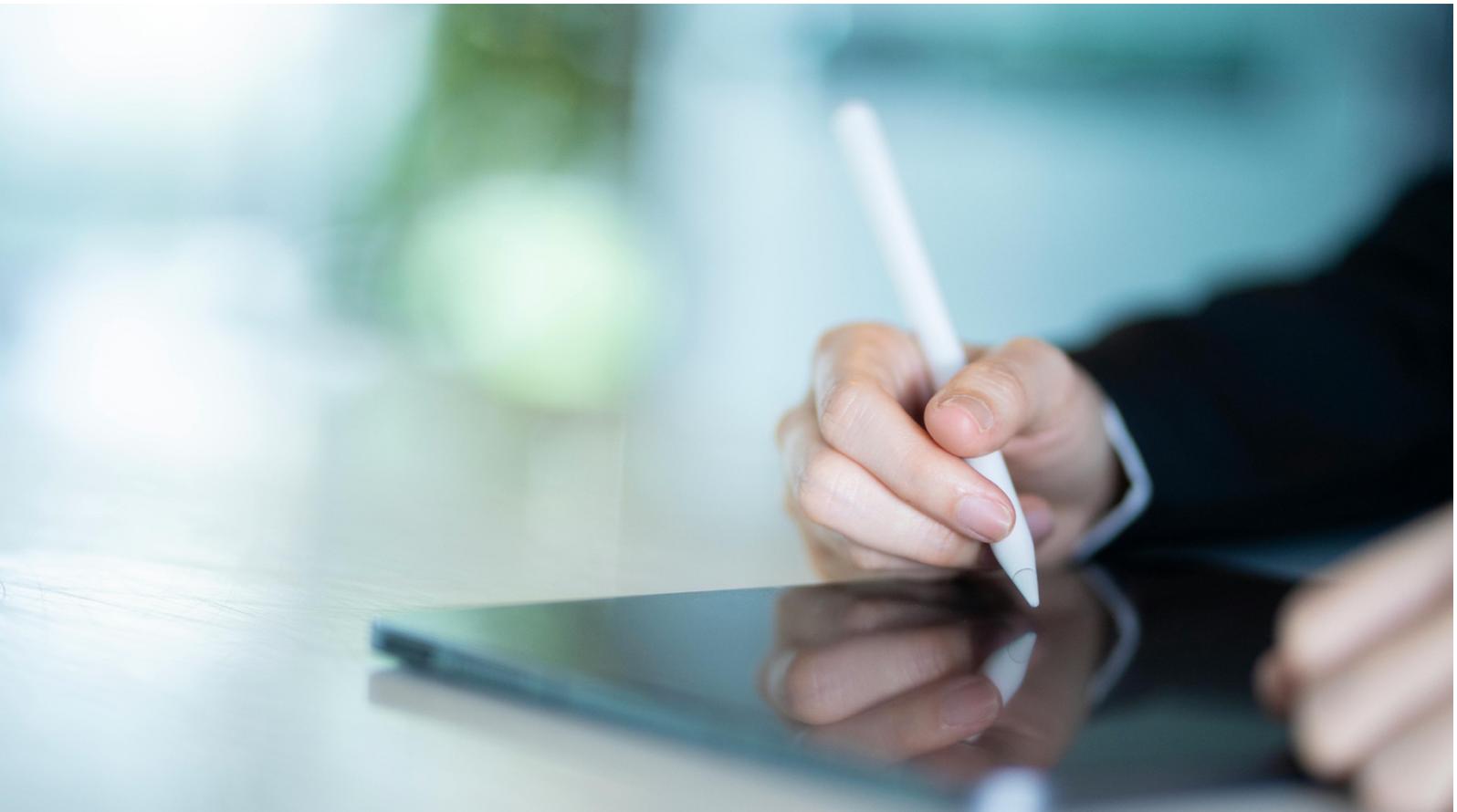
---

# A1.4

## ALPHA CO<sub>2</sub>

### DECARBONISATION TOOL

### *USER GUIDANCE*



## Contents

Introduction .....	6
Kick Start.....	8
<b>Module 1: Individual system vs Shared district heating and cooling network.....</b>	<b>11</b>
Step 1 - Insert data for the Individual System .....	11
<i>First Household energy demand (manual) table .....</i>	<i>12</i>
<i>First Household energy demand (automatic) table .....</i>	<i>13</i>
<i>First Household Equipment table.....</i>	<i>15</i>
<i>Second Household energy demand (manual) table / Second Household energy demand (automatic) table .....</i>	<i>17</i>
<i>Second Household Equipment table .....</i>	<i>18</i>
<i>Office energy demand (manual) table .....</i>	<i>19</i>
<i>Office energy demand (automatic) table .....</i>	<i>20</i>
<i>Office Equipment table .....</i>	<i>21</i>
<i>Industry energy demand table .....</i>	<i>23</i>
<i>Industry Equipment table .....</i>	<i>24</i>
<i>Global energy consumption (kWh/year) table.....</i>	<i>25</i>
Step 2 - Insert data for the Shared District Heating and Cooling Network .....	26
<i>Heating and Cooling Needs (kWh/year) table .....</i>	<i>26</i>
<i>% of fulfilment of the total network need demand table .....</i>	<i>26</i>
<i>Final distribution equipment table .....</i>	<i>28</i>
<i>Production equipment table.....</i>	<i>30</i>
Comparative results.....	32
<b>Module 2: Network Assessment.....</b>	<b>33</b>
Step 1 - Insert data for the Central Production of the network.....	33
<i>Central Production of the network table .....</i>	<i>33</i>
Step 2 - Insert energy demand and equipment data for each branch of the network.....	36
Branches - energy demand and equipment.....	36

---

<i>Branch [#] Household energy demand table (entered either manually or via automatic calculation) .....</i>	36
<i>Branch [#] Household equipment table (located under the “Branch [#] Household energy demand” table).....</i>	38
<i>Branch [#] Office energy demand table (entered either manually or via automatic calculation) .....</i>	40
<i>Branch [#] Office equipment table (located under the “Branch [#] Office energy demand” table).....</i>	42
<i>Branch [#] Industry energy demand table (entered manually) .....</i>	44
<i>Branch [#] Industry equipment table (located under the “Branch [#] Industry energy demand” table).....</i>	45
<i>Branch total emissions.....</i>	47
<i>Branch [#] Network energy consumption per type (kWh/year) table.....</i>	47
<i>Branch [#] Total emissions (kgCO<sub>2</sub>e) table.....</i>	47
<i>Comparative results.....</i>	48
<b>Module 3: Decarbonisation actions .....</b>	<b>50</b>
<b>Step 1 - Insert data for identifying and assessing decarbonisation actions .....</b>	<b>52</b>
<b>Database section .....</b>	<b>55</b>

## List of Figures

Figure 1 Kick Start page .....	8
Figure 2 “Click to select Country” button and dialog box.....	8
Figure 3 Country selection (drop down menu) .....	9
Figure 4 Navigation buttons.....	9
Figure 5 Module 1 interface - Individual System and Shared Network .....	11
Figure 6 “First Household energy demand (manual)” table.....	13
Figure 7 “First Household energy demand (automatic)” table .....	14
Figure 8 “First Household Equipment” table .....	15
Figure 9 “Second Household Equipment” tables - manual or automatic.....	17
Figure 10 “Second Household Equipment” table .....	18
Figure 11 “Office energy demand (manual)” table.....	19
Figure 12 “Office energy demand (automatic)” table .....	20
Figure 13 “Office Equipment” table.....	21
Figure 14 “Industry energy demand (manual)” table .....	23
Figure 15 “Industry Equipment” table .....	24
Figure 16 “Global energy consumption (kWh/year)” mini table .....	25
Figure 17 “Heating and Cooling Needs (kWh/year)” table .....	26
Figure 18 “Percentage (%) of fulfilment of the total network need demand” mini table along with the “Fulfilment of total demand” chart .....	27
Figure 19 “Final distribution equipment” table.....	28
Figure 20 “Production equipment” table .....	30
Figure 21 Comparative results and “GHG emissions (kgCO <sub>2</sub> )” chart.....	32
Figure 22 “Central Production of the network” table .....	35
Figure 23 “Branch [#] Household energy demand (manual)” table .....	37
Figure 24 “Branch [#] Household energy demand (automatic)” table .....	37
Figure 25 “Branch [#] Household equipment” table .....	39
Figure 26 “Branch [#] Office energy demand (manual)” table .....	40
Figure 27 “Branch [#] Office energy demand (automatic)” table .....	41
Figure 28 “Branch [#] Office equipment” table .....	43
Figure 29 “Branch [#] Industry energy demand” table (manual).....	44
Figure 30 “Branch [#] Industry equipment” table .....	46
Figure 31 “Branch [#] Network energy consumption per type (kWh/year)” mini table .....	47
Figure 32 “Branch [#] Total emissions (kgCO <sub>2</sub> e)” mini table .....	47
Figure 33 Comparative results.....	49

---

Figure 34 “Network theoretical efficiency” table .....	49
Figure 35 “Network’s Emissions” chart .....	49
Figure 36 “Network’s Efficiency” chart .....	49
Figure 37 Table presenting the avoided GHG emissions and gains in energy efficiency of the analysed network.....	51
Figure 38 “Network GHG emissions” chart .....	51
Figure 39 “Decarbonisation Actions” table .....	52
Figure 40 Fields for manual insertion of decarbonisation actions .....	54
Figure 41 “Waterfall chart” .....	54
Figure 42 List of factors in the Database section.....	55
Figure 43 List of calculations in the Database section.....	56

---

## Introduction

The presented tool forms part of ALPHA project's Activity 1.4, which aims at **customising an existing open-source planning and evaluation tool** developed in the context of Interreg North-West Europe programme project "D2Grids". The customised tool (**ALPHA CO<sub>2</sub> Calculation Tool**) introduces new functionalities tailored to the needs of the ALPHA project and the specific characteristics of the Alpine Space. In this way, **the tool supports the optimal deployment of fifth-generation district heating and cooling (5GDHC) networks, while also enhancing the capacity of ALPHA partners to plan, evaluate, and decarbonise such networks.**

To this end, the tool has been designed as a **practical and strategic resource** for local authorities, engineers, planners, and other stakeholders across the Alpine region. It enables users to:

- Compare the GHG emissions of individual energy systems with those of shared district heating networks.
- Assess the operational performance and efficiency of existing district heating and cooling networks.
- Identify and evaluate decarbonisation measures in terms of both efficiency gains and GHG emission reductions.

This **manual** provides comprehensive instructions and guidance to help users navigate the tool effectively, enter data correctly, and make full use of its functionalities. The chapters that follow present each module of the tool outlining:

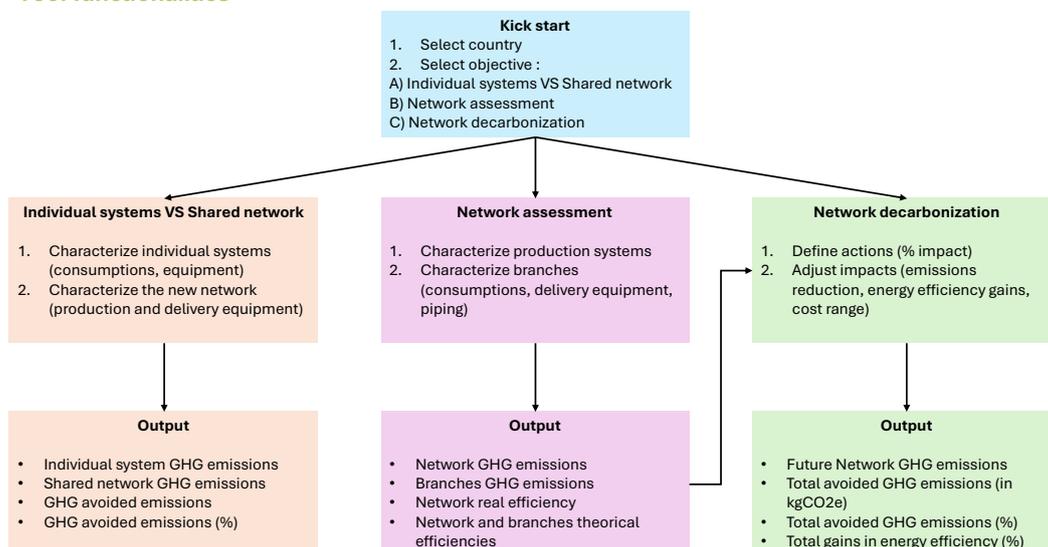
- The purpose and operation of the module.
- The navigation interface.
- Instructions for accurate data entry.

Each module is designed to accommodate different needs and parameters in relation to the network that the user opts to describe and/or optimise. The sections are structured according to the order of the steps the user needs to follow in order to achieve the desired network evaluation.

The tool consists of a homepage (Kick Start) and three main modules:

- **Individual vs Shared** - comparison of GHG emissions between an individual system and a shared DHC network.
- **Network Assessment** - evaluation of GHG emissions and efficiency of an existing shared DHC network.
- **Decarbonisation** - identification and assessment of decarbonisation actions for the analysed network or individual system.

### Tool functionalities



The tool also includes a **Database** section, providing reference data for each country in the ALPHA consortium.

In addition, separate **technical documentation** is provided, containing all necessary information for the ongoing operation of the tool and enabling administrators to manage its content effectively over the long term.

## Kick Start

The tool is operating in .xlsm format, which means that Excel macros should be enabled to optimise the user's interface.

Therefore, when opening the file, please enable the macros (yellow pop-up banner).

When opening the Excel file of the tool, a homepage (Kick Start) appears. From this page, users can select the country where the network is located, ensuring that the tool proceeds with the appropriate configurations for the GHG emissions assessment.

The countries that can be selected are: Austria, France, Germany, Italy, Slovenia.



Figure 1 Kick Start page

To select a country, users can click the “Click to select Country” button. A dialog box will appear, prompting the user to confirm the displayed country. Users should continue until the desired country appears.

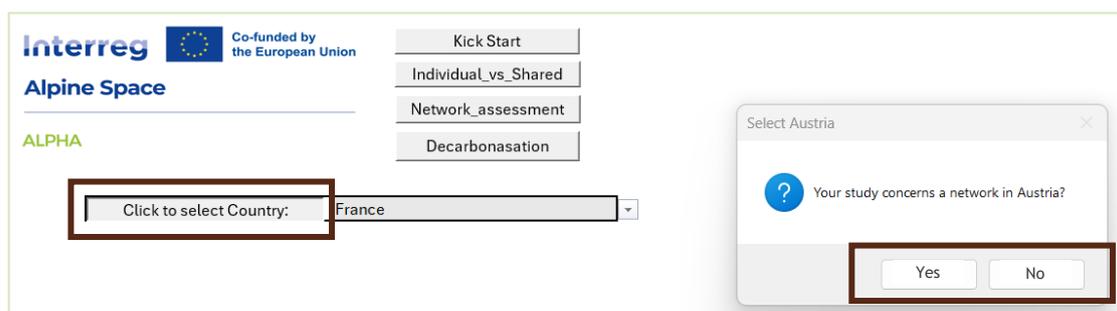


Figure 2 “Click to select Country” button and dialog box

Alternatively, users can directly select the country through the drop-down menu.

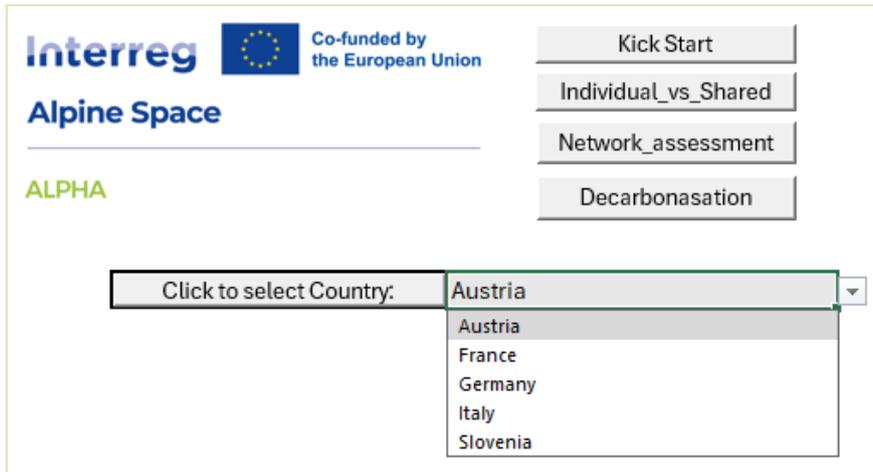


Figure 3 Country selection (drop down menu)

On the home page, there are also **three buttons** which navigate users directly to the Kick Start page and each module.



Figure 4 Navigation buttons

Each of the three **module** includes:

- Step-by-step instructions presented in **blue info boxes**, along with **arrows** guiding users through the process.
- A **top-line menu** that includes:
- In the upper left corner: The **project's logo** (which links to the project's website), the **module buttons** and the **selected country**.
- In the upper right corner: Two **navigation buttons** (Start / End) allowing users to jump directly to the beginning or end of the module for ease of use and improved navigation.

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

### AIM

This module enables users to compare the GHG emissions between an existing individual energy system and a shared district heating and cooling network.

For this module, users are required to enter the energy values for each type of equipment, both for the **Individual System** (tables on the left) and for the **Shared Network** (tables on the right). Each network may involve more than one energy source and type of equipment.

The screenshot shows the software interface for Module 1. At the top, there are logos for Interreg, the European Union, and ALPHA, along with navigation buttons like 'Kick Start', 'Individual\_vs\_Shared', 'Network\_assessment', and 'Decarbonisation'. A 'Selected Country' dropdown is set to 'Slovenia'. A blue instruction box states: 'For this objective please fill in, the energy values per different type of equipment for the individual system (on the left) and for the shared network (on the right). Each network is permitted to more than one energy source and type of equipment.' Below this, there are two main data entry tables.

Individual System					Shared Network				
First Household energy demand (manual)					Heating and Cooling Needs (kWh/year)				
Energy category	Surface (total m <sup>2</sup> )	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)	Space heating consumption	Domestic Hot Water consumption	Space cooling consumption	Q delivered (kWh/year)
A									
TOTAL									

Figure 5 Module 1 interface - Individual System and Shared Network

To insert the necessary data and carry out the comparison of GHG emissions between an existing individual energy system and a shared district heating and cooling (DHC) network, users should follow the steps outlined below.

### Step 1 - Insert data for the Individual System

Users should begin by selecting the **type of establishment** that best describes their case in relation to the individual system.

They can choose from the following options: *household*, *office*, or *industry*.

For each establishment type, there are two ways to calculate the energy demand (Q delivered - kWh/year):

- By inserting data manually
- Through automatic calculation based on the energy class of the establishment by

inserting surfaces (available only for *household* and *office*; not available for *industry*).

The user can select the manual input process and/or the automatic calculation.

### First Household energy demand (manual) table

If the establishment corresponds to a **household**, users select the "First Household energy demand (manual)" input table.

Users select the **energy category** and enter the **total surface area (in m<sup>2</sup>)** of their establishment. If there is more than one household within the same energy category, the total surface area (in m<sup>2</sup>) of all such households should be summed and entered in the corresponding field.

e.g.

Household 1 of category A =  
30m<sup>2</sup>

→ Data to be inserted = 80m<sup>2</sup> in category A

Household 2 of category A =  
50m<sup>2</sup>

The user should then enter values for **space heating, domestic hot water, and space cooling annual consumption**. If there is more than one establishment in an energy category, their consumption values must be summed and entered into the corresponding fields for each type of energy consumption. *All three categories must be completed.*

e.g.

<b>'Space heating consumption'</b>	Household 1 of category A = 1200 kWh/year	→ Data to be inserted for category A = 2500 kWh/year
	Household 2 of category A = 1300 kWh/year	

<b>'Domestic Hot Water consumption'</b>	Household 1 of category A = 1100 kWh/year	→ Data to be inserted for category A = 2300 kWh/year
	Household 2 of category A = 1200 kWh/year	

<b>'Space cooling'</b>	Household 1 of category A = 1000	→ Data to be inserted for
------------------------	----------------------------------	---------------------------





First Household energy demand (automatic)					
Energy category	Surface (total m2)	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A		-	-	-	-
B		-	-	-	-
C		-	-	-	-
D		-	-	-	-
E		-	-	-	-
F		-	-	-	-
G		-	-	-	-
Household energy consumption (kWh/year)		-	-	-	-

Figure 7 “First Household energy demand (automatic)” table

## First Household Equipment table

After selecting either the manual or automatic input process, the tool enables users to choose the household equipment (via a drop-down list) that provides the energy input for the establishments (“First Household Equipment” table).

First Household Equipment	Consumption in kWh	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Biomass boiler (>2020)		Biomass	0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
<b>Total emissions (kgCO2e)</b>			-	-

Figure 8 “First Household Equipment” table

The drop-down list includes the following equipment types:

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Gas boiler (&gt;20 years)</li> <li>2. Gas boiler (&lt;10 years)</li> <li>3. Oil boiler (&gt;20 years)</li> <li>4. Oil boiler (&lt;10 years)</li> <li>5. Coal boiler (&gt;20 years)</li> <li>6. Coal boiler (&lt;10 years)</li> </ol> | <ol style="list-style-type: none"> <li>14. Gas boiler CHP (gas turbine)</li> <li>15. Aquifer</li> <li>16. Geothermal wells</li> <li>17. Mine workings</li> <li>18. Solar thermal</li> <li>19. Metro shaft</li> </ol> |
|--|--|

- |                                    |   |
|------------------------------------|---|
| 7. Biogas boiler (<2020)           | 20. Sewers                              |
| 8. Biogas boiler (>2020)           | 21. Solar panel in-house                |
| 9. Biomass boiler (<2020)          | 22. Industrial fumes                    |
| 10. Biomass boiler (>2020)         | 23. National grid electricity inputs    |
| 11. Waste incineration CHP         | 24. Self-produced renewable electricity |
| 12. Waste incineration (heat only) | 25. Heat pump (air source)              |
| 13. Gas boiler CHP (gas engine)    | 26. No equipment                        |

Users can then select the **types of equipment** used and enter the corresponding **annual consumption values in kWh**.

The tool will automatically display the primary energy source and calculate both the fossil emissions and the biogenic emissions (in kgCO<sub>2</sub>e) for each equipment type, taking into account national emission factors.

At the bottom of the table, the **total emissions** for all selected equipment are summed up and displayed.

## Second Household energy demand (manual) table / Second Household energy demand (automatic) table

A second table is also provided if further data needs to be inserted for household establishments (either for the manual input process or the automatic calculation). The rationale is the same as described under the “First Household energy demand” tables (see above).

Second Household energy demand (manual)					
Energy category	Surface (total m2)	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A					-
B					-
C					-
D					-
E					-
F					-
G					-
Household energy consumption (kWh/year)		-	-	-	-
Second Household energy demand (automatic)					
Energy category	Surface (total m2)	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A		-	-	-	-
B		-	-	-	-
C		-	-	-	-
D		-	-	-	-
E		-	-	-	-
F		-	-	-	-
G		-	-	-	-
Household energy consumption (kWh/year)		-	-	-	-

Figure 9 “Second Household Equipment” tables - manual or automatic

## Second Household Equipment table

If users enter data in the “Second Household Energy Demand” table, they can then select the corresponding equipment in the “Second Household Equipment” table. The rationale and procedure are the same as those outlined for the “First Household Equipment” table (see above).

Second Household Equipment	Consumption in kWh	Primary Energy	Fossil emissions (kgCO <sub>2</sub> e)	Biogenic emissions (kgCO <sub>2</sub> e)
Coal boiler (>20 years)		Commercial fuel	0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
<b>Total emissions (kgCO<sub>2</sub>e)</b>			-	-

Figure 10 “Second Household Equipment” table

## Office energy demand (manual) table

If the establishment corresponds to an office, users select the “Office energy demand (manual)” input table.

Users select the **energy category** and enter the **total surface area (in m<sup>2</sup>)** of their establishment. If there is more than one office within the same energy category, the total surface area (in m<sup>2</sup>) of all such offices should be summed and entered in the corresponding field (see the [first example in p. 6](#)).

The user should then enter values for **space heating, domestic hot water, and space cooling annual consumption**. If there is more than one establishment in an energy category, their consumption values must be summed and entered into the corresponding fields for each type of energy consumption (see the [second example in p. 6](#)). *All three categories must be completed.*

The tool will then generate a  $Q_{delivered}$  value, representing the **total energy consumption for each office energy category and for all three types of energy consumption (space heating, domestic hot water, space cooling)**.

Office energy demand (manual)					
Energy category	Surface (m2)	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A					-
B					-
C					-
D					-
E					-
F					-
G					-
Office energy consumption (kWh/year)		-	-	-	-

Figure 11 “Office energy demand (manual)” table

## Office energy demand (automatic) table

If the establishment concerns an office and users wish to apply the automatic calculation, they can select the “Office energy demand (automatic)” input table. The automatic calculation is based on the percentage distribution of energy consumption according to the respective energy category.

Users choose the **energy category** and enter the **total surface area (in m<sup>2</sup>)** of their establishment. If there is more than one office within the same energy category, the total surface area (in m<sup>2</sup>) of all such offices should be summed and entered in the corresponding field (see the [first example in p. 6](#)).

The tool, according to the country data, calculates automatically the **space heating**, **domestic hot water**, and **space cooling consumption** values, and generates a *Q\_delivered* value, representing the total energy consumption for the denoted establishment by summing all three categories automatically.

Office energy demand (automatic)					
Energy category	Surface (m <sup>2</sup> )	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A		-	-	-	-
B		-	-	-	-
C		-	-	-	-
D		-	-	-	-
E		-	-	-	-
F		-	-	-	-
G		-	-	-	-
Office energy consumption (kWh/year)		-	-	-	-

Figure 12 “Office energy demand (automatic)” table

## Office Equipment table

After selecting either the manual or automatic input process, the tool enables users to choose the office equipment (via a drop-down list) that provides the energy input for the establishments (“Office Equipment” table).

Office Equipment	Consumption in kWh	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Waste incineration CHP		Waste Heat	0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
<b>Total emissions (kgCO2e)</b>			-	-

Figure 13 “Office Equipment” table

The drop-down list includes the following equipment types:

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Gas boiler (&gt;20 years)</li> <li>2. Gas boiler (&lt;10 years)</li> <li>3. Oil boiler (&gt;20 years)</li> <li>4. Oil boiler (&lt;10 years)</li> <li>5. Coal boiler (&gt;20 years)</li> <li>6. Coal boiler (&lt;10 years)</li> <li>7. Biogas boiler (&lt;2020)</li> <li>8. Biogas boiler (&gt;2020)</li> <li>9. Biomass boiler (&lt;2020)</li> <li>10. Biomass boiler (&gt;2020)</li> <li>11. Waste incineration CHP</li> <li>12. Waste incineration (heat only)</li> <li>13. Gas boiler CHP (gas engine)</li> </ol> | <ol style="list-style-type: none"> <li>14. Gas boiler CHP (gas turbine)</li> <li>15. Aquifer</li> <li>16. Geothermal wells</li> <li>17. Mine workings</li> <li>18. Solar thermal</li> <li>19. Metro shaft</li> <li>20. Sewers</li> <li>21. Solar panel in-house</li> <li>22. Industrial fumes</li> <li>23. National grid electricity inputs</li> <li>24. Self-produced renewable electricity</li> <li>25. Heat pump (air source)</li> <li>26. No equipment</li> </ol> |
|--|---|

Users can then select the types of equipment used and enter the corresponding annual consumption values in kWh.

The tool will automatically display the primary energy source and calculate both the fossil emissions and the biogenic emissions (in kgCO<sub>2</sub>e) for each equipment type, taking into account national emission factors.

At the bottom of the table, the **total emissions** for all selected equipment are summed up and displayed.

## Industry energy demand table

If the establishment corresponds to an industry, users should select the "Industry energy demand" input table. *For this type, data can only be entered manually.*

Users provide values directly for space heating, domestic hot water, and space cooling annual consumption of the industrial environment - without the need to insert square metres. *All three categories must be completed.*

The tool will then generate a  $Q_{delivered}$  value, representing the total energy consumption for each industrial environment and for all three types of energy consumption (space heating, domestic hot water, space cooling).

Users can enter values for up to five industrial environments.

Industry energy demand				
ID	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
Industry #1	-	-	-	-
Industry #2	-	-	-	-
Industry #3	-	-	-	-
Industry #4	-	-	-	-
Industry #5	-	-	-	-
Industry energy consumption (kWh/year)	-	-	-	-

Figure 14 "Industry energy demand (manual)" table

## Industry Equipment table

After selecting either the manual or automatic input process, the tool enables users to choose the industry equipment (via a drop-down list) that provides the energy input for the establishments (“Industry Equipment” table).

Industry Equipment	Consumption in kWh	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Self-produced renewable electricity		Self-produced renewable electricity	0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
No equipment			0,00	0,00
<b>Total emissions (kgCO2e)</b>			-	-

Figure 15 “Industry Equipment” table

The drop-down list includes the following equipment types:

- |                                    |   |
|------------------------------------|---|
| 1. Gas boiler (>20 years)          | 14. Gas boiler CHP (gas turbine)        |
| 2. Gas boiler (<10 years)          | 15. Aquifer                             |
| 3. Oil boiler (>20 years)          | 16. Geothermal wells                    |
| 4. Oil boiler (<10 years)          | 17. Mine workings                       |
| 5. Coal boiler (>20 years)         | 18. Solar thermal                       |
| 6. Coal boiler (<10 years)         | 19. Metro shaft                         |
| 7. Biogas boiler (<2020)           | 20. Sewers                              |
| 8. Biogas boiler (>2020)           | 21. Solar panel in-house                |
| 9. Biomass boiler (<2020)          | 22. Industrial fumes                    |
| 10. Biomass boiler (>2020)         | 23. National grid electricity inputs    |
| 11. Waste incineration CHP         | 24. Self-produced renewable electricity |
| 12. Waste incineration (heat only) | 25. Heat pump (air source)              |
| 13. Gas boiler CHP (gas engine)    | 26. No equipment                        |

Users can then select the types of equipment used and enter the corresponding annual

consumption values in kWh.

The tool will automatically display the primary energy source and calculate both the fossil emissions and the biogenic emissions (in kgCO<sub>2</sub>e) for each equipment type, taking into account national emission factors.

At the bottom of the table, the **total emissions** for all selected equipment are summed up and displayed.

### Global energy consumption (kWh/year) table

The tool then presents the **global energy consumption (kWh/year)** for each type of consumption (i.e., Space heating, Domestic Hot Water, Space cooling) by summing up the respective values from all establishments entered by the user or calculated automatically by the tool (“Global energy consumption (kWh/year)” mini table).

The mini table also displays the **total *Q<sub>delivered</sub>*** value, calculated as the sum of all *Q<sub>delivered</sub>* values across those establishments.

	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
Global energy consumption (kWh/year)	-	-	-	-

Figure 16 “Global energy consumption (kWh/year)” mini table

## Step 2 - Insert data for the Shared District Heating and Cooling Network

### Heating and Cooling Needs (kWh/year) table

Users can click the **Start** button on the top right corner for ease of navigation.

The first table in the Shared District Heating and Cooling Network section (“**Heating and Cooling Needs (kWh/year)**”) automatically retrieves and displays the total energy consumption values from the **Global Energy Consumption (kWh/year)** table of the individual system.

Essentially, this table represents the total heating, domestic hot water and cooling demand (kWh/year) covered by the shared network.

Heating and Cooling Needs (kWh/year)	Space heating consumption	Domestic Hot Water consumption	Space cooling consumption	Q delivered (kWh/year)
TOTAL	-	-	-	-

Figure 17 “Heating and Cooling Needs (kWh/year)” table

### % of fulfilment of the total network need demand table

The following mini table “% of fulfilment of the total network need demand” displays the percentage of energy demand fulfilled by the total shared network when applying the final distribution equipment for each type of consumption (i.e., Space heating, Domestic Hot Water, Space cooling).

This is calculated automatically by dividing the consumption entered for each final distribution equipment (see the “[Final distribution equipment](#)” table below) against the corresponding total demand presented in the first table of the shared network [“Heating and Cooling Needs (kWh/year)”].

A chart below the mini table (“Fulfilment of total demand”) also visualises the fulfilment percentage of the total shared network demand.

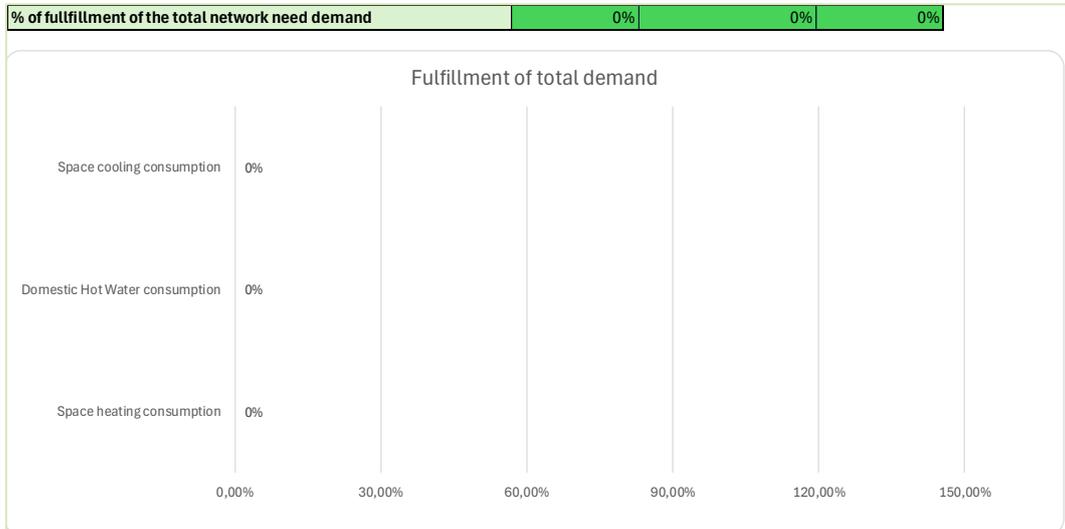


Figure 18 “Percentage (%) of fulfilment of the total network need demand” mini table along with the “Fulfilment of total demand” chart

## Final distribution equipment table

Users should then proceed to the following table (“Final distribution equipment”), where they must enter the annual energy consumption (kWh/year) for each distribution equipment intended for use in the shared network – that is, how much energy each piece of equipment consumes annually.

Final distribution equipment	Consumption in kWh	Use of equipment	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Biogas boiler (>2020)		Domestic Hot Water consumption	Biogas	0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Space cooling consumption		0,00	0,00
No equipment		Space heating consumption		0,00	0,00
No equipment		Space heating consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Space cooling consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
<b>Total emissions (kgCO2e)</b>				-	-

Figure 19 “Final distribution equipment” table

Users select the types of equipment intended to be used in the shared network from the following drop-down menu:

- |                           |                   |
|---------------------------|-------------------|
| 1. Gas boiler (>20 years) | 17. Mine workings |
| 2. Gas boiler (<10 years) | 18. Solar thermal |

- |                                    |   |
|------------------------------------|---|
| 3. Oil boiler (>20 years)          | 19. Metro shaft                         |
| 4. Oil boiler (<10 years)          | 20. Sewers                              |
| 5. Coal boiler (>20 years)         | 21. Solar panel in-house                |
| 6. Coal boiler (<10 years)         | 22. Industrial fumes                    |
| 7. Biogas boiler (<2020)           | 23. National grid electricity inputs    |
| 8. Biogas boiler (>2020)           | 24. Self-produced renewable electricity |
| 9. Biomass boiler (<2020)          | 25. Heat pump (air source)              |
| 10. Biomass boiler (>2020)         | 26. No equipment                        |
| 11. Waste incineration CHP         | 27. Electric convector                  |
| 12. Waste incineration (heat only) | 28. Heat exchanger                      |
| 13. Gas boiler CHP (gas engine)    | 29. Electric valve                      |
| 14. Gas boiler CHP (gas turbine)   |   |
| 15. Aquifer                        |   |
| 16. Geothermal wells               |   |

*\* For certain equipment types, the age is included in the list. This is necessary because their efficiency depends on age, which must be factored into the calculation.*

For each equipment, users enter the **consumption in kWh/year** and specify (from a drop-down menu) the **use of the equipment** (i.e., Space heating consumption, Domestic Hot Water consumption, Space cooling consumption).

The table then **automatically identifies the primary energy source** associated with each equipment.

Finally, the table **calculates the CO<sub>2</sub> emissions (kgCO<sub>2</sub>e)** per equipment and displays the **total emissions** at the bottom of the table, summing up the emissions from the selected equipment.

## Production equipment table

Users should then proceed to the following table (“Production equipment”), where they must enter the annual energy consumption (kWh/year) for each production equipment intended to deliver energy in the shared network.

Production equipment	Consumption in kWh	Use of equipment	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Biogas boiler (>2020)		Domestic Hot Water consumption	Biogas	0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Space cooling consumption		0,00	0,00
No equipment		Space heating consumption		0,00	0,00
No equipment		Space heating consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Space cooling consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
No equipment		Domestic Hot Water consumption		0,00	0,00
<b>Total emissions (kgCO2e)</b>				-	-

Figure 20 “Production equipment” table

Users select the types of production equipment in the shared network from the following drop-down menu:

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Gas boiler (&gt;20 years)</li> <li>2. Gas boiler (&lt;10 years)</li> <li>3. Oil boiler (&gt;20 years)</li> <li>4. Oil boiler (&lt;10 years)</li> </ol> | <ol style="list-style-type: none"> <li>17. Mine workings</li> <li>18. Solar thermal</li> <li>19. Metro shaft</li> <li>20. Sewers</li> </ol> |
|--|---|

- |                                    |   |
|------------------------------------|---|
| 5. Coal boiler (>20 years)         | 21. Solar panel in-house                |
| 6. Coal boiler (<10 years)         | 22. Industrial fumes                    |
| 7. Biogas boiler (<2020)           | 23. National grid electricity inputs    |
| 8. Biogas boiler (>2020)           | 24. Self-produced renewable electricity |
| 9. Biomass boiler (<2020)          | 25. Heat pump (air source)              |
| 10. Biomass boiler (>2020)         | 26. No equipment                        |
| 11. Waste incineration CHP         | 27. Electric convector                  |
| 12. Waste incineration (heat only) | 28. Heat exchanger                      |
| 13. Gas boiler CHP (gas engine)    | 29. Electric valve                      |
| 14. Gas boiler CHP (gas turbine)   |   |
| 15. Aquifer                        |   |
| 16. Geothermal wells               |   |

For each equipment, users enter the **consumption in kWh/year** and specify (from a drop-down menu) the **use of the equipment** (i.e., **Space heating consumption**, **Domestic Hot Water consumption**, **Space cooling consumption**).

The table then **automatically identifies the primary energy source** associated with each equipment.

Finally, the table **calculates the CO<sub>2</sub> emissions (kgCO<sub>2</sub>e)** per equipment and displays the **total emissions** at the bottom of the table, summing up the emissions from the selected equipment.

## Comparative results

The final table presents an overview of the above calculations, by displaying:

- The total GHG emissions from the individual system, in kgCO<sub>2</sub>e
- The total GHG emissions from the shared district heating and cooling network, in kgCO<sub>2</sub>e
- The avoided GHG emissions, in kgCO<sub>2</sub>e, resulting from the use of the improved network
- The avoided GHG emissions as a percentage.

The above results are also displayed in the “GHG emissions (kgCO<sub>2</sub>e)” chart (located under the final table).

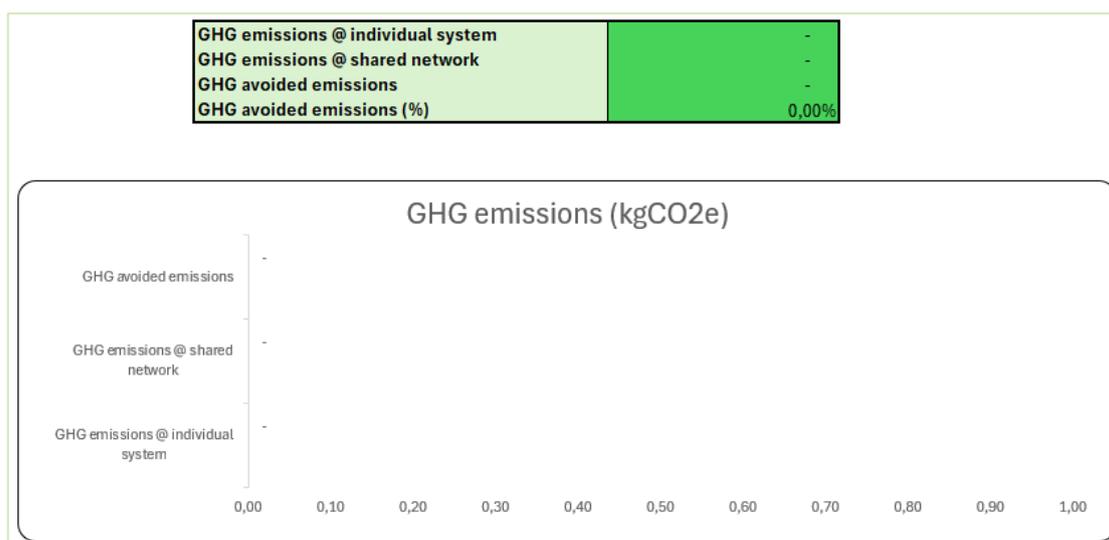


Figure 21 Comparative results and “GHG emissions (kgCO<sub>2</sub>)” chart

## Module 2: Network Assessment

### AIM

This module enables users to assess the GHG emissions and efficiency of existing district heating and cooling networks.

To insert the necessary data and carry out the assessment of GHG emissions and efficiency of existing district heating and cooling networks, users should follow the steps outlined below.

### Step 1 - Insert data for the Central Production of the network

#### Central Production of the network table

In the first table (“Central Production of the network”) users must enter the **annual energy consumption** (kWh/year) for **each production equipment** that delivers the primary energy into the shared network.

Users select the types of production equipment in the shared network from the following drop-down menu:

- |                            |   |
|----------------------------|---|
| 1. Gas boiler (>20 years)  | 17. Mine workings                       |
| 2. Gas boiler (<10 years)  | 18. Solar thermal                       |
| 3. Oil boiler (>20 years)  | 19. Metro shaft                         |
| 4. Oil boiler (<10 years)  | 20. Sewers                              |
| 5. Coal boiler (>20 years) | 21. Solar panel in-house                |
| 6. Coal boiler (<10 years) | 22. Industrial fumes                    |
| 7. Biogas boiler (<2020)   | 23. National grid electricity inputs    |
| 8. Biogas boiler (>2020)   | 24. Self-produced renewable electricity |
| 9. Biomass boiler (<2020)  | 25. Heat pump (air source)              |
| 10. Biomass boiler (>2020) | 26. No equipment                        |
| 11. Waste incineration CHP | 27. Electric convector                  |

- 
- |                                    |                    |
|------------------------------------|--------------------|
| 12. Waste incineration (heat only) | 28. Heat exchanger |
| 13. Gas boiler CHP (gas engine)    | 29. Electric valve |
| 14. Gas boiler CHP (gas turbine)   |                    |
| 15. Aquifer                        |                    |
| 16. Geothermal wells               |                    |

For each equipment, users enter the **consumption in kWh/year** and specify (from a drop-down menu) the **use of the equipment** (i.e., **Space heating consumption, Domestic Hot Water consumption, Space cooling consumption**).

The table then **automatically identifies the primary energy source** associated with each equipment.

Finally, the table **calculates the CO<sub>2</sub> emissions (kgCO<sub>2</sub>e)** per equipment and displays the **total emissions** at the bottom of the table, summing up the emissions from the selected equipment.



## Step 2 - Insert energy demand and equipment data for each branch of the network

### Branches - energy demand and equipment

The module contains tables where users should enter data on the **energy demand** and **equipment** for the network's branches.

Users can insert data for up to four branches.

The tables in each branch follow the same structure and logic as in Module 1. For each branch, users can provide data for the following establishments:

Branch [#] Household energy demand table (entered either manually or via automatic calculation)

The “Branch [#] Household energy demand” table (either manual or automatic) generates a  $Q_{delivered}$  value, representing the **total energy consumption for each household energy category and for all three types of energy consumption (space heating, domestic hot water, space cooling)**.

In the manual table, users select the **energy category** and enter the **total surface area (in m<sup>2</sup>)** of their establishment. If there is more than one household within the same energy category, the total surface area (in m<sup>2</sup>) of all such households should be summed and entered in the corresponding field (see the [first example in p. 6](#)).

The user should then enter the different annual **consumption values** for each type of energy consumption type (**heating, domestic hot water and cooling**). If there is more than one establishment in an energy category, their consumption values must be summed and entered into the corresponding fields for each type of energy consumption (see the [second example in p. 6](#)). *All three categories must be completed.*

Branch #1 Household energy demand (manual)					
Energy category	Surface (total m2)	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A					-
B					-
C					-
D					-
E					-
F					-
G					-
Household energy consumption (kWh/year)		-	-	-	-

Figure 23 “Branch [#] Household energy demand (manual)” table

In the **automatic table**, users choose the **energy category** and enter the total surface area (in m<sup>2</sup>) of their establishment. As above, if there is more than one establishment within the same energy category, the total surface area (in m<sup>2</sup>) of all should be summed and entered in the corresponding fields (see the [first example in p. 6](#)).

The annual consumption values are automatically calculated based on the percentage distribution of energy consumption according to the respective energy category.

Branch #1 Household energy demand (automatic)					
Energy category	Surface (total m2)	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A		-	-	-	-
B		-	-	-	-
C		-	-	-	-
D		-	-	-	-
E		-	-	-	-
F		-	-	-	-
G		-	-	-	-
Household energy consumption (kWh/year)		-	-	-	-

Figure 24 “Branch [#] Household energy demand (automatic)” table

---

Branch [#] Household equipment table (located under the “Branch [#] Household energy demand” table)

The “Branch [#] Household equipment” table calculates both the **fossil emissions** and the **biogenic emissions** (in kgCO<sub>2</sub>e) for each equipment type, according to national emission factors.

For each equipment, users enter the **annual consumption in kWh/year** and specify (from a drop-down menu) the **use of the equipment** (i.e., Space heating consumption, Domestic Hot Water consumption, Space cooling consumption).

The table then **automatically identifies the primary energy source associated with each equipment**.

At the bottom of the table, the **total emissions for the selected equipment** are summed up and displayed.

Branch #1 Household Equipment	Consumption in kWh	Use of equipment	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Biomass boiler (<2020)		Domestic Hot Water consumption	Biomass	-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
<b>Total emissions (kgCO2e)</b>				-	-

Figure 25 “Branch [#] Household equipment” table

Branch [#] Office energy demand table (entered either manually or via automatic calculation)

The “Branch [#] Office energy demand” table (either manual or automatic) generates a  $Q_{delivered}$  value, representing the total energy consumption for each office energy category and for all three types of energy consumption (space heating, domestic hot water, space cooling).

In the manual table, users select the energy category and enter the total surface area (in  $m^2$ ) of their establishment. If there is more than one household within the same energy category, the total surface area (in  $m^2$ ) of all such offices should be summed and entered in the corresponding field (see the [first example in p. 6](#)).

The user should then enter the different annual consumption values for each type of energy consumption type (heating, domestic hot water and cooling). If there is more than one establishment in an energy category, their consumption values must be summed and entered into the corresponding fields for each type of energy consumption (see the [second example in p. 6](#)). *All three categories must be completed.*

Branch #1 Office energy demand (manual)					
Energy category	Surface (m <sup>2</sup> )	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A					-
B					-
C					-
D					-
E					-
F					-
G					-
Office energy consumption (kWh/year)		-	-	-	-

Figure 26 “Branch [#] Office energy demand (manual)” table

In the automatic table, users choose the energy category and enter the total surface area (in  $m^2$ ) of their establishment. As above, if there is more than one establishment within the same energy category, the total surface area (in  $m^2$ ) of all should be summed and entered in the corresponding fields (see the [first example in p. 6](#)).

The annual consumption values are automatically calculated based on the percentage distribution of energy consumption according to the respective energy category.

Branch #1 Office energy demand (automatic)					
Energy category	Surface (m2)	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
A		-	-	-	-
B		-	-	-	-
C		-	-	-	-
D		-	-	-	-
E		-	-	-	-
F		-	-	-	-
G		-	-	-	-
Office energy consumption (kWh/year)		-	-	-	-

Figure 27 “Branch [#] Office energy demand (automatic)” table

---

Branch [#] Office equipment table (located under the “Branch [#] Office energy demand” table)

This table calculates both the **fossil emissions** and the **biogenic emissions** (in kgCO<sub>2</sub>e) for each equipment type, according to national emission factors.

For each equipment, users enter the **annual consumption in kWh/year** and specify (from a drop-down menu) the **use of the equipment** (i.e., Space heating consumption, Domestic Hot Water consumption, Space cooling consumption).

The table then **automatically identifies the primary energy source associated with each equipment**.

At the bottom of the table, the **total emissions for the selected equipment** are summed up and displayed.

Branch #1 Office Equipment	Consumption in kWh	Use of equipment	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Biomass boiler (<2020)		Domestic Hot Water consumption	Biomass	-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Space heating consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
<b>Total emissions (kgCO2e)</b>				-	-

Figure 28 “Branch [#] Office equipment” table

Branch [#] Industry energy demand table (entered manually)

The “Branch [#] Industry energy demand” table generates a  $Q_{delivered}$  value, representing the total energy consumption for each office energy category and for all three types of energy consumption (i.e., Space heating, Domestic Hot Water, Space cooling).

Users provide values directly for space heating, domestic hot water, and space cooling annual consumption of the industrial environment - without the need to insert square metres. *All three categories must be completed.*

Branch #1 Industry energy demand				
ID	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
Industry #1				-
Industry #2				-
Industry #3				-
Industry #4				-
Industry #5				-
<b>Industry energy consumption (kWh/year)</b>	-	-	-	-

Figure 29 “Branch [#] Industry energy demand” table (manual)

Branch [#] Industry equipment table (located under the “Branch [#] Industry energy demand” table)

The “Branch [#] Industry equipment” table calculates both the **fossil emissions** and the **biogenic emissions** (in kgCO<sub>2</sub>e) for each equipment type, according to national emission factors.

For each equipment, users enter the **annual consumption in kWh/year** and specify (from a drop-down menu) the **use of the equipment** (i.e., Space heating consumption, Domestic Hot Water consumption, Space cooling consumption).

The table then **automatically identifies the primary energy source associated with each equipment**.

At the bottom of the table, the **total emissions for the selected equipment** are summed up and displayed.

Branch #1 Industry Equipment	Consumption in kWh	Use of equipment	Primary Energy	Fossil emissions (kgCO2e)	Biogenic emissions (kgCO2e)
Heat pump (air source)		Domestic Hot Water consumption	National grid electricity inputs	-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
No equipment		Domestic Hot Water consumption		-	-
<b>Total emissions (kgCO2e)</b>				-	-

Figure 30 “Branch [#] Industry equipment” table

## Branch total emissions

After entering the data for each branch, users will find the following tables at the bottom:

- “Branch # Network energy consumption per type (kWh/year)”
- “Branch # Total emissions (kgCO<sub>2</sub>e)”

### Branch [#] Network energy consumption per type (kWh/year) table

This mini table presents the energy consumption (kWh/year) of each branch of the network by indicating:

- The total value of each type of energy consumption (Space heating, Domestic Hot Water, Space cooling) by summing up the respective values from all establishments (entered by the user or automatically calculated) in the specific branch.
- The final *Q<sub>delivered</sub>* value (kWh/year), shown on the right side of the table, calculated as the sum of the total values of the three types of energy consumption.

	Space heating consumption (kWh/year)	Domestic Hot Water consumption (kWh/year)	Space cooling consumption (kWh/year)	Q delivered (kWh/year)
Branch #1 Network energy consumption per type (kWh/year)	-	-	-	-

Figure 31 “Branch [#] Network energy consumption per type (kWh/year)” mini table

### Branch [#] Total emissions (kgCO<sub>2</sub>e) table

This mini table displays the emissions of the branch’s equipment (kgCO<sub>2</sub>e), automatically calculated as the sum of emissions from each establishment’s equipment table in that branch (separately for fossil and biogenic).

	Fossil emissions	Biogenic emissions
Branch #1 Total emissions (kgCO <sub>2</sub> e)	-	-

Figure 32 “Branch [#] Total emissions (kgCO<sub>2</sub>e)” mini table

## Comparative results

The comparative results for this module are indicated in the **final table** at the end of the module.

GHG emissions @ branch#1	-
GHG emissions @ branch#2	-
GHG emissions @ branch#3	-
GHG emissions @ branch#4	-
GHG emissions @ network	-
Network real efficiency	0,00%
Network generation	3GDHC
Network theoretical efficiency	80-85%

Figure 33 Comparative results

Specifically, the final table displays the following:

- GHG emissions @ branch (#):** Shows the GHG emissions of each branch, by taking into account the sum of fossil emissions per branch, the  $Q_{delivered}$  value per branch (from the table: *Branch # Network energy consumption per type (kWh/year)*), the sum of all  $Q_{delivered}$  values of all branches, and the fossil emissions from the central production equipment of the network (from the table: *Production equipment for the network*)
- GHG emissions @ network:** Shows the total GHG emissions of all branches combined.
- Network real efficiency:** Shows the actual efficiency of the shared network, by taking into account the sum of all  $Q_{delivered}$  values across branches, the consumption values of the selected equipment in all branches, and the consumption values of the production equipment (from the table: *Production equipment for the network*).
- Network theoretical efficiency:** Shows the typical theoretical efficiency of the whole network, considering the network generation. Those numbers can be customised in the [Database section](#).

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

Figure 34 “Network theoretical efficiency” table in the Database section of the tool

At the end of the module, **two charts** are provided: one illustrating the **total “Network’s Emissions”** and the other the **“Network’s Efficiency”**.

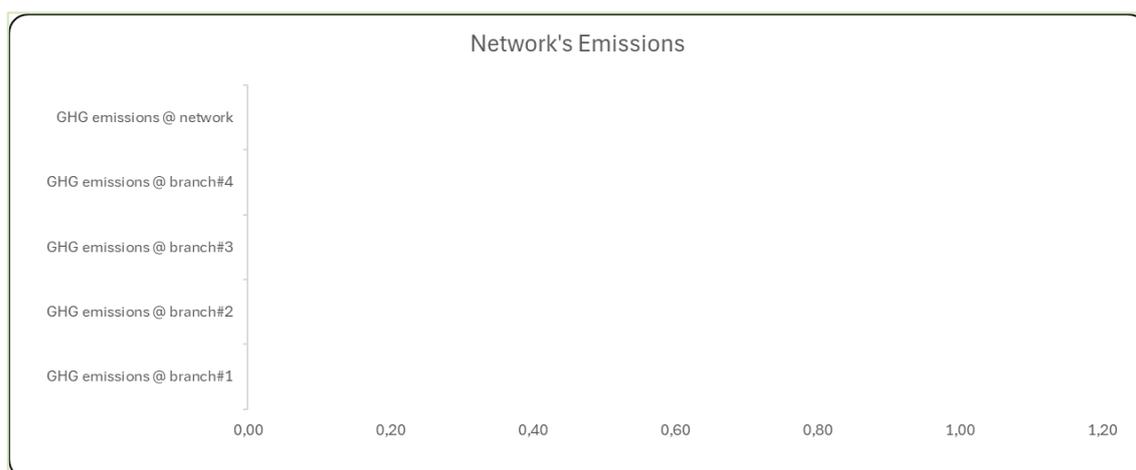


Figure 33 “Network’s Emissions” chart

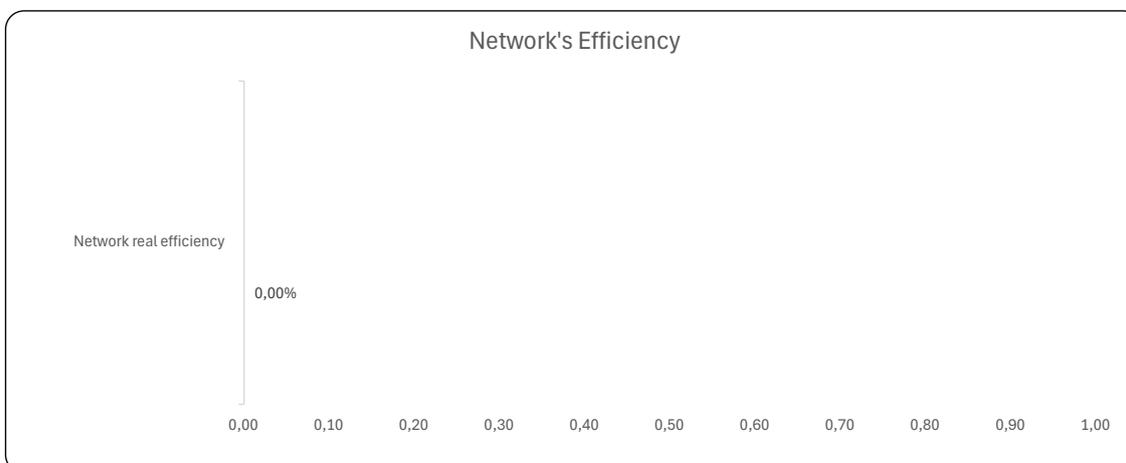


Figure 34 “Network’s Efficiency” chart

## Module 3: Decarbonisation actions

### AIM

This module enables users to identify and evaluate decarbonisation actions in terms of efficiency gains and GHG emission reductions for the network assessed in Module 2.

A second sheet named `Decarbonisation_Individual_Syst` performs the same functions as described below, but for decarbonising Individual Systems described in Module 1.

The first table in the module displays the following information:

- ❖ **Current Network GHG emissions:** This value is based on the assessment of GHG emissions of the network analysed and calculated in Module 2.
- ❖ **Future Network GHG emissions:** This value shows the difference of GHG emissions between the future and current network (when applying the selected decarbonisation actions). This will be calculated by assessing the desired decarbonisation actions that users will identify in Module 3, compared to the “Current Network GHG emissions”.
- ❖ **Total avoided GHG emissions (in kgCO<sub>2</sub>e):** This value corresponds to the sum of “GHG avoided emissions (kgCO<sub>2</sub>e)” (see table below) of all selected actions.
- ❖ **Total avoided GHG emissions (%):** This value shows the percentage of total avoided GHG emissions that the future network will achieve (through the selected decarbonisation actions) compared to the current network.
- ❖ **Total gains in energy efficiency (%):** This value shows the percentage of total energy efficiency gains that the future network will achieve through the selected decarbonisation actions.

<b>Current Network GHG emissions</b>	-
<b>Future Network GHG emissions</b>	-
<b>Total avoided GHG emissions (in kgCO2e)</b>	-
<b>Total avoided GHG emissions (%)</b>	0%
<b>Total gains in energy efficiency (%)</b>	0%

Figure 35 Table presenting the avoided GHG emissions and gains in energy efficiency of the analysed network

These values are also displayed in the “Network GHG emissions” chart at the end of the module.

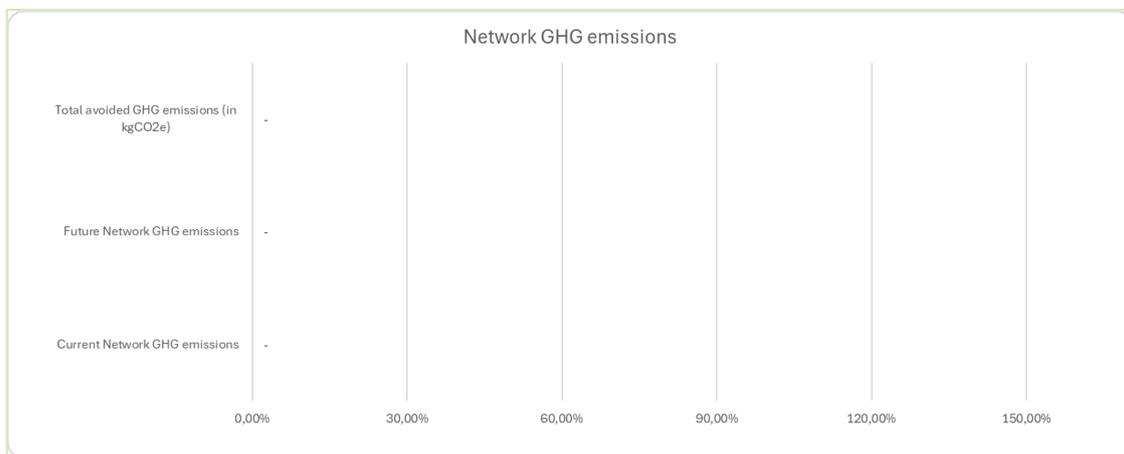


Figure 36 “Network GHG emissions” chart

## Step 1 - Insert data for identifying and assessing decarbonisation actions

The second table (“Decarbonisation Actions”) presents a set of predefined decarbonisation actions with descriptions from which users can select those that will be applied in the future network.

Matching Action	Description	Scope (%)	GHG Emissions Reduction (%)	Energy Efficiency Gain (%)	Optional Comments	Cost Range (euros/per MW (installed capacity))	GHG avoided emissions (kgCO <sub>2</sub> e)
Optimisation of equipment performance.	Regular adjustment, retrofitting, or replacement of boilers, pumps, and heat exchangers to ensure operation at design efficiency and minimise excess fuel consumption.		20,00%	20,00%		50,000-80,000	0,00
Reduction of heat losses (Insulation, leak detection system).	Detecting and repairing leaks, improving pipe insulation, and upgrading distribution infrastructure to reduce unnecessary thermal losses across the network.		10,00%	35,00%		50,000-80,000	0,00
Lowering the operating temperature of the network.	Shift towards lower supply and return temperatures, efficient for distribution losses, while integrating renewable resources and improving end-use efficiency.		10,00%	7,00%		50,000-80,000	0,00
Measurement and control systems (smart meters, SCADA, and temperature optimisation algorithms).	Balancing supply and demand by deploying advanced monitoring and control platforms, while optimising temperature and flow and improving network responsiveness.		6,00%	6,00%		50,000-80,000	0,00
Implementation of digital twin and predictive maintenance tools to support long term operational optimisation and emissions reduction.	Simulating network behaviour, predict failures and optimise long-term performance through use of virtual models		19,00%	15,00%		50,000-80,000	0,00
Deployment of solar thermal systems with geothermal energy or large-scale heat pumps connected to the district heating network.	Integrate renewable heat sources, such as solar collectors, geothermal wells, or heat pump into the network, displacing fossil-based generation.		45,00%	20,00%		50,000-80,000	0,00
Use of biomass boilers or biogas combined heat and power (CHP) plants.	Use biomass or biogas CHP systems to substitute fossil fuel boilers, hence providing renewable-based, high-efficiency heat and electricity.		70,00%	70,00%		50,000-80,000	0,00
Introduction of decentralised, prosumer-based generation models that allow buildings to feed surplus heat into the grid.	Surplus heat from buildings and local facilities is potentially produced and directed into the grid leading to a more distributed energy system		7,00%	5,00%		50,000-80,000	0,00
Capture of industrial excess heat (e.g. from manufacturing processes, data centres, or waste incineration) and reinjection into the network.	Reusing low-or-medium grade waste heat from industries, data centres or waste incineration, as a sustainable heat source		40,00%	25,00%		50,000-80,000	0,00
Deployment of heat recovery units in buildings or substations.	Installation of local heat recovery systems, i.e. from ventilation exhaust or cooling units, reducing primary energy demand.		10,00%	10,00%		50,000-80,000	0,00
Development of thermal energy storage solutions (short- or long-term) to optimise the temporal match between supply and demand.	Increase system flexibility by aligning variable supply from renewables with fluctuating demand (i.e. integrating hot water tanks, pits, or seasonal storage)		15,00%	5,00%		50,000-80,000	0,00
User action #01						50,000-80,000	0,00
User action #02						50,000-80,000	0,00
User action #03						50,000-80,000	0,00
User action #04						50,000-80,000	0,00
User action #05						50,000-80,000	0,00
User action #06						50,000-80,000	0,00
User action #07						50,000-80,000	0,00
User action #08						50,000-80,000	0,00
User action #09						50,000-80,000	0,00
User action #10						50,000-80,000	0,00

Figure 37 “Decarbonisation Actions” table

The list includes the following predefined actions:

- Optimisation of equipment performance.
- Reduction of heat losses (Insulation, leak detection system).
- Lowering the operating temperature of the network.

- Measurement and control systems (smart meters, SCADA, and temperature optimisation algorithms).
- Implementation of digital twin and predictive maintenance tools to support long-term operational optimisation and emissions reduction.
- Deployment of solar thermal systems with geothermal energy or large-scale heat pumps connected to the district heating network.
- Use of biomass boilers or biogas combined heat and power (CHP) plants.
- Introduction of decentralised, prosumer-based generation models that allow buildings to feed surplus heat into the grid.
- Capture of industrial excess heat (e.g. from manufacturing processes, data centres, or waste incineration) and reinjection into the network.
- Deployment of heat recovery units in buildings or substations.
- Development of thermal energy storage solutions (short- or long-term) to optimise the temporal match between supply and demand.

GHG Emissions Reduction (%)	Energy Efficiency Gain (%)
20,00%	20,00%
10,00%	35,00%

In addition, the table displays pre-defined values for the **GHG Emissions Reduction (%)** and **Energy Efficiency Gain (%)** of each action, which can be modified by the user.

Users need to insert the scope (as a percentage, %) to select an action and define the impact it will have in the network assessed in Module 2.

Scope (%)

Cost Range (euros/per MW (installed capacity))	GHG avoided emissions (kgCO <sub>2</sub> e)

Based on this input, the table automatically calculates the estimated cost range [Cost Range (euros/per MW<sub>th</sub> (installed capacity))] and avoided GHG emissions [GHG avoided emissions (kgCO<sub>2</sub>e)], shown on the right side of the table.

Users also have the option to add comments for each selected action.

Optional  
Comments

In addition, users can manually add further actions by providing:

- A short title of the action
- A brief description of the action
- The expected GHG Emissions Reduction (as a percentage)
- The Energy Efficiency Gain (as a percentage)
- Any comments they would like to add.

For these manually added actions, the estimated cost range [Cost Range (euros/per MW<sub>th</sub> (installed capacity))] and avoided GHG emissions [GHG avoided emissions (kgCO<sub>2</sub>e)] are likewise calculated automatically on the right side of the table.

User action #01						50,000-80,000	0.00
User action #02						50,000-80,000	0.00
User action #03						50,000-80,000	0.00
User action #04						50,000-80,000	0.00
User action #05						50,000-80,000	0.00
User action #06						50,000-80,000	0.00
User action #07						50,000-80,000	0.00
User action #08						50,000-80,000	0.00
User action #09						50,000-80,000	0.00
User action #10						50,000-80,000	0.00

Figure 38 Fields for manual insertion of decarbonisation actions

The results of GHG avoided emissions for each selected decarbonisation action is also displayed in the “Waterfall chart” that follows.



Figure 39 “Waterfall chart”

## Database section

The database section contains all the factors and data that are used for the calculations performed for the respective country within the consortium.

The factors provided in the Database refer to various coefficients, co-aggregated by country, and are outlined below:

- Emission Factors for each equipment, based on the energy used
- Energy class for households and offices
- Distribution of energy types per establishment (KWH/m<sup>2</sup>/year)
- Equipment Efficiency Factors *n<sub>generation</sub>* (%)
- Coefficients of performance (COP) per Technology and factor
- Cost Range of decarbonisation actions (euros/per MW<sub>th</sub> (installed capacity))

For this tool the following factors were taken into account, aggregated based on country.

Emission Factor		Austria		France		Germany		Italy		Slovenia	
Energy input	Energy type	Fossil emissions	Biogenic emissions								
Boilers (KWh LCV)	Gas boiler (>20 years)	0,2020	0,0000	0,2020	0,0000	0,2020	0,0000	0,2020	0,0000	0,2020	0,0000
Boilers (KWh LCV)	Gas boiler (<10 years)	0,2020	0,0000	0,2020	0,0000	0,2020	0,0000	0,2020	0,0000	0,2020	0,0000
Boilers (KWh LCV)	Oil boiler (>20 years)	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000
Boilers (KWh LCV)	Oil boiler (<10 years)	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000
Boilers (KWh LCV)	Coal boiler (>20 years)	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000
Boilers (KWh LCV)	Coal boiler (<10 years)	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000	0,2800	0,0000
Boilers (KWh LCV)	Biogas boiler (<2020)	0,0016	0,0000	0,0016	0,0000	0,0016	0,0000	0,0016	0,0000	0,0016	0,0000
Boilers (KWh LCV)	Biogas boiler (>2020)	0,0016	0,0000	0,0016	0,0000	0,0016	0,0000	0,0016	0,0000	0,0016	0,0000
Boilers (KWh LCV)	Biomass boiler (<2020)	0,0132	0,3770	0,0132	0,3770	0,0132	0,3770	0,0132	0,3770	0,0132	0,3770
Boilers (KWh LCV)	Biomass boiler (>2020)	0,0132	0,3770	0,0132	0,3770	0,0132	0,3770	0,0132	0,3770	0,0132	0,3770
Boilers (KWh heat)	Waste incineration CHP	0,2485	0,3503	0,2485	0,3503	0,2485	0,3503	0,2485	0,3503	0,2485	0,3503
Boilers (KWh heat)	Waste incineration (heat only)	0,1812	0,2554	0,1812	0,2554	0,1812	0,2554	0,1812	0,2554	0,1812	0,2554
Boilers (KWh heat)	Gas boiler CHP (gas engine)	0,3526	0,0000	0,3526	0,0000	0,3526	0,0000	0,3526	0,0000	0,3526	0,0000

Figure 40 List of factors in the Database section

Each partner of the consortium must provide specific country data and information, and complete the database section wherever required, following the guidance provided by the tool administrator (CCI NCA).

In addition, the Database includes the following complex calculations, which support the visualisation of results for users:

- Calculation for Module 1: Individual vs Shared - Fossil & Biogenic emissions
- Calculations for Module 2: Network assessment - Fossil & Biogenic emissions & Equipment efficiency
- Network theoretical efficiency table
- Calculations for the “Waterfall chart”

For this tool the following complex calculations are performed here, partitioned due to technical limitations.



Calculation: (@IndividualvsShared) Fossil & Biogenic emissions		Austria	France	Germany	Italy	Slovenia
First Household Equipment	Fossil emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Biogenic emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Fossil emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Biogenic emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Fossil emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Biogenic emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Fossil emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Biogenic emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Fossil emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Biogenic emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Fossil emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00
First Household Equipment	Biogenic emissions (kgCO2e)	0,00	0,00	0,00	0,00	0,00

Figure 41 List of calculations in the Database section