

CO₂ COMPARE



CO₂ Model for operational Programme Assessment in EU Regions

User Tutorial



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Abstract

This document is a tutorial for users of the CO₂MPARE model and provides step by step guidance on the different functionalities of the model for both basic and expert users.

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1

Introduction

The CO₂MPARE model has been created to assess the carbon impacts of Operational Programmes co-financed through the European Regional Development Fund (ERDF). Through its regional policy, the European Union co-invests in structural development programmes in the EU Member States and regions. It aims to support job creation, competitiveness, economic growth, improved quality of life and sustainable development.

With its investments, it supports the delivery of the Europe 2020 strategy. Reducing greenhouse gas emissions is a key objective of this strategy. The EU climate change policy defines a reduction target for 20% lower greenhouse gas emission levels in 2020 compared to 1990. On a longer term (2050), a reduction of 80-95% is considered.

Achieving these targets requires that the carbon intensity of the economy is reduced across all sectors. This, in turn, requires policies to channel investments towards decarbonisation. In part, this can be achieved by dedicated policy instruments such as the EU Emissions Trading System. For another part, existing policy instruments with an impact on investments will have to be employed to stimulate low-carbon investments.

EU Regional Policy generally relates to the latter type of instruments. Through its Regional Policy, the EU co-finances a wide range of investments, and the impacts of these investments on carbon emissions can be positive, neutral or negative. By selecting appropriate investments to support, the instruments in the Regional Policy can therefore be employed to channel investments towards low-carbon alternatives.

Information is essential to make choices between investment options, and policy makers should be able to compare investment options in terms of CO₂ emissions. CO₂MPARE is designed to support such comparisons. Ultimately, it aims to enable national and regional authorities to include climate considerations in their investment decisions relating to their Operational Programmes.

1.1 Generic model with regional application

The CO₂MPARE model has been developed as a generic model that requires regionalization before functional use within a region or at national scale. The generic model comprises a model core with functional algorithms, but includes only default data. Before regional use, data should be updated and parameters need to be set to reflect regional practice. This process of regionalization is described in the technical background and guidance document. This user tutorial assumes that regionalization has taken place and that a national or regional application is thus available to the user.

The next chapters will present the functionalities and interfaces of the CO₂MPARE model, on a step by step approach.

- Chapter 2 describes the model's general purpose and functionality.
- Chapter 3 describes the model structure and presents the procedure to prepare the model for use.
- Chapter 4 provides step by step guidance on using the main functions of the model in basic mode (the essential steps in any scenario evaluation).
- Chapter 5 presents the results and the way they must be interpreted.
- Chapter 6 provides the step by step guidance on the advanced functionalities accessible through the expert mode.
- Chapter 7 provides the glossary.

2

Purpose & Functionality

2.1 Purpose

The purpose of CO₂MPARE is to support national and regional authorities in making balanced decisions when allocating budget towards the “Main Programme Themes” (priority axes) of their Operational Programmes financed under the European Regional Development Fund (ERDF).

The model aims to inform policy makers of the consequences on CO₂ emission that investments in various theme elements can have. It assesses the combined carbon impact of all activities that take place under a programme, and provides an insight into the relative contributions of the different themes.

Ex-ante comparison of alternative programmes (investment portfolios with different budget allocations) and their respective carbon consequences can help to include climate considerations as part of the selection criteria for a prospective portfolio. Although the climate performance of a programme may not necessarily be the prime criterion in such decision, differences in climate performance could (help to) tip the balance between various alternatives. Moreover, through this approach, policy makers may align their Operational Programmes with regional, national, and European low carbon development goals.

With CO₂MPARE, users can model Operational Programmes and attain evaluations of their carbon impact. The model allows assessing possible alternative programmes (i.e. testing alternative investment allocations with an equal overall budget) and comparing them in terms of CO₂ emissions. It can therefore:

1. Identify investments with significant CO₂ consequences
2. Test the impact of different investment schemes on emissions

2.2 Functionality and Limitations

2.2.1 Functionality

To understand the functionalities of the model, it is essential to first focus on its subject: Operational Programmes. They represent the way investments from the EU will be allocated within regions.

In order to track and classify EU contribution to programmes, investments are classified using themes (e.g. energy, transport, etc.), which are divided into sub-themes (e.g. transport theme is divided in motorways, railways, cycle tracks, etc.). Budget allocations are attributed to each of the theme and sub-theme of an Operational Programme. The EU uses one common classification for all ERDF programs, although each region usually has its own specific and adapted method to classify their investments.

The model uses the budget allocation over the main programme themes, sub-themes and theme elements in a region's Operational Programme. The model is based on the concept that the budget in each theme element is divided over investments in various "Standardized Investment Components" (SICs). Default values for these investment divisions are provided in the model, but specific programme evaluation is improved when the user further details the division for the intended programme. Chapter 4 of this tutorial provides step by step guidance for this procedure. One of the main strengths of the model is that operating it requires the user to specify the budget allocation, but that the user does not need to provide technical details. This allows the model to be used easily by non-technical policy makers.

Based on the economic and physical properties of the standardized investment components within the theme element, the model calculates the expected physical activity that can take place for the given budget. The model then calculates the emission consequences for each activity and finally aggregates them to totals per theme element, main theme, and for the full programme. Figure 1 shows the steps of disaggregation and aggregation that form the general principle of the model.

The user should take note that the model generates approximations of the carbon impact rather than exact numbers. Programmes may generally include a wide range of activities, with a wide range of carbon impacts. Even within a theme element, different ways of executing an activity may lead to different carbon impacts, and the exact way of execution is often not known yet at the time of budget allocations. The model therefore approximates the expected impact by using generic values for the SICs. The relative importance of different components within a theme element can be adjusted to the user's requirements. The user should be aware however that the economic and physical properties of actually executed projects may differ from those assumed for the SICs. An overview of the SICs and a short description of the activities covered in each SIC are provided in Appendix A.

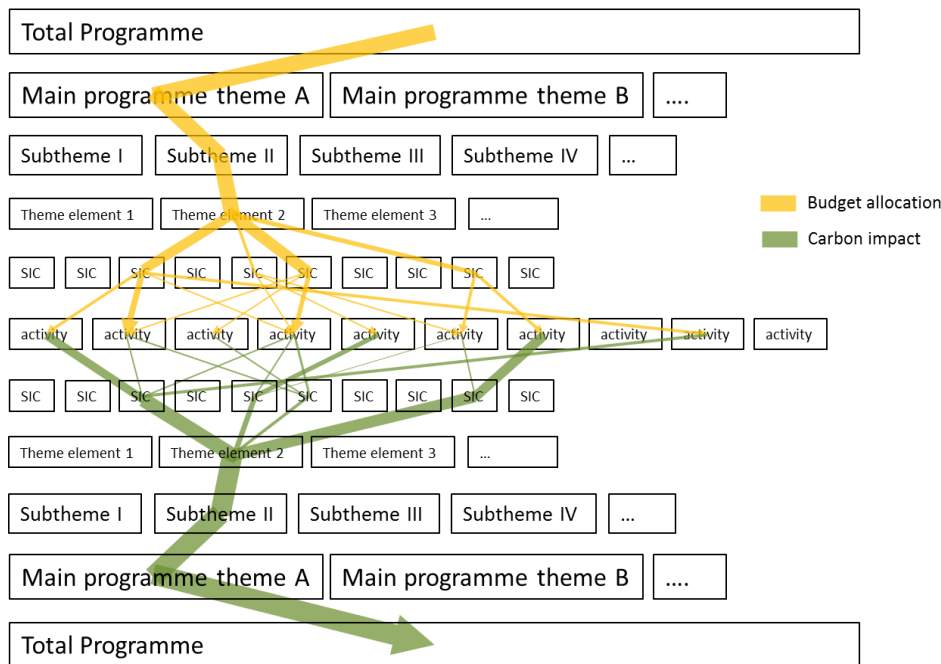


Figure 1: General model principle

2.2.2 Limitations

This generic approach may likely lead to errors in estimations for individual activity levels and their carbon consequences. However, in aggregating the activity levels at the level of theme elements, main programme themes or in the total programme, errors are likely to compensate each other and therefore become relatively smaller. As a consequence, the results are expected to provide a reliable estimate of the impact of total activities in most themes and the total programme.

However, the approach means that the results for themes in which only few activities are likely to take place may have a relatively large margin of error, as the generic SIC values may not be representative for the actual activity. Therefore the presented results should not be interpreted individually without considering further individual characteristics. A good understanding of programme content and carbon consequences of various activity types is therefore recommended when using the model. Due to this use of generic indicators, the model is not suitable to evaluate impacts on a project basis.

In special cases, this caution may also relate to the comparison of total programme impacts. If differences in the carbon impacts result from differences in themes with few projects, the total programme impacts may not provide a robust basis for decision making.

Finally, in addition to uncertainties and inaccuracies following from the generic structural nature of the SICs, there is also uncertainty related to the specific parameter values used for the SICs. Even if a SIC would describe the structure and operational environment of a given project (set of projects) accurately, the specific parameter values used in the model (e.g. costs, material use etc.) are also uncertain and may differ

significantly as a function of, for example, economic environment and sub-regional, local conditions. The sensitivity analysis function of the model can help in illustrating the effect this uncertainty could have on the programme scale.

2.3 Scope

2.3.1 Geographical scope

The model assesses Operational Programmes on the European NUTS 0 to NUTS 2 region scale. As activities in different regions may have different costs and carbon impacts, it uses regionalized data to assess these impacts when relevant. Assessing the same programme for different regions will therefore result in different outcomes.

Programmes may have carbon impacts both inside and outside the region, and the model shows the expected combined effects. For some activities it is clear where emissions will take place. Often such activities relate to fuel combustion at the project site. However for other activities, the exact location of carbon impact is not always clear. This is the case for example for electricity consumption, materials production, or avoided emissions from renewable energy production. Differentiating from emissions from inside and outside a region is a difficult task since it is really unlikely that one could define which category emissions belong to. For instance, embedded emissions from material production and freight may be classified as inside emissions if the production is operated inside the region, or outside if materials are imported from another region. Therefore, to still allow the consideration for all emission impacts, it was decided to disaggregate emissions into:

- Direct emissions (physical emission changes originating directly from the project, e.g. switching from oil-fired boiler into a bio-fuel fired one, commuting patterns).
- Indirect emissions (e.g. regional changes in electricity use, induced by the production/consumption of electricity by the project, embedded emissions from material production/freight, etc.).

2.3.2 Temporal scope

Operational Programmes often have an emission impact both during the construction phase of projects and during their operation phase. Construction phase impacts typically only last for a small period of time whereas effects due to the operational phase may last decades depending on the lifetime of investments. Annual effects of an investment may therefore change over time. The model keeps track of construction phase and operation phase impacts separately. By allowing the user to set the required period of assessment, the model allows assessing emission impacts over different timeframes. Apart from annual impacts, the model also calculates cumulative emissions over time which can be accessed by the user.

2.3.3 Financial scope

Projects that receive funding through the ERDF generally are co-financed by other public and private funds. Because it is impossible in practice to separate carbon consequences resulting from ERDF finance or other finance sources, the model assesses the impact of the total activity financed by the combined budgets. It therefore adds the budget eligible for ERDF support and the other public and private budgets. If only partial information on the available budget is available, the model uses default values to estimate the total budget.

2.4 Regional applications and intended users

As explained earlier, CO₂MPARE evaluates programmes by disaggregating them into standardized investment components, allowing users to assess CO₂ emission implications by providing financial data as inputs.

Depending on the region or country where the Operational Programmes are applied, the evaluation of programme may lead to different results. For instance, a new building constructed may not have the same energy performance and thus carbon impact in Sweden as in Greece.

To take these issues into account, the calculation chain used in the model uses two types of ratios:

- General ratios, which are not geographically dependant. It has been assumed that they are equal, no matter which programme in which region is evaluated (e.g. the emission factor of steel, in tCO₂/t).
- Regional ratios, which differ from one region to another (e.g. the construction costs of a building, in €/m²).

The generic version of the model provides default values for the general and regional ratios. Therefore, before starting the analysis, the default ratios need to be adjusted to fit regional characteristics. This regionalization process requires technically educated staff with a good understanding of Life Cycle Analysis and associated data collection. This user guidance document assumes that regionalization of the model has already taken place and the model is ready for use by national and regional authorities. The advised steps for model developers to prepare the model for use in a new region or country are described in the technical guidance document.

After regionalization, the model is fully operational and can be used by infrastructure development authorities, policy-makers, environmental authorities, etc., and other professionals involved in the preparation of future Operational Programmes.

To meet these different user needs, two modes have been distinguished to use the model:

- A "basic mode", for users who want to analyse and compare the effect of different investment schemes on the carbon impact of an Operational Programme,

- An "expert mode", allowing users to go further into the adjustment of the model parameters and of the programme being assessed.

2.5 Resource requirements

2.5.1 IT requirements

Operating the model requires a computer with Microsoft Excel version 2003 or more recent.

2.5.2 Data requirements

Data to adjust the model (expert mode) to a given region

As explained in the previous section, the model contains regional ratios that need to be set at regional or national scale to make the model operational for a given region or country¹. A complete description of these ratios is provided in the technical model documentation² available through DG REGIO, but information on ratios is directly available through the model (see Chapter 6 for more details).

Mainly, these ratios and linked functionalities are applied by expert users and can be managed within the Expert mode.

Data to run the model (basic mode)

To run the model, the user will need to enter financial inputs, i.e. the budget allocation over each theme element defined in the Operational Programme to be evaluated. These data are entered as inputs and are thus essential for the evaluation of a programme.

If available, physical indicators about the projects financed under the Operational Programme (for instance, length of highways constructed) can also be entered in the model, but are not essential to run it. See Chapter 4 for a detailed description.

2.5.3 Skills requirement

The user needs to have a good knowledge of:

- The financial model of the programme (i.e. how the budget is allocated over the different theme elements)
- The Operational Programme in its whole, so as to be able to evaluate the type of projects that are financed under it.

For interpretation of the results a proper understanding of causes and effects of greenhouse gas emissions is recommended.

¹ The model allows to work with definition of a 'region' at NUTS0, NUTS1 or NUTS2 level.

² [CO₂MPARE - Technical background and guidance for deployment in EU regions.](#)

3

Getting started

Please note that all screenshots presented in this document have been realised using Excel 2007. Using Excel 2003 may lead to slightly different interfaces, but model functionalities remain the same.

This chapter describes the model structure and the first steps the user should take to open the model and activate it, before actually starting the evaluation of Operational Programmes.

3.1 Model structure

CO₂MPARE is an excel tool composed of several interfaces, dedicated to different types of users:

- Users who will run the model to analyse the carbon impact of Operational Programmes according to different investment schemes.
- Expert users who will for instance, be in charge of adjusting the model so as to make the carbon assessment specific to one Operational Programme.

Through the Basic mode, presented along Chapter 4, users have access to:

- The *Scenario Management Interface* (and its related setting interfaces, in blue on Figure 2:), which will allow the user to create and manage scenarios.
- The *Results Interface*, extracting results of the carbon assessment of the scenarios created.

Through the Expert mode, users additionally have access to:

- Programme Management, to create and/or modify the architecture of the Operational Programmes that will be analysed.
- Ratio Management, to help them update and specify ratios used by the model, at the scale of their respective regions.
- SIC Management, where general information on SICs can be obtained and modified (like the lifetime considered -for a given SIC- in the calculation of its carbon impact).

These advanced functionalities are detailed in Chapter 6.

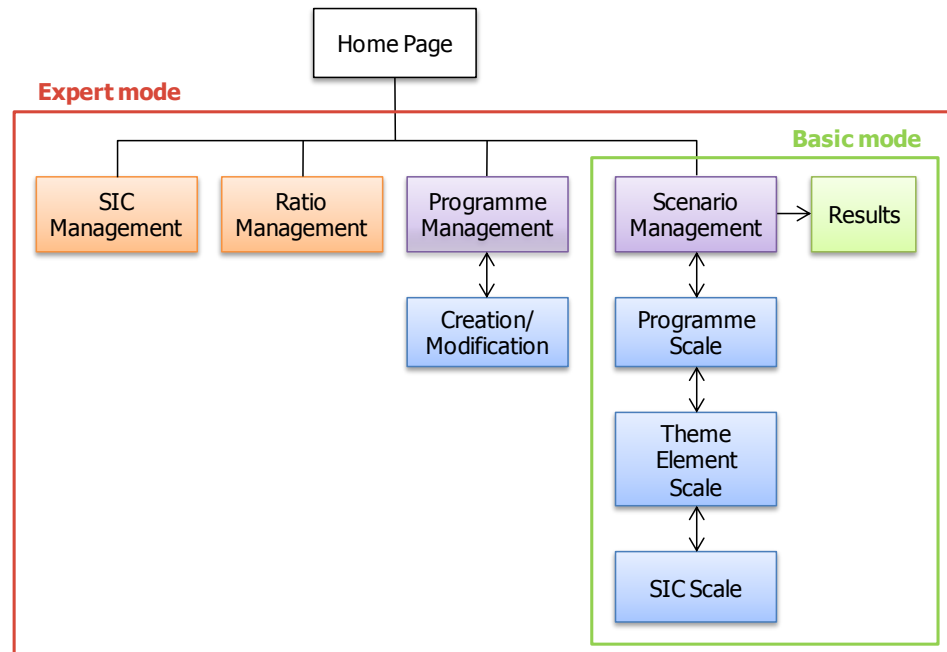


Figure 2: Diagram of the model structure, presenting the different user interfaces of the model

Interfaces in orange and purple are referred to as "Management" interfaces, whereas interfaces in blue are referred to as "Setting" interfaces.

Note: Apart from the differentiation on expert and basic functionality, the model structure can also be differentiated from a technical perspective, into the model core and a working area (see Figure 3). The working area represents the elements of the model in which defining variants allows comparison of programme scenarios, whereas the elements that constitute the model core form the base of the calculation, which should be uniform to allow comparisons.

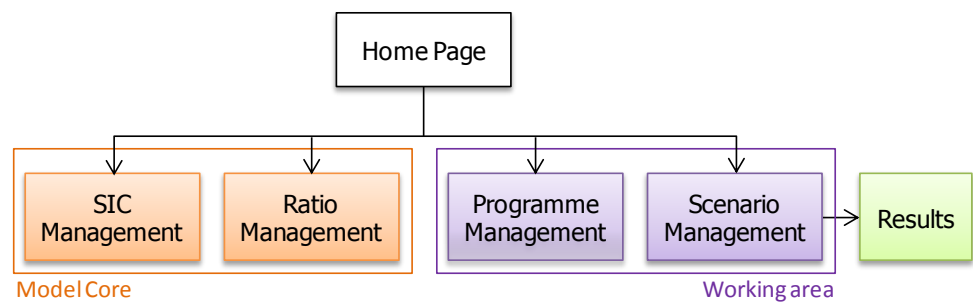


Figure 3: Diagram of the structure of the model opposing Model core and Working area

The Scenario Management and Programme Management functionalities can be run to assess the carbon impact of scenarios and programmes. The user has to enter inputs that vary amongst scenarios (working areas) to test investment schemes for a given programme. On the contrary, ratios and SICs are intrinsic parameters of the model (model core); they can be adjusted and updated through their respective management interfaces, but should be set to allow the evaluation and comparison of different scenarios.

3.2 Navigating the model

To navigate through the different management interfaces (horizontal navigation), users can click buttons on the top right corner of the home page, directly leading to the corresponding management interface. According to which mode is enabled (Basic or Expert) the set of buttons available is different as shown on Figure 4 and Figure 5 . See paragraph 3.3.3 to learn how to enable/disable the Expert mode.



Figure 4: Set of buttons under Basic mode, available on the Home Page



Figure 5: Set of buttons under Expert mode, available on the Home Page

To navigate through setting interfaces (vertical navigation on Figure 2), use the green arrows in the navigation bar present on top of each interface, to go back and forth, when possible. See Figure 6.



Figure 6: Navigation bar for Scenario Management

Note:



The help button leads to the glossary of the model. In this pop up window, the user can find descriptions of each SIC, definition of terms related to programmes, to SICs and to carbon evaluation.



The red button should be used when the user wants to quit the model.

3.3 Model start up

The model is an Excel file named "Co2mpare" or "Co2mpare.xlsm" and should be located in a folder that also contains the sub-folders "Model_Files" and "Results". The main folder should be located on the user's computer or on a server.

To run the model properly:

1. **Excel 2003** or a more recent version is needed.
2. The folders "Model_Files" and "Results" should **never be deleted or modified**. This may cause the settings of the model to change, which can lead to the model not functioning anymore.

Open the Excel file. The home page is appearing on screen.



Figure 7: CO₂MPARE home page

3.3.1 Enabling macros

The model uses macros to run its procedures; it does not function if macros are disabled. If macros are disabled on the computer, the user may see a warning message on top of the page.

To enable macros, click Options on this message and then Enable this content (see Figure 8). Once macros are enabled, the model is fully functional.



Figure 8: Pop up message allowing enabling macros

3.3.2 Home page configuration

When opened for the first time, the model is run in Basic mode and the home page groups 3 buttons on the top right corner (see Figure 7 and Figure 4):

- Two that allow the user to set "Preferences" (display control panel, Figure 9, and language settings). They are described hereafter.
- One leading to the *Scenario Management Interface*, where scenarios can be created, analysed and compared. This button gives access to the main functionalities of the model that are detailed in Chapter 4.

Note: When used under Expert mode, 5 additional buttons are displayed on the Home Page. See Figure 5. To enable Expert mode, select the option in General Preferences, see paragraph below.

3.3.3 General Preferences

When clicking the General Preferences button, a pop up window opens. This window is divided into two parts:

- Setting preferences for users,
- Setting preferences for developers.

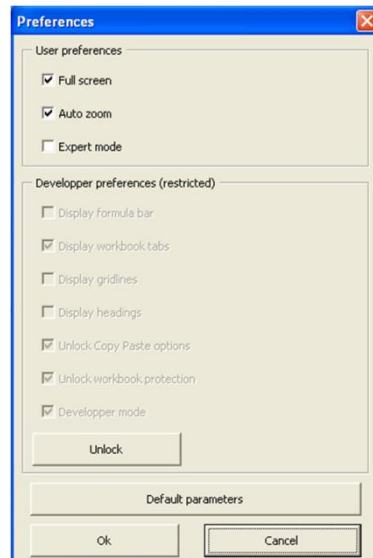


Figure 9: Pop up window for setting General Preferences.

Users can choose different display options:

- Full screen.
- Auto zoom.
- Expert mode: to go from Basic mode, to Expert mode. When ticking this option, additional buttons will appear on the home page, as just explained, offering the user new functionalities, like Programme Management and Ratio Management. See Chapter 6 for more details.

The developers' preferences (display and security) are protected by a developer's password and allow the controlling of display and protection options. For normal use of the model (programme evaluation), adjusting developers' preferences is not needed. To unlock developers' options, click **Unlock** and enter the password: **pw_dev**.

The user also has the choice to reset default parameters by clicking the corresponding button.

3.3.4 Language settings

The model language can be changed through the **Change language** button on the Home Page.

On clicking, a pop up window will open. Select the preferred language and click **OK** to confirm.

3.3.5 Region settings

This functionality is available only in the Expert mode.

As explained in Section 2.4 some ratios are specific to a geographical area. Depending on available information and relevance, they can be specific to a region (NUTS 1, NUTS 2) or a country (NUTS 0).

The model may contain several values for the same ratio, corresponding to different regions, but it will load only the ratio database corresponding to one single region, formerly set in the model.

To set the region for which the model will be run and thus select the appropriate ratios, the user can click **Change region** in the Preferences box on the home page. A pop up will open where the region can be selected at three different scales, NUTS 0, NUTS 1 or NUTS 2.

Once the user enabled the expert mode and selected the appropriate region, Programme, Ratio and SIC Management functionalities are fully operational. Chapter 6 describes how to use them and for what purpose.

3.3.6 Import package

When running the model in Expert mode, users have the possibility to directly import "packages" (.pkg) in the model, like scenarios and programmes, or ratio databases, by using the button **Import package** on the home page. This is useful when several users want to share their work on a scenario, programme or a ratio database. Import functionalities are also accessible through Scenario Management (cf. Section 4.3.4) and Ratio Management (cf. Section 6.3.2).

4

CO₂MPARE Step by step - Basic mode

As described previously, CO₂MPARE allows the user to assess the carbon impact of an Operational Programme as well as to analyse the emission impacts of alternative scenarios for the distribution of the financial resources over theme elements. These scenarios are the core of how programmes are evaluated using CO₂MPARE. By comparing several scenarios of a same programme, the user can identify the main carbon impacts and possibly find alternative or complementary investment schemes to reduce the global carbon impact of the programme.

This chapter focuses on Scenario Management and describes the different main functionalities of the model, when run in basic mode, through three sections:

- The process of creating a scenario.
- Step by step definition of a scenario.
- Managing scenarios.

4.1 The process of creating a scenario

The regionalized CO₂MPARE model provides a financial architecture that fits with the regional or national programme, with default distributions of SICs to theme elements based on historic data. Priorities in a regional or national programme may change from one programming period to another. Therefore, to evaluate the coming programming period, the first step to take is to create a new scenario that properly reflects the region's priorities for the programme it wishes to evaluate.

Creating a scenario is a 3 stage process, where the user will have to:

- Enter financial data for each theme element. This will be done on the 1st setting interface, where the user can work at "programme scale"
- Modify the financial disaggregation at the scale of a theme element,
- Enter physical data when possible, to refine the calculation, at the scale of a SIC.

The Scenario Management functionality is built upon 3 layers, one for each of these stages and for which a separate user interface has been created, as shown in Figure 10. This chapter will present these different interfaces one by one.

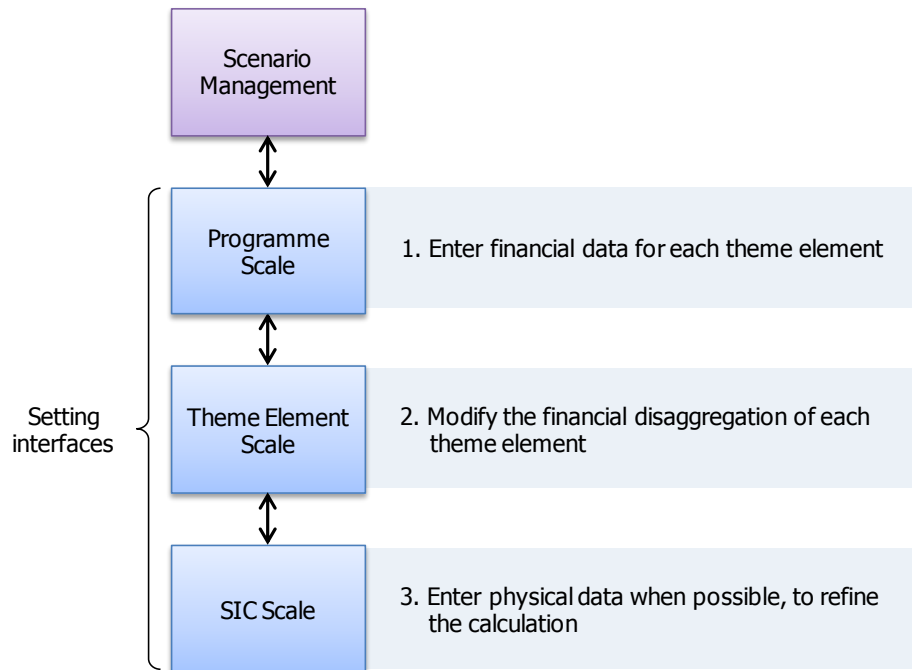


Figure 10: The 3 stages of the creation of a scenario and their associated setting interfaces

To start creating an initial scenario,

- First go to the *Scenario Management Interface* presented below.
- Then follow the step by step description given along this section.

4.1.1 Presentation of the Scenario Management Interface

To start using the model and create the first scenario, click the **Scenario Management** button on the Home Page. The *Scenario Management Interface* will open, as shown on Figure 11 below.

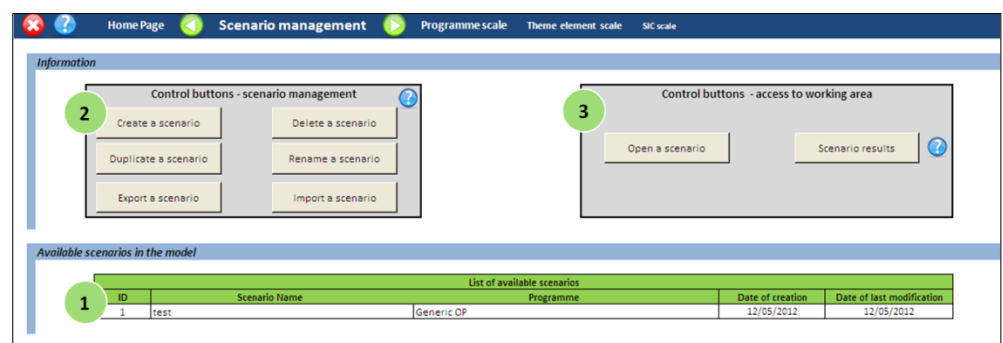


Figure 11: Screenshot of the *Scenario Management Interface*

This interface shows:

- 1 A table listing the different scenarios currently saved in the model and giving information about the scenario, such as:
 - The identification number (ID) of the scenarios.
 - The name of the scenarios.
 - The date of creation.
 - The date of last modification.
- 2 A first set of control buttons are dedicated to scenario management, the user will be able to:
 - Create new scenarios.
 - Copy, rename or delete existing scenarios.
- 3 A second set of control buttons will help the user to:
 - Edit scenarios (and thus modify them).
 - Extract results.

On the Scenario Management Interface, the user has access to the main functionalities of the model.

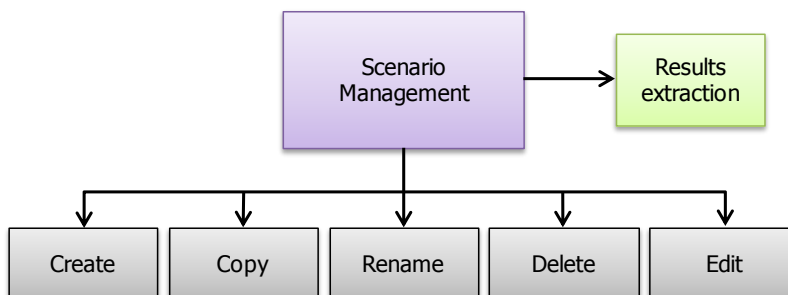


Figure 12: Diagram of the functionalities offered in the *Scenario Management Interface*

4.1.2 Creating the shell of a scenario

To create a first scenario and start entering its financial inputs, click **Create a scenario** on the *Scenario Management Interface*.

A pop up window will open. Write the name of this new scenario in the corresponding box as shown on the figure below, and click **OK**.

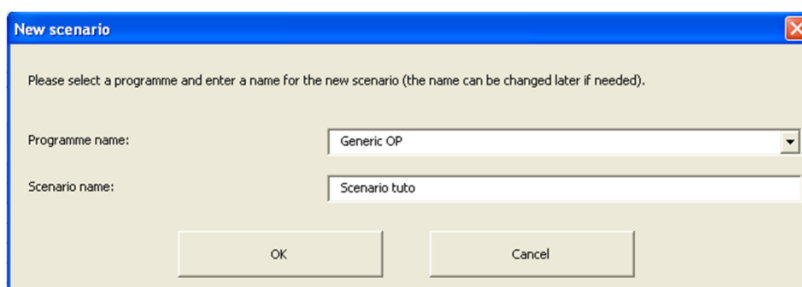


Figure 13: Pop up window allowing the creation of scenarios

The new scenario has then been created and will appear in the table listing all the scenarios saved in the model, on the *Scenario Management Interface*.

Note: When creating a scenario, a warning message appears to inform the user that the creation may take some time and suggest copying a scenario instead. Ignore this message and click **YES** if you want to create a new clean scenario.

To start defining the scenario parameters, the user will have to open the scenario that has just been created.

Click **Open scenario** in the *Scenario Management Interface*. A pop up window will open listing the available scenarios in the model. Select the new scenario and click **Open**, as shown on Figure 14 below.

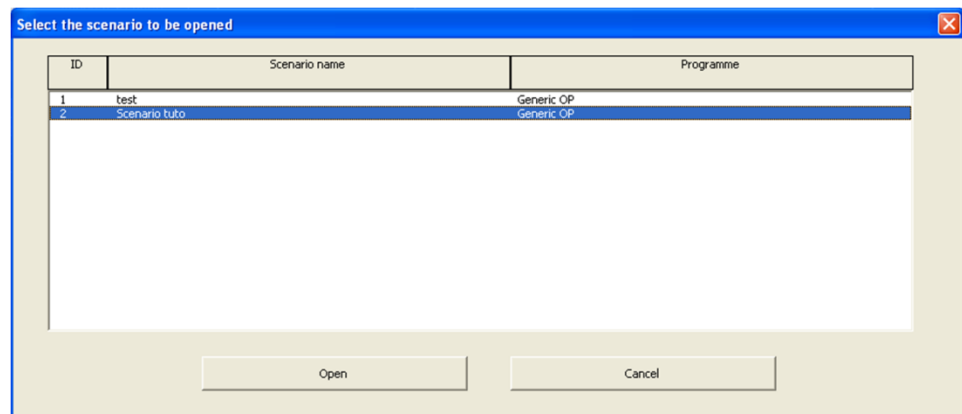


Figure 14: Pop up window used to open a scenario

The *Programme Scale Interface* will open, allowing the user to start working at a programme scale and enter financial data in the table.

4.2 Step by step definition of a scenario

4.2.1 Programme Scale Interface

Objective: enter financial data for each theme element

The model is developed to assess the carbon impact of scenarios and thus Operational Programmes, based on their financial models. For each euro allocated to a theme element, the model calculates a quantity of CO₂ emissions, as explained in Section 2.2.1. Therefore, for a given programme, the distribution of the overall budget over its theme elements is the model's main required input.

Financial data can be entered in three ways (see Box 1):

- ERDF and "all other contributions".
- ERDF contribution only.
- Total investment only.

Box 1 Entering ERDF funding and cofunding in CO₂MPARE

Often investments comprise both ERDF funding and co-funding from other sources. Since the model aims to evaluate the total impact of the programme, it requires input of the total investment. If for example, only ERDF contributions are taken into account and additional investments (private or public) are neglected, the carbon impact of the overall project is not fully accounted for.

If the user cannot provide the total investment for each of the theme elements of the programme to be evaluated, they will be calculated by the model; if only the ERDF contribution can be provided, the model will use a default leverage effect to determine the total investment. If both ERDF and all other contributions can be provided, the model will simply sum them both to obtain the total investment.

This section shows how to proceed to enter financial inputs, by using the *Programme Scale Interface*, which is described hereafter.

Presentation of the Programme Scale Interface

The screenshot displays the 'Programme scale' interface. It is divided into several sections:

- 1** **General Information:** A box containing scenario details such as ID (12), name (Scenario tuto), creation date (10/09/2012), last modification date (20/09/2012), status (Saved), and data entry method (ERDF & all other contributions).
- 2** **Control buttons:** A central area with buttons for 'Modify expenditures', 'Save', and 'Display SICs and theme elements association'.
- 1'** **Synthesis:** A box showing financial and carbon metrics: ERDF contribution (€ - M€), other contributions (€ - M€), Total (€ - M€), Total emissions (kt CO₂ / yr), and Ratio kg CO₂ / yr / €.
- 3** **Working area:** A large table with columns for ID levels (1-3), Programme architecture levels (1-3), ERDF contribution (€), Other contributions (€), Total (€), Emissions (kt CO₂ / yr), Ratio kg CO₂ / yr / €, and State of detailed entry.

ID level 1	ID level 2	ID level 3	Programme architecture - level 1	Programme architecture - level 2	Programme architecture - level 3	ERDF contribution €	Other contributions €	Total €	Emissions t CO ₂ / yr	Ratio kg CO ₂ / yr / €	State of detailed entry
01		01	Research and technological development		RTD activities in research centres	0	0	0	0	0.300	Default
01		02	Research and technological development		RTD infrastructures (including physical plans)	0	0	0	0	0.300	Default
01		03	Research and technological development		Technology transfer and improvement of co	0	0	0	0	0.300	Default
01		04	Research and technological development		Assistance to RTD, particularly in SMEs (incl	0	0	0	0	0.300	Default
01		05	Research and technological development		Advanced support services for firms and gov	0	0	0	0	0.300	Default
01		06	Research and technological development		Assistance to SMEs for the promotion of ex	0	0	0	0	0.300	Default
01		07	Research and technological development		Investment in firms directly linked to resear	0	0	0	0	0.300	Default
01		08	Research and technological development		Other investment in firms	0	0	0	0	0.300	Default
01		09	Research and technological development		Other measures to stimulate research and	0	0	0	0	0.300	Default
02		10	Information society		Telephone infrastructures (including broad	0	0	0	0	0.300	Default
02		11	Information society		Information and communication technologi	0	0	0	0	0.300	Default
02		12	Information society		Information and communication technologi	0	0	0	0	0.300	Default
02		13	Information society		Services and applications for the citizen (e	0	0	0	0	0.300	Default
02		14	Information society		Services and applications for SMEs (e-com	0	0	0	0	0.300	Default
02		15	Information society		Other measures for improving access to an	0	0	0	0	0.300	Default
03		16	Transport		Railways	0	0	0	0	1.033	Default
03		17	Transport		Railways (TEN-T)	0	0	0	0	1.033	Default
03		18	Transport		Mobile rail assets	0	0	0	0	1.033	Default
03		19	Transport		Mobile rail assets (TEN-T)	0	0	0	0	1.033	Default
03		20	Transport		Motorways	0	0	0	0	1.842	Default
03		21	Transport		Motorways (TEN-T)	0	0	0	0	1.811	Default
03		22	Transport		Regional roads	0	0	0	0	1.911	Default
03		23	Transport		Regional/local roads	0	0	0	0	1.911	Default
03		24	Transport		Cycle tracks	0	0	0	0	1.690	Default
03		25	Transport		Urban transport	0	0	0	0	1.712	Default
03		26	Transport		Multimodal transport	0	0	0	0	0.881	Default
03		27	Transport		Multimodal transport (TEN-T)	0	0	0	0	0.881	Default

Figure 15: Screenshot of the *Programme Scale Interface*

This interface is composed of 3 main parts:

1

Boxes listing general information about the scenario that is currently opened:

- The ID and name of the scenario.
- The date of creation and of last modification.
- The status of the scenario (saved or under modifications).

1'

- The chosen data entry method.
- Financial information (ERDF, non-ERDF and total costs of the scenario).
- Carbon information (CO₂ emissions calculated for the scenario + carbon content indicator).

2

A box with interface specific control buttons, allowing the user to:

- Modify expenditures.
- Save the data entered.
- See the Standardized Investment Components defined for each theme element.

3

A "data entry" table, showing:

- The model architecture (theme elements in blue).
- The associated investments (in green).
- The CO₂ emissions emitted (total and per k€, in orange and purple).
- The status of the financial entry (in grey; the status can indicate either default or customised values).

In this interface, the only modifiable cells are the ones from the columns related to funding (in green). According to the type of financial inputs the user wants to enter (see Section 4.2.1), one or two of these columns will turn orange. These are the columns that need to be filled in by the user.

All the other columns are write-protected and provide the context for the required data.

Help buttons are present on the page to remind the user what the different buttons or pieces of information are related to.



By clicking this symbol, the user can write down and save comments. For instance, it could be interesting to take notes on changes made compared with another scenario, to keep tracks of major modifications, or details that could be important.

Enter financial inputs

To start entering the financial inputs of the scenario, click **Modify expenditures**. A pop up window will open on asking to select the type of financial data to be entered:

ERDF and "all other" contributions

ERDF contribution only

Total investment only

Select the type of data you want to enter as inputs and click **OK**.

It will allow the model to determine how the financial data should be processed, if they are not directly "total investment", as explained formerly in this section.

Based on the type of data selected, the corresponding cells in the table will unlock and turn orange, see Figure 16. Fill them with financial inputs and click **Save** to continue.

Example: On this figure, the cells from the first green column are orange, which means the type of data selected was "ERDF contribution". These cells can then be filled in with the proper financial information.

Programme architecture - level 3	ERDF contribution €	Other contributions €	Total €	Emission
activities in research centres	0	0	0	
infrastructure (including physical plants)	0	0	0	
technology transfer and improvement of competitiveness to RTD, particularly in SMEs (including support services for firms and grants)	0	0	0	
investment in firms directly linked to research and development	0	0	0	
investment in firms	0	0	0	
measures to stimulate research and development	0	0	0	
innovation infrastructures (including broadband)	0	0	0	

Figure 16: Screenshot of *Programme Scale Interface* zoomed-in, showing where to enter financial inputs

Note: When entering ERDF contribution only, the user may want to modify the leverage effect that is assumed to apply. Please, refer to Section 6.1.3 to learn how to do this.

Display SICs and theme elements associations

The carbon impact of theme elements is directly linked to the SICs that are associated to them. Indeed, as described in Section 2.2.1, the model is based on the idea that the investments on the level of theme elements can be further disaggregated into the actual physical activities that will take place for the budget. It works from the presumption that even though activities undertaken in different projects under the same theme element may differ in scope and specification, such activities are generally of a similar nature. Thus, the model breaks down the activities within a theme element into a predefined set of standardized activities, called Standardized Investment Components (SICs).

A SIC comprises a coherent set of physical activities, e.g. the SIC 'road building construction' contains activities that take place for building a road, such as earthworks, paving, construction, etc. The model uses a set of SICs to describe all the activities that may take place within the various theme elements.

The user can have an overview of the SICs associated to theme elements by clicking **Display SICs and theme elements association**.

Note: no modification can be done by using this functionality. To modify SIC distribution, click on the top right green arrow to go the *Theme Element Scale Interface* and refer to Section 4.2.2.

Warnings and tips

If the data entered is not saved and the user wants to either go back to the *Scenario Management Interface* or enter the next setting interface, a warning pop up window will appear, offering to save, not to save or quit.

When clicking **Save**, a confirmation pop up window will open. Click **OK** to continue and reach the *Theme Element Scale Interface*.

Warning:

Never save the Excel file directly. To save scenarios, use the "**Save**" button of the model. Using the regular Excel 'save' button can cause model errors or non-responding.

The 1st stage of the creation of a scenario is now complete. The total budget of the programme has been redistributed over the theme elements defined in the programme.

The next section will describe how to operate the 2nd stage of creating a scenario, i.e. modifying the financial disaggregation of each of these theme elements into Standardized Investment Components.

4.2.2 Theme Element Scale Interface

Objective: *refine financial disaggregation of theme elements*

For a given theme element, the budget allocated can be spent in a number of ways. For instance, the theme element "Railways" may be distributed as follows:

- 40 % to railway construction.
- 6 % to railway renovation.
- 23 % to railway electrification.
- 13 % to equipment.
- 8 % to civil engineering.

These specific categories of expenditures are called "Standardized Investment Components" (SICs).

These SICs do not have the same carbon impact per euro invested, so the more precise their financial weight is (for a given theme element), the more accurate the evaluation of the theme element will be.

For each theme element there is a predefined default split of budget for a set of SICs. The user can change this default financial disaggregation in order to:

- Refine the underlying description of the theme element (i.e. what SICs are really financed under it).
- Test the impact of different types of investments.

This section explains how to refine the financial disaggregation of a theme element into SICs, using the *Theme Element Scale Interface*.

Presentation of the Theme Element Scale Interface

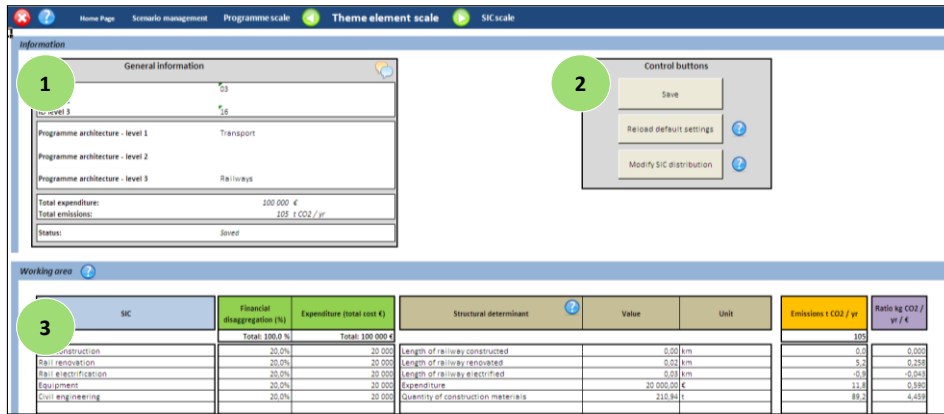


Figure 17: Screenshot of the *Theme Element Scale Interface*

This interface consists of 3 main parts:

- 1 A summary of general information concerning the theme element that is being modified. It shows:
 - ID of the theme element.
 - Name of the theme element (field of action + theme element).
 - Total expenditures.
 - CO₂ emissions implications.
 - The status of the data entered in the table (saved or not saved).
- 2 A box containing the control buttons, allows the user to:
 - Modify SIC distribution,
 - Save changes,
 - Reload default settings.
- 3 A table listing information about the relevant Standardized Investment Components for the specific theme element selected:
 - The name of the Standardized Investment Components.
 - The financial disaggregation between the Standardized Investment Components.
 - Information about the structural determinant: name, value and unit (see Section 4.2.3 for more details on structural determinant).
 - CO₂ emission totals for each of the Standardized Investment Components.
 - CO₂ emissions per euro invested in each Standardized Investment Component.

In this interface, the only modifiable cells are the ones in the column "financial disaggregation" (in green). They are highlighted in orange to help the user quickly see which data should be modified.

All the other columns are locked and are for indicative purposes.

Modifying the disaggregation into Standardized Investment Components

To reach the *Theme Element Scale Interface*, click the green arrow button in the navigation bar of the *Programme Scale Interface*. A pop up window will open. Select the desired theme element and click **Open**.

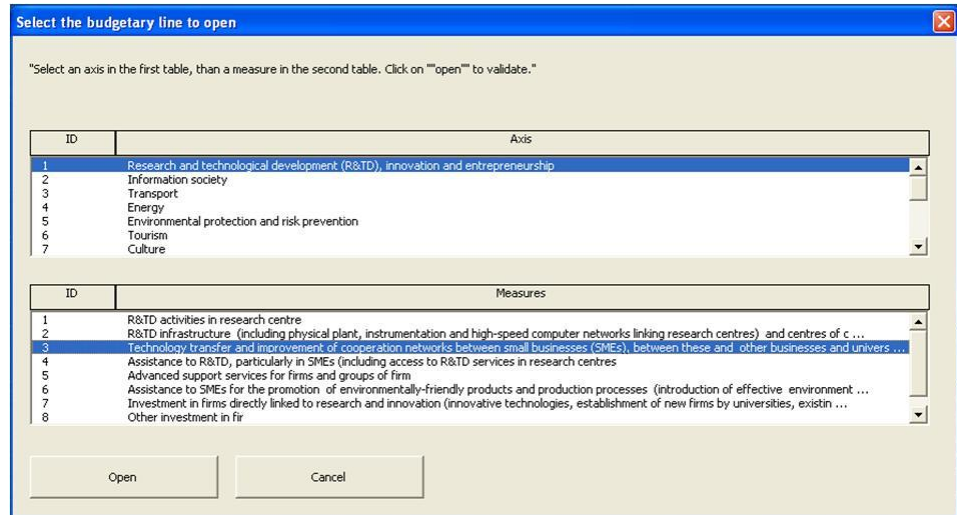


Figure 18: Pop up window for the selection of the theme element to be opened

The *Theme Element Scale Interface* will open, allowing to adjust the settings for a given theme element, i.e. refine the definition of the activities financed under it.

The model initially uses a default disaggregation of each theme element into SICs, which has been defined when setting the programme (see Section 6.1.2 describing the creation of a programme).

To change the budget allocation among the SICs for this given scenario, click **Modify SIC distribution**. The cells for which data can be entered will turn orange.

SIC	Financial disaggregation (%)	Expenditure (total cost €)
	Total: 100,0 %	Total: 100 000 €
Rail construction	20,0%	20 000
Rail renovation	20,0%	20 000
Rail electrification	20,0%	20 000
Equipment	20,0%	20 000
Civil engineering	20,0%	20 000

Figure 19: Screenshot of the *Theme Element Scale Interface* zoomed-in, showing where to refine financial disaggregation to SICs

Click in the cells to modify the percentages and click **Save** to continue to the next step.

To revert back to the default disaggregation (for this given theme element only), simply click the button **Reload default settings**. Note that the default disaggregation is the one that has been defined directly when creating the programme.

The financial disaggregation is independent from the financial data entered at programme scale, so financial inputs for a given theme element can be modified without affecting its disaggregation to SICs.

Note: At this stage, the user cannot directly remove or add any SICs beyond the ones that have already been defined for the theme elements, for a given scenario and programme. However, it is easy to simulate the deletion of a SIC, by simply allocating 0 % of the budget to it. To add other SICs, the whole programme structure needs to be modified using expert functionalities. See Section 6.1.3 for more details.

4.2.3 SIC Scale interface

Objective: refine emission calculations by entering physical indicators

Most SICs include alternative realisation pathways. For instance, for the SIC "road construction", the type of road constructed can be specified and disaggregated to:

- Local roads.
- National roads.
- Highways.

The technical model term for the criterion "type of road" in the example is called a "characterization". It allows the inclusion of more detailed information for the individual SICs, which is especially important when the SIC covers a range of projects with rather different emission implications.

The corresponding disaggregation to the "characterizations" can be given in a monetary or physical unit.

From the characterization values (in the example, local roads, national roads or highways), the model calculates physical indicators, from which the CO₂ emissions will be evaluated.

For instance, for "local roads construction", the model calculates first the "length of local roads constructed" and from this value, deduces the emission implications of this road construction.

This physical indicator, "length of local roads constructed", introduced in the calculation chain is called the "determinant" associated to the specific SIC "local roads construction". In the model, "determinants" are referred to as "structural data".

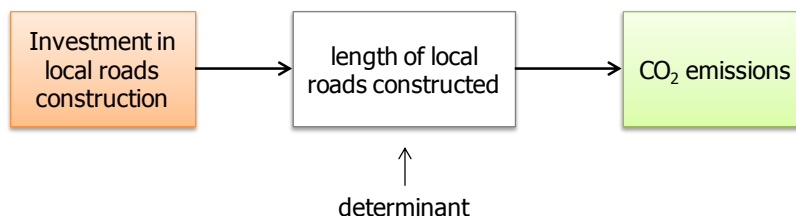


Figure 20: Method of calculation (1/2)

Structural data are automatically calculated by the model, based on the financial entries. However, if the value of the determinant "length of local roads constructed" is known for a given theme element, it can be directly entered into the model. The CO₂ emissions associated with this SIC will then be directly calculated based on this determinant value.

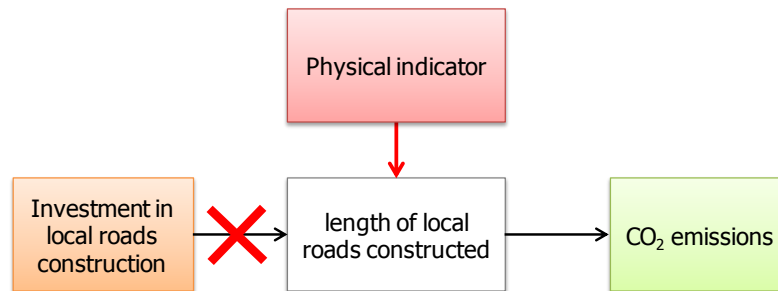


Figure 21: Method of calculation (2/2)

Note: At the scale of the SIC –and for analytical purposes only- the notion of structural determinant has been introduced, as it can be seen in the *Theme Element Scale Interface*.

For instance, for the SIC "road construction" and the characterization "type of road constructed" –the index of which can be local roads, national roads or highways- the determinants are:

- Length of local roads constructed (LR).
- Length of national road constructed (NR).
- Length of highways constructed (HW).
- The structural determinant for this SIC is: total length of road constructed = LR + NR + HW.

This value thus gives the user a general indication of the length of the roads that could be financed; together with the global carbon impact associated with the road construction and operation. As it is calculated from the individual determinants, it cannot be directly modified.

Entering structural data has two main advantages:

- It improves the accuracy of the model by including known information, instead of relying on model assumptions for calculating the physical outcomes of investments.
- It allows the user to test eco-criteria, like for instance, comparing the impact of building construction when budget is allocated to high energy efficiency buildings rather than to regular ones.

This section describes how to modify structural data at characterization scale, for each Standardized Investment Component, using the *SIC Scale Interface*.

Presentation of the SIC Scale Interface

The screenshot shows the SIC Scale Interface with three main parts highlighted by green circles:

- 1** General Information table:
- 2** Control buttons (Modify structural data):
- 3** Structural data tables:

General Information		
ID level 1	03	
ID level 2	16	
ID level 3		
Programme architecture - level 1	Transport	
Programme architecture - level 2		
Programme architecture - level 3	Railways	
SIC:	Rail construction	
Total expenditure:	20 000 €	
Total emissions:	0 t CO2/year	
Length of railway constructed :	0,00 km	

Structural data		
Expenditure per type of rail - Default settings		
Highspeed railway	9 000,00 €	50,0%
Classic railway	9 000,00 €	50,0%
Length per type of rail - Default settings		
Highspeed railway	0,00 km	33,3%
Classic railway	0,00 km	66,7%
Annual traffic induced - Default settings		
Highspeed railway passenger traffic	690,33 passenger.km/year	
Classic railway passenger traffic	1 380,65 passenger.km/year	

Figure 22: Screenshot of the *SIC Scale Interface*

The *SIC scale Interface* is divided again into 3 main parts:

- 1** A box listing general information about the Standardized Investment Component that is opened:
 - ID of the theme element.
 - Name of the theme element.
 - Name of the Standardized Investment Component.
 - Total expenditures.
 - Total emissions.
 - Value of the structural determinant.
- 2** A control button allowing the user to modify structural data
- 3** A block showing the structural data of the Standardized Investment Component, and listing the different characterizations for the Standardized Investment Component concerned and the associated determinant values.

In this interface, data cannot be directly modified. However, the user has the possibility to change the data from the structural data tables (3), by using the button **Modify structural data**. A pop up window will open in which the user can modify the data, as described in the next paragraph (see Figure 23).

Modify structural data

Open the *SIC Scale Interface* by clicking the green arrow in the navigation bar of the model and select, in the pop up window, the SIC for which structural data can be entered. Click **OK** to choose the highlighted SIC.

In this interface, the user can modify structural data for one given SIC in a given theme element.

When clicking **Modify structural data**, a pop window will open. After selecting a characterization from the drop down menu, the user can modify the structural indicators that are considered for the calculation of the carbon impact of the SIC.

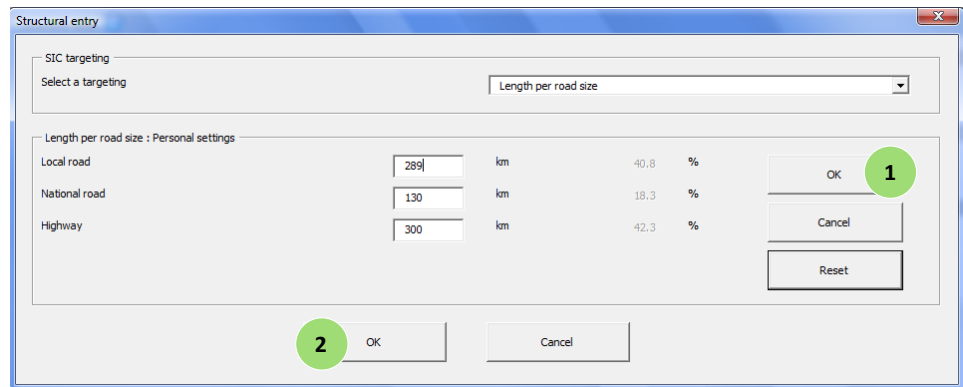


Figure 23: Pop up window allowing modifying characterization criterions

Based on the characterization that has been selected, the user can alter two types of indicators:

- monetary indicators (in percentage).
- physical indicators (in percentage or physical units).

To enter structural data, click in the corresponding cells and change values. The buttons on the right will become unlocked: click **OK** on the right (1) to accept modification (it will recalculate the percentages indicated on the right).

To reload the default settings for this specific characterization, click **Reset**. Click **OK** on the bottom (2) to save changes and go back to the interface.

Entering structural data for a SIC is the most detailed step of scenario creation. The user can now go back to modify the parameters of other SICs and/or other theme elements, and then go back to the *Scenario Management Interface*, to use the other functionalities and reach the *Results Interface* to see the carbon impact of the scenario that has been created.

4.3 Managing scenarios

Once the first scenario has been created, several management actions can be accessed through the control buttons on the *Scenario Management Interface*, see Section 4.1.1.

Users can:

- Create a new scenario (explained in sections 4.1 and 4.2).
- Copy, delete or rename an existing scenario.
- And import/export scenarios.
- Open a scenario.
- Extract results, see Chapter 5.

This section describes how to use these management functionalities.

4.3.1 Copying a scenario

Scenario copies are useful for analysing how changes to the original scenario may affect the outcomes. The original version and the modified one can be compared in the *Results Interface*.

The user can copy a scenario by clicking on the corresponding button. Select the scenario to be duplicated in the pop up window. A default name, "copy of [name of the scenario you want to duplicate]", is automatically given to the new scenario, but can be adjusted by the user. When clicking **OK**, the user confirms the copy. The new scenario is then automatically added to the scenario list.

4.3.2 Rename a scenario

Clicking on the button **Rename a scenario** brings up a pop up window with a scenario list. Select the scenario to be renamed, type the desired new name in the textbox that appears and click **OK** to save the changes.

The new name will be automatically updated in the available scenario list on the *Scenario Management Interface*.

4.3.3 Delete a scenario

To delete a scenario, click **Delete scenario**. Select the scenario to be deleted and click **OK**. The scenario deleted will not appear in the available scenario list anymore. Note that deleting a scenario is permanent; no backup files are stored for scenarios.

4.3.4 Import/export a scenario

When different users are working on different computers and want to share their scenarios (send them by email to other users for instance), they can use the buttons **Export a scenario** and/or **import a scenario**.

To export a scenario, click the **Export** button on the *Scenario Management Interface*. Select the scenario to be exported and click **OK**. The user can change the name of the scenario being exported and add comments if needed. When done, click **Export scenario** and choose the folder to save the file (.pkg).

Note: when exporting a scenario, the programme to which it is linked is also exported in the "package" file (.pkg)

To import a scenario, click the corresponding button and choose the file (.pkg) that should be imported. Click **Open** when done. The scenario is being imported and will automatically appear in the available scenario list on the *Scenario Management Interface*.

Note: when importing a scenario, the programme to which it is linked will also be imported. If the programme already exists, the scenario will be linked to it directly, without creating a copy of the programme. If it does not exist, it will be automatically created and will thus appear in the list of programmes available in the model.

4.3.5 Open and modify a scenario

To open a scenario, click on the corresponding button on the *Scenario Management Interface*. Select the scenario to be opened and click Open. The *Programme Scale Interface* appears on the screen. The user can modify financial entries, SICs distribution and structural data the same way as it has been explained in previous sections for the creation of a new scenario, and as shortly reminded hereafter.

How to modify an existing scenario?

- To modify a scenario, first open it as explained above.
- The approach is the same as for creating a new scenario, except that they are already financial inputs saved for the scenario that is being operated.
- On the *Programme Scale Interface*, select the method for data entry and then modify the corresponding cells (in orange) if needed. Do not forget to save changes.
- Then either go back to the *Scenario Management Interface* if no more modifications have to be made, or enter the *Theme Element Scale Interface* after selecting the theme element that should be managed.
- In the *Theme Element Scale Interface*, the user has access to the financial disaggregation of the selected theme element to SICs. Change the disaggregation (orange cells) and click save changes.
- If the user has access to useful indicators that could help to refine the evaluation of the scenario, open the *SIC scale interface* and enter the data as described in Section 5.1.c.

With the steps described in this chapter, the user is able to perform all steps that are required to operate the Co₂mpare model in basic mode. However, to go further into the understanding of the model and to improve accuracy of the results, the user can enable the expert mode. The new functionalities activated require more technical knowledge on calculation processes and are thus to be run by expert users. The next chapter gives an overview of these advanced functionalities and describes how they can be used.

5

How to extract and interpret the results?

Once a scenario has been created, the user can analyse its carbon impact, thanks to different tables and graphs provided in the *Results Interface*.

The model also gives the possibility to analyse and compare several scenarios in the same results spreadsheet. By comparing different scenarios of a same programme, the user can directly study the effect of different investment schemes and determine where actions should be taken.

This section will present first some key elements for the understanding of the outputs, explain how to open the *Results Interface* and then will detail the different type of results the user can find on this interface.

The results description is organised in two or three sections:

- One describing general results.
- One giving more detailed results on CO₂ emission implications.
- In expert mode, a section concerning the estimation of uncertainties.

For each graph and table, key notions necessary for a complete understanding of the results will also be given.

5.1 Calculation principles

5.1.1 Emissions assessment on life cycle

Calculation of emissions results is inspired by the Life Cycle Assessment method (LCA), which is mainly applied to industrial objects and products. This method allows assessing environmental impacts of a whole product life, from cradle-to-grave. Generally speaking, this helps to avoid a narrow outlook on environmental concerns.

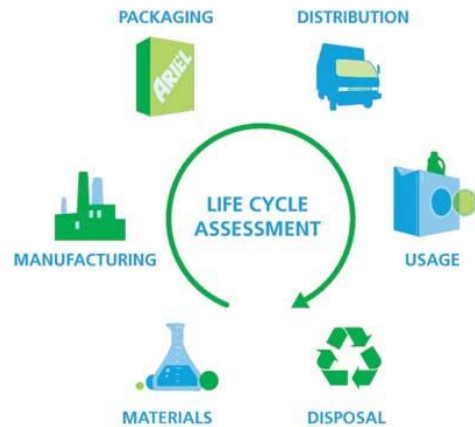


Figure 24: Principle of Life Cycle Analysis (LCA)

As most projects financed by ERDF are long term projects and knowing the negligible CO₂ impact of final disposal, the method used to assess emissions is similar to LCA without disposal impact. For each SIC, emissions are divided in two phases:

- Construction phase: Raw materials, Manufacturing of products, Distribution, Construction site, etc. Emissions are expressed in t CO₂.
- Operation phase: Use. Since emissions are assessed yearly, the unit used is t CO₂ /year.

5.2 Example on building refurbishment

The following graph shows yearly emissions implication for building thermal refurbishment, with an operational lifetime estimated around 25 years.

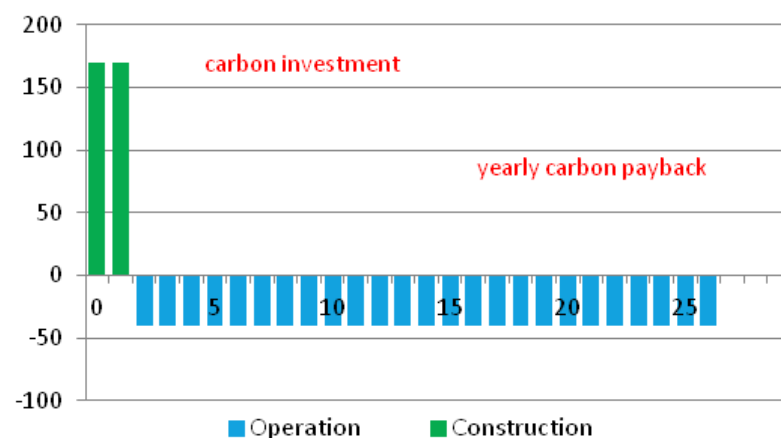


Figure 25: Annual emissions of a building refurbishment project

In the first two years, carbon emissions mainly correspond to embedded emissions of materials used for the refurbishment of the building, energy consumed for the construction site and commuting by workers. This leads to positive emissions that could be considered as a carbon investment.

Since the building heating needs have been reduced by the refurbishment, energy consumption and CO₂ emissions are lower: these emissions avoided are therefore negative, and can be considered as a carbon payback.

To calculate the global impact of refurbishment, emissions are cumulated year after year.

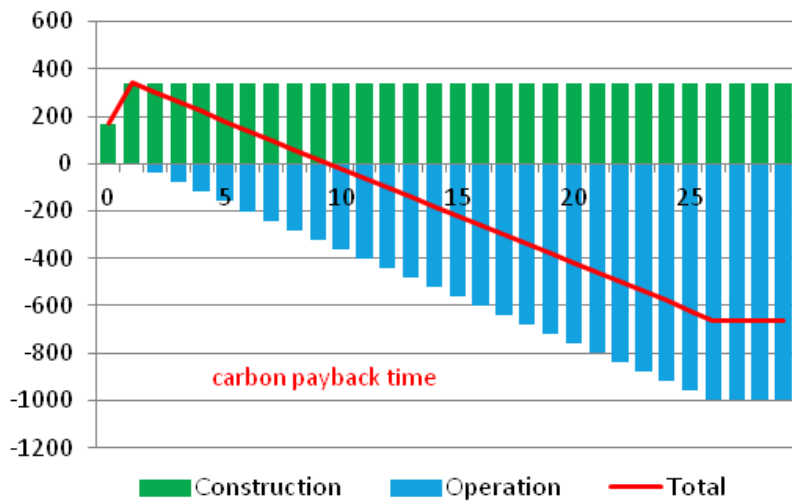


Figure 26: Cumulative emissions of a building refurbishment project

Cumulative emissions year after year provides an important indicator: cumulative emissions on the lifetime of the project. Among others, this indicator is used throughout the results spreadsheet.

Other SICs such as building construction are only emitting CO₂. They generate positive emissions for both construction phase (materials, etc.) and operation phase (new energy consumption). In that case, there is no carbon payback.

5.2.1 SICs lifetime

The duration of the operation phase is essential in the calculation of CO₂ emissions implications, since emissions associated to the operation phase are multiplied every year until a new investment has to be done for the project to continue.

Per default, each SIC has a specific lifetime and emissions are calculated according to it. Nevertheless, the user has the possibility to set a global lifetime for all SICs if results are needed for instance, for a specific time period.

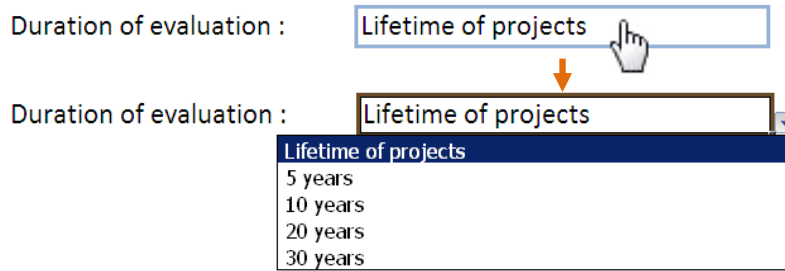


Figure 27: How to choose duration of evaluation

5.2.2 Classification of emissions

As described before, emissions are divided in two distinct phases: construction phase and operation phase. Emissions are further distinguished into direct and indirect emissions:

- Direct emissions: emissions from sources that are owned or controlled by the entity. It includes emissions from fossil fuels burned on site, commuting of workers.
- Indirect emissions: emissions resulting from the consumption of electricity, modal shift for transport projects and emissions from the production and distribution of materials used for both construction and operation (also called embedded emissions).

5.3 Presentation of the Results Interface

Once the scenarios to be evaluated have been set up, go back to the *Scenario Management Interface* and click Scenario Results.

A pop up window will appear, allowing the user to select up to 4 scenarios for analysis and/or comparison.

Note: Only scenarios reflecting a same programme can be compared (i.e. the ID number of the programme shown on the pop up window -2nd column, needs to be the same for all scenarios to be analysed).

Select all the scenarios to be evaluated and click **OK** to open the *Results Interface*.

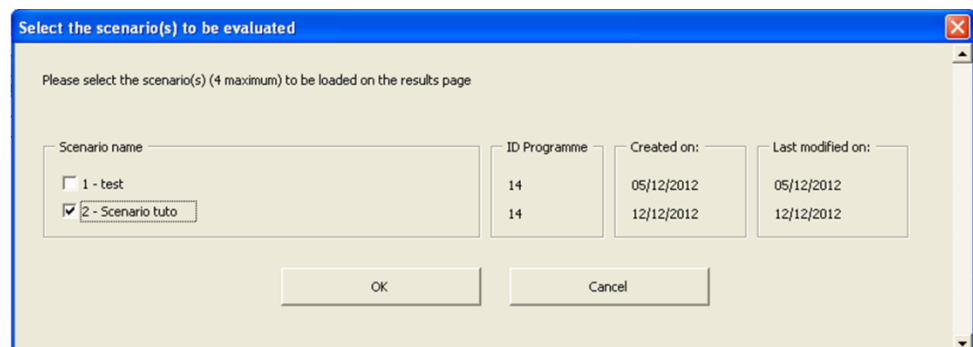


Figure 28: Pop up window allowing choosing scenarios to see in the *Results Interface*

An excel file containing three tabs will open:

- One for general results.
- One for a more detailed CO₂ analysis.
- One for uncertainty analysis (available only when the model is run in expert mode).

Each scenario is given a colour so that it can be recognized throughout the whole Excel file (blue, yellow, green and orange).

Tip: The results spreadsheet, when generated, is automatically saved in the "Results" folder of the model (cf. § 3.3). To save it to a different folder, simply use the "save as" function of Excel.

5.4 General results

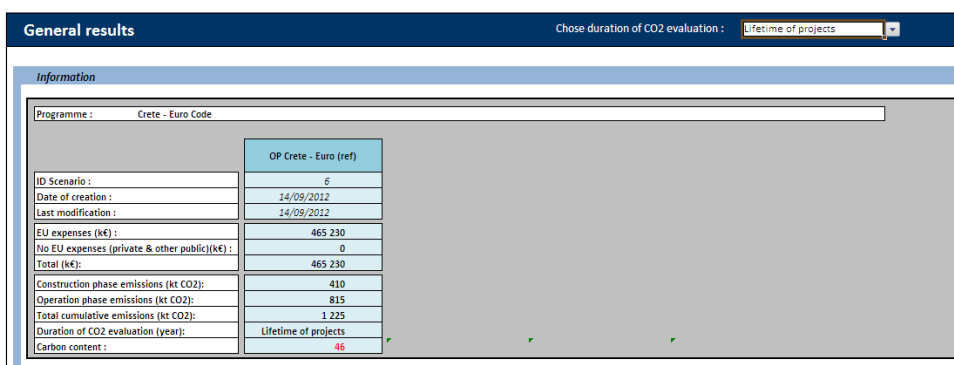
On this tab, a range of tables and graphs are automatically created. Three types of output are provided:

- General information about scenarios.
- Total investment per main programme theme.
- CO₂ emissions per main programme theme.
- Total investment and CO₂ emissions per theme element.

Also on the top line of this tab, it is possible to change the duration of evaluation, as seen on Figure 27: Lifetime of projects, 5 years, 7 years, 10 years, etc. This chosen duration is applied to all operational emission results in every tab presented.

5.4.1 Information

The first one summarises general information about the scenario(s): Date of creation and of last modification, information about expenditures Information about CO₂ emissions.



Information	
Programme :	Crete - Euro Code
	OP Crete - Euro (ref)
ID Scenario :	6
Date of creation :	14/09/2012
Last modification :	14/09/2012
EU expenses (kt€) :	465 230
No EU expenses (private & other public)(kt€) :	0
Total (kt€) :	465 230
Construction phase emissions (kt CO2) :	410
Operation phase emissions (kt CO2) :	815
Total cumulative emissions (kt CO2) :	1 225
Duration of CO2 evaluation (year) :	Lifetime of projects
Carbon content :	46

Figure 29: Main information on scenario results (Table)

Carbon content is an indicator made to assess how close the programme is to compensating for its own emissions.

Carbon content = (total emissions) ÷ (|positive emissions| + |negative emissions|)
 Its minimum and maximum values are -100 (purely compensating programme) and 100 (purely emitting programme). The closer this carbon indicator is to 0, the more carbon neutral it is.

5.4.2 Total investment per main programme theme

These outputs present the total budget allocated to each main programme theme (level 1 of the architecture). Results are given both in a graph and in a table and allow the user to quickly see how the investment has been spread over the programme.

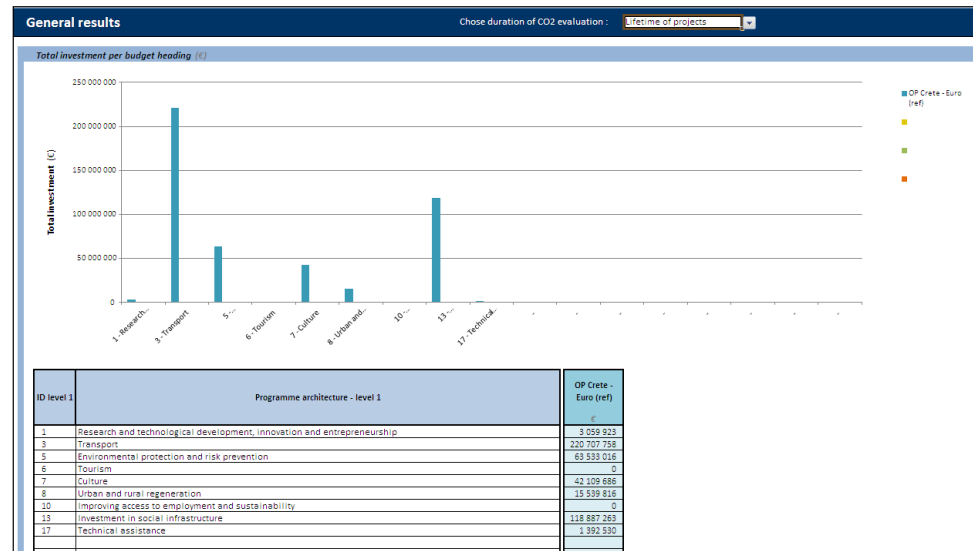


Figure 30: Total investment per main programme theme (Graph and table)

5.4.3 Cumulative CO₂ emissions per theme element

Here the cumulative CO₂ emissions of the programme are presented, both in a graph and table, for each main programme theme. When read in comparison with the previous graph, it allows a first analyse of the carbon balance of the programme.

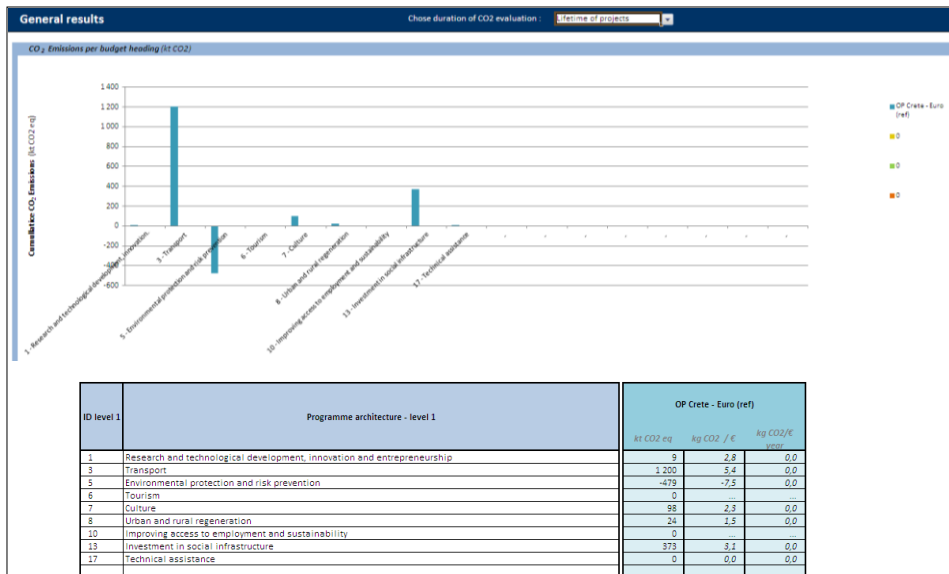


Figure 31: CO₂ emissions per main programme theme (Graph and table)

5.4.4 Total investment and CO₂ emissions per theme elements

For each theme element, this table provides the total budget allocated and what it represents in terms of:

- Total expenditure (€).
- Total emissions (ktCO₂).
- Emissions per € invested (kgCO₂/€).
- Annual emissions per € invested (gCO₂/€/year).

This will help the user analyse what particular type of investment is more emitting or more compensating.

ID level 1	ID level 2	ID level 3	Programme architecture - level 1	Programme architecture - level 2	Programme architecture - level 3	Scenario Crete 1			
						€	kt CO2	kg CO2/€	kg
1		1.02	Research and technological		R&D infrastructure (includ	3 059 923	9	2,8	0,0
1		1.08	Research and technological		Other investments in firms	0	0	...	...
3		3.23	Transport		Regional/local roads	212 999 689	954	4,5	0,0
3		3.3	Transport		Ports	7 708 069	247	32,0	0,2
5		5.44	Environmental protection a		Management of household	10 884 729	-608	-55,8	-0,3
5		5.45	Environmental protection a		Management and distribut	10 962 244	23	2,1	0,0
5		5.46	Environmental protection a		Water treatment (waste wa	33 795 526	104	3,1	0,0
5		5.51	Environmental protection a		Promotion of biodiversity a	0	0	...	...
5		5.52	Environmental protection a		Promotion of clean urbanit	0	0	...	...
5		5.53	Environmental protection a		Risk prevention	7 890 517	2	0,2	0,0
6		6.57	Tourism		Other assistance to improv	0	0	...	...
7		7.58	Culture		Protection and preservatio	15 790 919	-2	-0,1	0,0
7		7.59	Culture		Development of cultural in	26 318 767	99	3,8	0,0
8		8.61	Urban and rural regeneratio		Integrated projects for urba	15 539 816	24	1,5	0,0
10		10.69	Improving access to employ		Measures to improve acce	0	0	...	...
13		13.75	Investment in social infrast		Education infrastructure	87 204 557	315	3,6	0,0
13		13.76	Investment in social infrast		Health infrastructure	18 410 379	1	0,1	0,0
13		13.77	Investment in social infrast		Child care infrastructure	12 389 822	53	4,3	0,0
13		13.79	Investment in social infrast		Other social infrastructure	882 505	4	4,6	0,0
17		17.85	Technical assistance		Preparation, implementati	1 066 430	0	0,0	0,0
17		17.86	Technical assistance		Evaluation and studies, int	326 100	0	0,0	0,0

Figure 32: Total investment and CO₂ emissions per theme element (Table)

5.5 Detailed CO₂ analysis

Here the results are presented at a more detailed level in both tables and graphs, with outputs presenting:

- Cumulative CO₂ emissions per theme.
- Cumulative CO₂ emissions per SIC.
- Total investment per SIC and associated structural determinant.
- Cumulative CO₂ emissions per phase (construction and operation).
- Total cumulative CO₂ emissions over time.

5.5.1 Cumulative CO₂ emissions per theme

Here the table and graph are showing the cumulative CO₂ emissions using main themes (building, energy, transport, waste and water, others). Themes are more adapted to perform a carbon analysis of the programme, since each main theme is a group of SICs regardless in which theme or sub-theme they have been financed.

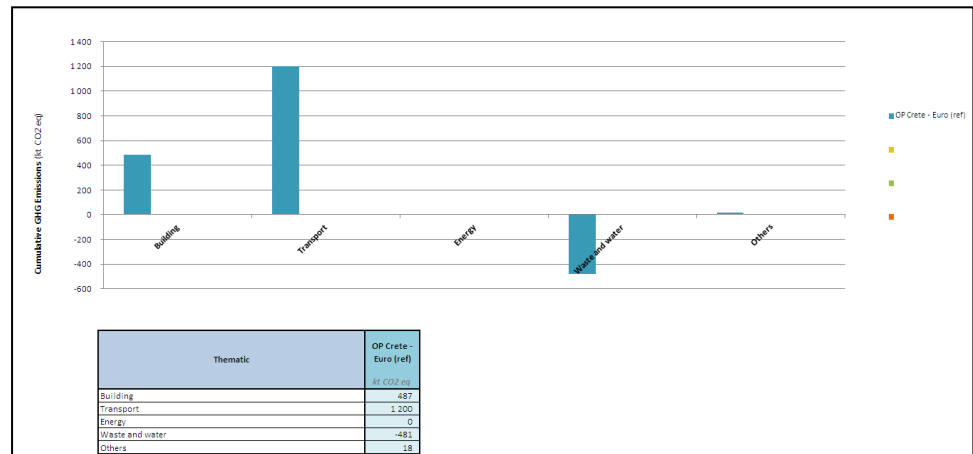


Figure 33: Cumulative CO₂ emissions per thematic (Graph and table)

5.5.2 Cumulative CO₂ emissions per SIC

The same results as the former ones are provided here at a smaller scale for each SIC, allowing the user to directly analyse the impact of each SIC over the programme emissions.

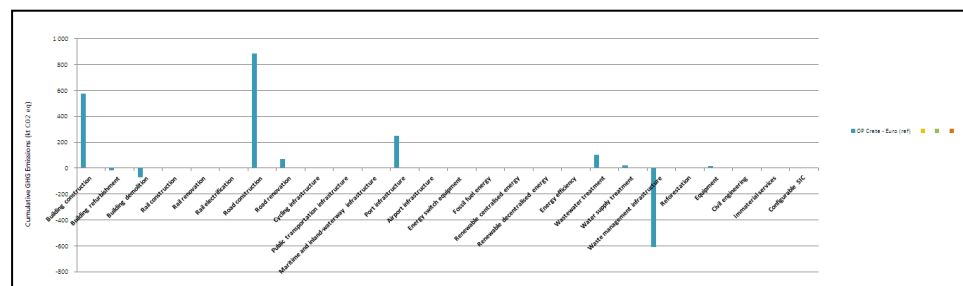


Figure 34: Cumulative CO₂ emissions per SIC (Graph)

Thematic	SIC	OP Crete - Euro (ref)				
		Total kt CO2	Construction kt CO2		Operation kt CO2	
			Direct	Indirect	Direct	Indirect
Building	Building construction	576	4	51	277	243
	Building refurbishment	-15	1	13	-21	-9
	Building demolition	-74	0	1	-61	-13
Transport	Rail construction	0	0	0	0	0
	Rail renovation	0	0	0	0	0
	Rail electrification	0	0	0	0	0
	Road construction	885	2	184	0	700
	Road renovation	69	1	68	0	0
	Cycling infrastructure	0	0	0	0	0
	Public transportation infrastructure	0	0	0	0	0
	Maritime and inland-waterway infrastructure	0	0	0	0	0
	Port infrastructure	247	0	7	46	193
	Airport infrastructure	0	0	0	0	0
Energy	Energy switch equipment	0	0	0	0	0
	Fossil fuel energy	0	0	0	0	0
	Renewable centralised energy	0	0	0	0	0
	Renewable decentralised energy	0	0	0	0	0
	Energy efficiency	0	0	0	0	0
Waste and water	Wastewater treatment	104	0	57	10	37
	Water supply treatment	23	0	2	0	20
	Waste management infrastructure	-608	0	0	-8	-601
Others	Reforestation	0	0	0	0	0
	Equipment	13	0	13	0	0
	Civil engineering	4	0	4	0	0
	Immaterial services	0	0	0	0	0
	Configurable SIC	0	0	0	0	0

Figure 35: Cumulative CO₂ emissions per SIC (Table)

5.5.3 Total investment per SIC and structural determinant associated

Figures 36 and 37 present the total investment in each SIC, independent to the theme element through which it is financed. Moreover, it shows how this investment is converted to physical determinants (km of roads, m² of building constructed, etc.) and totalled for a whole Operational Programme. This conversion depends on region specific costs, but also on the way SICs have been characterized by the user.

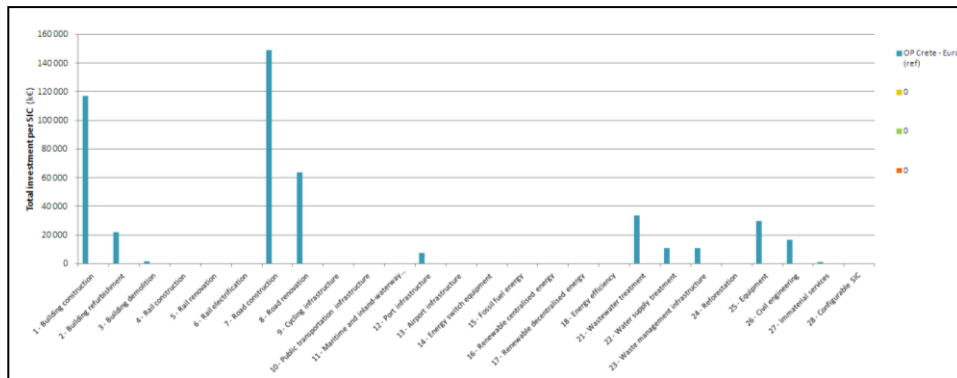


Figure 36: Total investment per SIC (Graph)

Thematic	SIC	OP Crete - Euro (ref)	
		k€	Main determinant and unit
Building	Building construction	117 191	240 146 m ²
	Building refurbishment	21 822	73 651 m ²
	Building demolition	1 744	20 290 m ²
Transport	Rail construction	0	-
	Rail renovation	0	-
	Rail electrification	0	-
	Road construction	149 100	279 km
	Road renovation	63 900	386 km
	Cycling infrastructure	0	-
	Public transportation infrastructure	0	-
	Maritime and inland-waterway infrastructure	0	-
	Port infrastructure	7 708	242 249 m ²
	Airport infrastructure	0	-
Energy	Energy switch equipment	0	-
	Fossil fuel energy	0	-
	Renewable centralised energy	0	-
	Renewable decentralised energy	0	-
	Energy efficiency	0	-
Waste and water	Wastewater treatment	33 796	16 037 megaliters/yr
	Water supply treatment	10 962	4 796 megaliters/yr
	Waste management infrastructure	10 885	20 247 t/yr
Others	Reforestation	0	-
	Equipment	29 906	29 906 468 €
	Civil engineering	16 824	185 088 t
	Immaterial services	1 393	1 392 530 €
	Configurable SIC	0	-

Figure 37: Total investment per SIC and structural determinant associated (Table)

5.5.4 Cumulative CO₂ emissions per phase (construction and operation)

The results are presented per phase (construction or operation) and per type of emissions in the table (direct, indirect). For operational emissions, emissions are given for both yearly and cumulative totals.

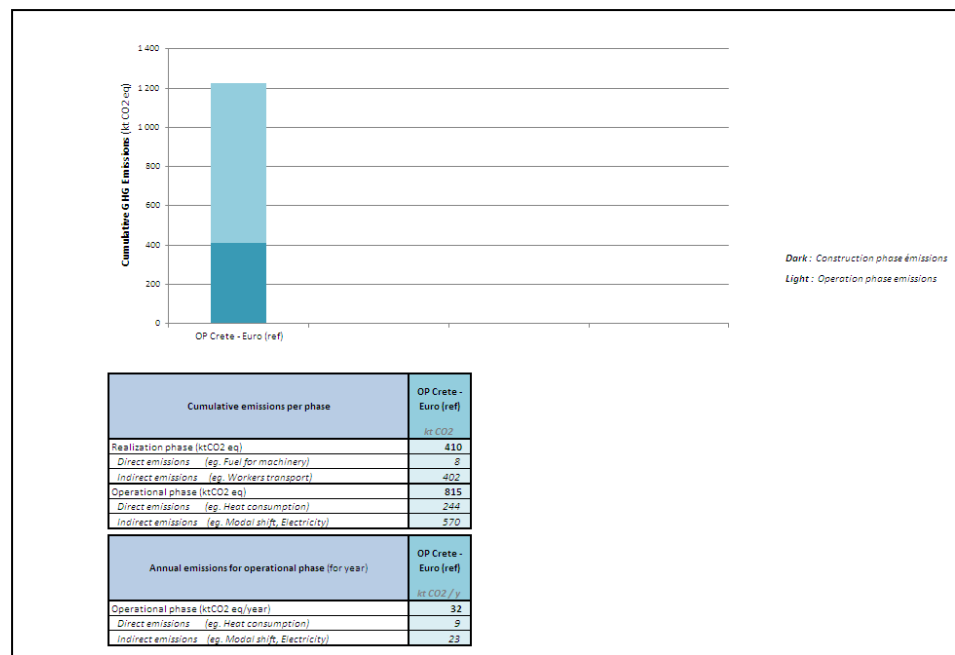


Figure 38: CO₂ Emissions per scope and phase

5.5.5 Total cumulative CO₂ emissions over time

Figure 39 shows the cumulative CO₂ emissions over the period of evaluation. The results are also given in a table. The first years describe the construction phase, which is mainly emitting. During the following years, the curve can either increase or decrease:

- Increase: It means that emissions are higher than compensations.
- Decrease: Compensations are higher than emissions. What is sought here is to modify the Operational Programme in order to compensate all construction and operation positive emissions to reach carbon neutrality (i.e. a carbon content of 0 at the end of period).

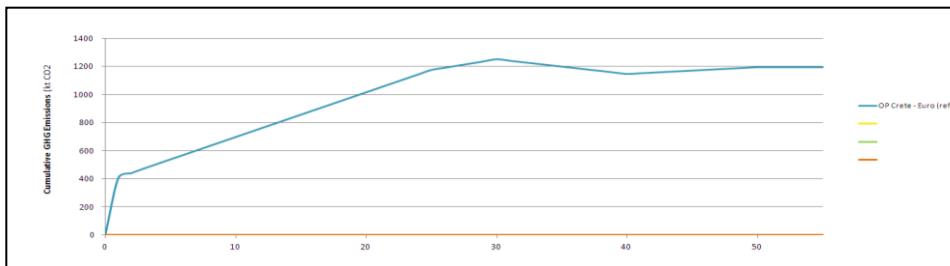


Figure 39: Cumulative CO₂ emissions over the period of evaluation

5.6 Uncertainty analysis

The uncertainty analysis sheet, visible only in expert mode, provides sensitivity results for the emission impacts of the scenarios. The results are based on SIC specific uncertainty estimates, propagated through the SIC portfolio of the programme. Uncertainty sheet uses the same duration of evaluation as the other sheet, but also includes another pull down menu for the confidence interval. The confidence interval affects the ranges shown in the results, which are drawn such that the likelihood of emissions being within this range matches the confidence interval chosen by the user. It needs to be noted that the analysis is stylized and meant for illustrating the general sensitivity of the results to uncertainties, not to suggest that the actual real life uncertainties have been quantified and captured accurately and in detail.

5.6.1 Total probabilistic CO₂ emissions

The first graph on the uncertainty sheet shows the total expected emissions (matching the emissions reported on the other results sheets) as well as the range around the expected values, calculated based on the SIC portfolio, SIC specific uncertainties and the confidence interval defined by the user. The table below the figure gives the precise numeric values for the graph.

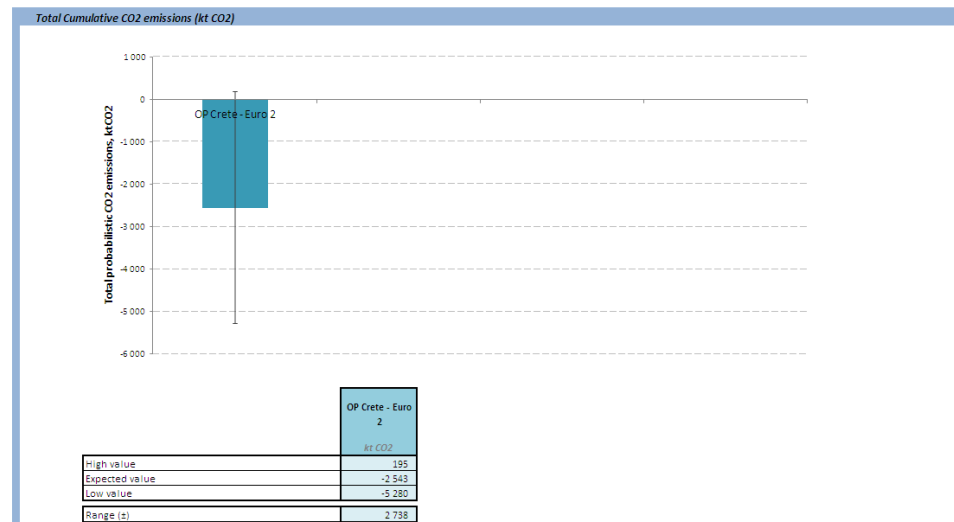


Figure 40: Total probabilistic CO₂ emissions (Graph and table)

5.6.2 Total probabilistic CO₂ emissions per thematic

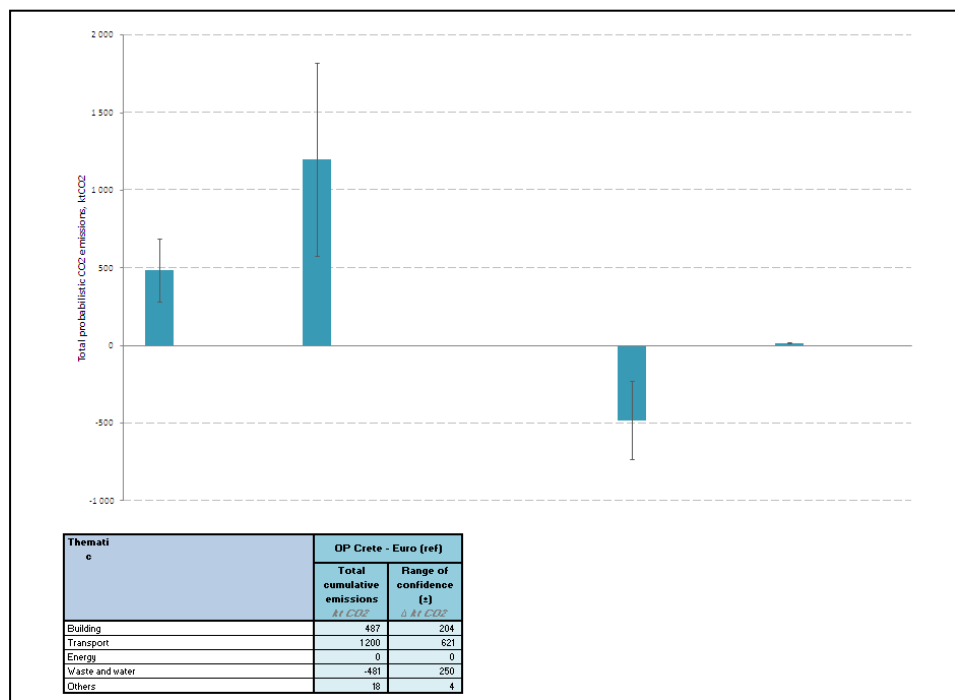


Figure 41: Total probabilistic CO₂ emissions per thematic (Graph and table)

This figure gives probabilistic results on the level of a theme. Ranges are calculated from the same data as for the total emissions, but now the theme specific SICs are considered separately for each theme.

5.6.3 Contribution of SICs to uncertainty – ranking

This table is used for highlighting SICs that contribute the most to uncertainty. The first set of SICs gives the top five in terms of their contribution to the variance of the emissions of the total programme. A high ranking SIC typically has a high investment level combined with high uncertainty and/or high emission impact per €. The list can be used for identifying the SICs that could be scrutinized more closely, as they create most of the uncertainty seen in the outcomes.

OP Crete - Euro (ref)		
	Name of SIC	Contribution to total variance %
SIC 1	Road construction	87%
SIC 2	Waste management infrastructure	6%
SIC 3	Building construction	6%
SIC 4	Port infrastructure	1%
SIC 5	Wastewater treatment	0%

Figure 42: Ranking of SICs per percentage of contribution to total variance (Table)

A second set of SICs gives the top five SICs in terms of relative contribution to uncertainty. In this case SICs contribution to total variance is divided by the share of funds that are directed to the SIC. This list removes the effect of investment volume and therefore helps in identifying the SICs that are, by their nature, likely to cause uncertainty if funds are directed towards them.

5.6.4 SIC standard deviation and variance

This table gives the SIC specific variance and standard deviation, derived from the investment flow and SIC specific emission and uncertainty characteristics. It mainly functions as an input to other calculations on the sheet, but has also the added value of providing SIC specific uncertainty data.

	OP Crete - Euro (ref)	
	Standard deviation <i>Δkt CO2</i>	Variance <i>Δkt CO2²</i>
Building construction	299	89 627
Building refurbishment	7	48
Building demolition	44	1 969
Rail construction	0	0
Rail renovation	0	0
Rail electrification	0	0
Road construction	885	783 113
Road renovation	52	2 669
Cycling infrastructure	0	0
Public transportation infrastructure	0	0
Maritime and inland-waterway infrastructure	0	0
Port infrastructure	247	60 823
Airport infrastructure	0	0
Energy switch equipment	0	0
Fossil fuel energy	0	0
Renewable centralised energy	0	0
Renewable decentralised energy	0	0
Energy efficiency	0	0
Wastewater treatment	63	3 921
Water supply treatment	14	188
Waste management infrastructure	365	132 988
Reforestation	0	0
Equipment	6	40
Civil engineering	2	3
Immaterial services	0	0
Configurable SIC	0	0
Total	1 037	1 075 388

Figure 43: SIC standard deviation and variance (Table)

6

To go further – Expert mode

This chapter focuses on advanced functionalities accessible through the expert mode such as Programme Management (working area), Ratio Management (system) and SIC Management (system).

Through the expert mode, the user will be able to:

- Create or modify programmes for which different scenarios can be analysed.
- Fine-tune model parameters (ratios and SIC duration) to improve the accuracy of programmes' evaluation.

Start up

To enable the Expert mode, go to **General Preferences** by using the corresponding button on the home page and select **Expert mode** (see Section 3.3.3).

When used under this mode, additional functionalities are available on the home page and manageable thanks to five more buttons, as shown in Figure 5.

Make sure the proper region has been selected before operating any changes, as explained in Section 3.3.5.

6.1 Programme management

CO₂MPARE has been created to evaluate programmes through the assessment of the carbon impact of different scenarios. Scenarios are linked to programmes and cannot be created if no programme has been defined first. Through the *Programme Management Interface*, new programmes can be created and existing ones can be modified, as detailed in the next paragraphs. The aim of programme management is to link sub-themes to themes, SICs to sub-themes and defining default characterization criteria for every SIC and sub-theme combination.

To open the *Programme Management Interface*, click the corresponding button on the home page.

6.1.1 Presentation of the Programme Management Interface

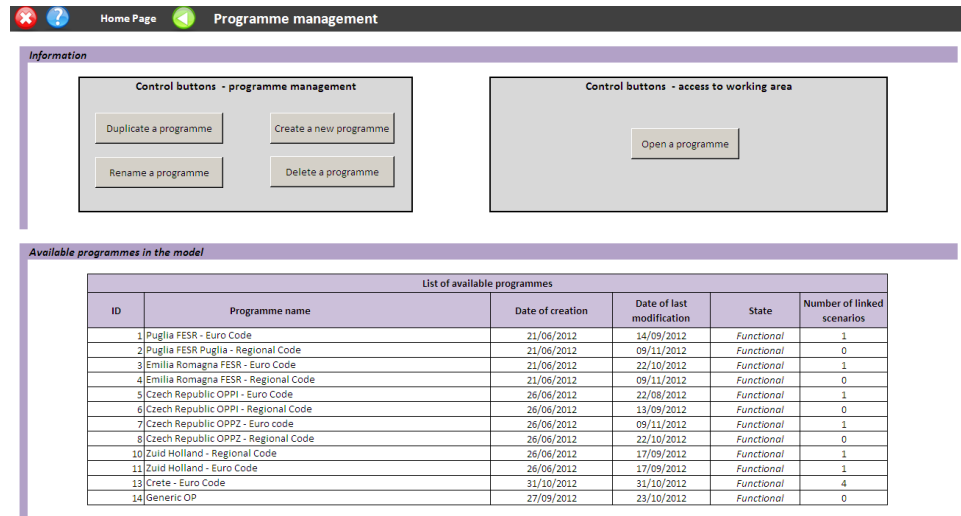


Figure 44: Screenshot of the *Programme Management Interface*

This interface presents:

- 1 A set of control buttons dedicated to programme management. The user has the possibility to:
 - Create a new programme.
 - Copy, delete or rename an existing programme.
- 2 To have access to the settings of a programme and/or to modify them, click the button **Open a programme**.
- 3 All the programmes available in the model are listed in this table. Several pieces of information are associated to each programme:
 - ID number + name.
 - Date of creation and of last modification.
 - State of the programme (functional or not).
 - Numbers of scenarios created for this programme.

6.1.2 How to create a new programme

On the *Programme Management Interface*, click the button **Create a programme** and enter the name of the new programme in the pop up window that will open. The *Creation Interface* will appear. This interface allows the user to create the architecture (composed of several theme elements) of the programme. Enter ID numbers and names for programme themes (level 1) and theme elements (level 3) in the proper columns, as shown in the figure below, and click **Save**.

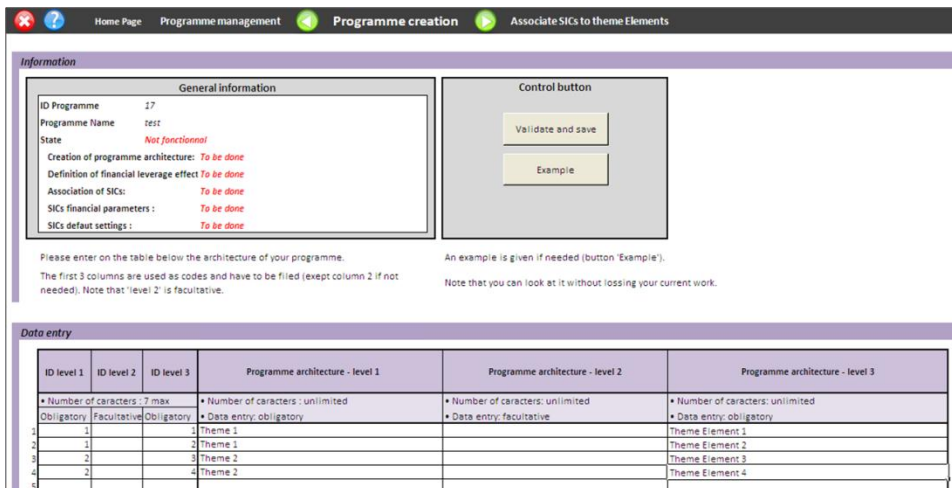


Figure 45: Screenshot of the *Programme Creation Interface*

Note: As the model calculates at the theme element level (level 3), the sub-theme level (level 2) of the architecture (sub-theme) is not essential for running the model. Level 2 can therefore be kept empty if preferred, e.g. in programmes that only have 2 levels. For a better understanding, the user has the possibility to take a look at an example, by clicking the corresponding button.

When the architecture is completed, click **Save** to reach the next stage. A green column called "leverage effect" appears on the right.

Reminder: Financial leverage = [All other financial contribution (€)] / [ERDF contribution (€)]

For instance, if 1M€ of ERDF contribution is allocated to an architecture line and all other contributions (public and private) represent 2M€, the financial leverage effect is 2M€ / 1M€ = 2. Generally the value of the leverage effect varies from 0,5 to 5.

Here again, the user has the possibility to have a look at an example to understand clearly what should be done. Enter the leverage effect associated to each theme element and click **Save** to confirm.

After saving, three other columns will appear on the right (cf. Figure 46). They are filled in red, indicating that the theme elements have not been parameterized yet.

Financial leverage	SICs associated	SIC financial settings	Default settings
1,00	No	To be done	
0,50	No	To be done	
0,00	No	To be done	
2,00	No	To be done	

Figure 46: Additional columns after saving financial leverage effects

Note: the last column "Default settings" is filled only when theme elements are linked to SICs (the column "SICs associated" is then filled with "Yes")

Two new buttons will also appear on the interface:

One will help the user to disaggregate theme elements to SICs and choose which SICs should be involved in the carbon assessment of a given theme element.

Another one can be used to define settings for each SIC with regards to their characterizations.

Disaggregation to SICs

The next step to take when creating a programme is to associate SICs to theme elements. The user will have to decide which set of SICs (and their respective weights) would optimally describe a given theme element.

This can be done by clicking **Associate SICs to theme elements**. A new interface will open, showing a table with theme elements per lines and SICs per column. To associate SICs, a percentage value should be entered for each SIC that should be part of the theme element, as shown on the Figure 47 below.

Programme architecture - level 3	Total (must be 100%)	Building construction	Building refurbishment	Building demolition	Rail construction	Rail renovation	Rail electrification	Road construction	Road renovation	Cycling infrastructure	Public transportation infra	Maritime and inland water
Theme Element 1	100%	13%	27%	0%								
Theme Element 2	100%				20%	10%	40%	0%	0%	0%	0%	0%
Theme Element 3	100%											
Theme Element 4	100%	10%										

Figure 47: Screenshot of the setting interface allowing users to link SICs to theme element and define the distribution amongst SIC inside a theme element.

Note: No more than 10 SICs can be associated to a single theme element.

Total of SICs percentages for one single theme element have to be equal to 100%.

SICs can be added without allocating any budget to it, by simply entering 0% in the corresponding box. This can be useful for instance, if a SIC is not needed in the initial programme, but could be useful to test a different investment scheme in a specific scenario.

SICs settings

Once the SICs have been associated to the theme elements, the user will need to define the parameters of the SICs, i.e. to set their respective characterizations, when necessary.

To do so, click **Set SICs default settings**. A pop up window will open, where the user can select a theme element to be edited.

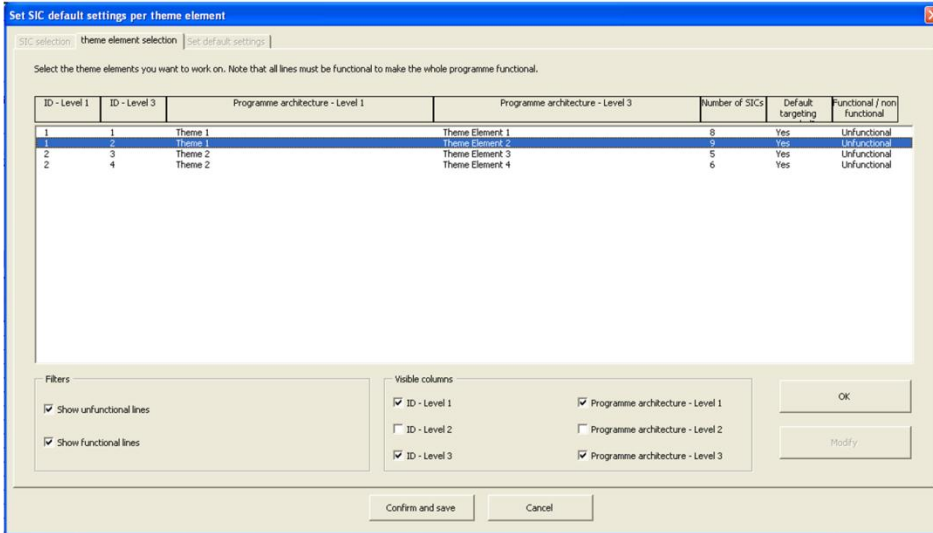


Figure 48: Pop up window used to select the theme element to be opened

The list of the SICs composing this theme element will appear in the pop up window. For each SIC, the user can see if it has been set and is thus functional or not. Select a SIC that is not yet functional and click **OK**. A list of characterizations will appear in the bottom part of the pop up. Some SICs need to be set (Needs default characterization: YES), and some others do not (Needs default characterization: NO).

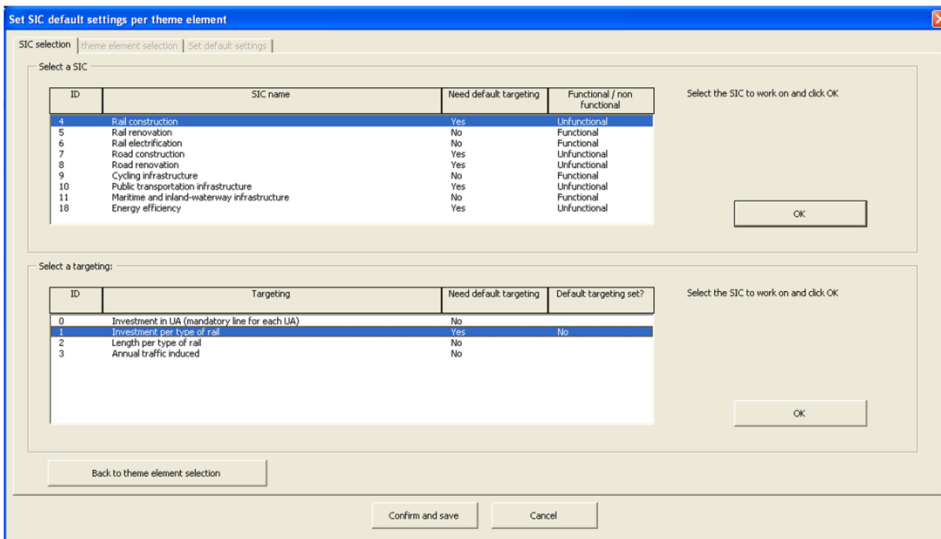


Figure 49: Pop up window for characterization selection.

Select a characterization indicating a YES for "needs default characterization" and a NO for "default characterization set" and click **OK**.

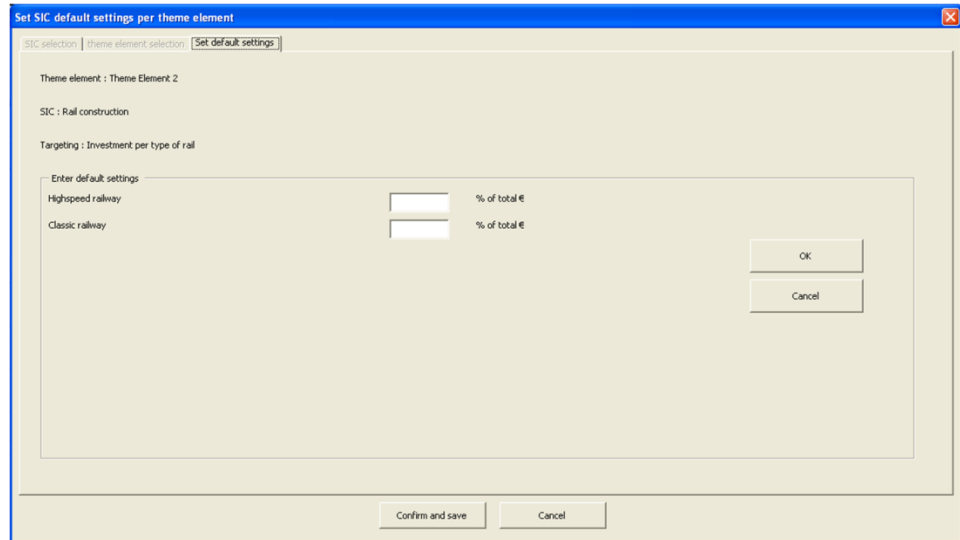


Figure 50: Pop up window allowing entering SIC default settings.

Enter the distribution amongst characterization values, click **OK** and then **Confirm and Save**.

Repeat the process to configure all non-functional SICs, for each theme elements. The indication on the "*Creation*" *Interface* will turn green. Once the work is saved, the new programme will automatically be listed as "functional" in the *Programme Management Interface*.

The new programme is now available for the creation of new scenarios.

6.1.3 Modify an existing programme

An existing programme can be adjusted in several ways:

- Modify the architecture of the programme.
- Adjust leverage effects.
- Add/delete SICs to/from theme elements.
- Modify SICs distribution.
- Set SICs parameters.

To modify a programme, the user will need to edit it by clicking **Open a programme** on the *Programme Management interface*.

The new interface that will open is organised the same way as for the creation of a new programme. Only the control buttons are different. They directly allow the user to:

- Modify the architecture of the programme.
- Modify financial leverage effects.
- Display SICs distribution over theme elements.
- Modify SICs distribution over theme elements.

Modify the architecture of a programme

The user has the possibility to alter the architecture of a programme by:

- Modifying the name of a theme element.
- Adding a theme element.

- Deleting a theme element.

To do so, open the programme to be modified and click **Modify programme architecture**.

Modify the financial leverages affected to theme elements

The financial leverage of each theme element can also be changed. Simply click the corresponding button to unlock the cells from the column "financial leverage" and click **Save** to reactivate the other functionalities.

Modify SICs

The button **Display SICs and theme elements** allows the user to see which SICs are associated with which theme elements. This interface is the same as for the creation of a new scenario, but is locked and thus for indicative purpose only. To change SICs distribution through theme elements, the user has to click the corresponding button, i.e. **Modify SICs and theme element association**. A pop up window will open, through which the user can:

- Add or delete SICs.
- Define SICs distribution (weight of each SIC for a given theme element).
- Set SICs parameters (characterizations).

Select the theme element to work on and the required action (see Figure 51 below). Explanations in the pop up window provide guidance on how to properly set the characterizations and the weight of each SIC through a given theme element.

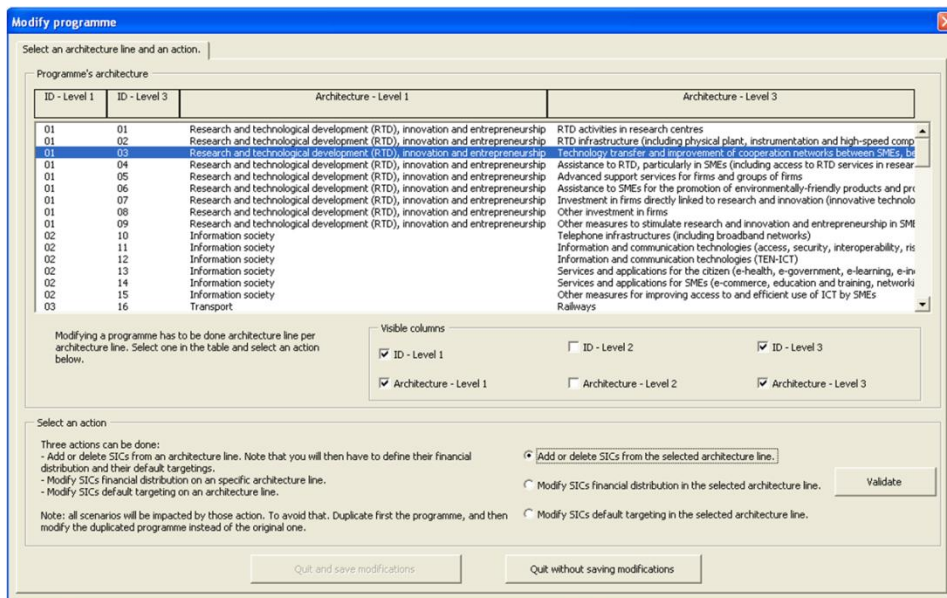


Figure 51: Pop up window used for modifying theme element disaggregation to SICs

6.1.4 Managing programmes in the model

The *Programme Management Interface* offers the user the possibility to: Create a new programme or open an existing one to modify it, as explained in the former sections.

Copy, rename or delete an existing programme. By clicking the corresponding buttons, pop-up windows will open, in which the user can select the programme to be copied, renamed or deleted.

6.2 Ratio Management

The *Ratio Management Interface* offers the possibility to modify ratio values if needed. Before elaborating the approach to do this, it should be noted that adjusting ratio values implies adjusting part of the model core. Modifying ratio values therefore has implications for all assessments made with the model, and goes beyond the scenario or even programme scale. If improperly used, adjusting ratios could lead to erroneous results.

To avoid irreparable damage when modifying ratios, the user has the possibility to store several ratio databases in the model, the same way several programmes or scenarios can be. In this way, a backup of the default database can be created to save a functional database, while modifying copies when needed.

Ratio Management can thus be split into two main functionalities:

- The modification of ratio values from the active database.
- The management of the different ratio databases contained in the model.

6.2.1 Presentation of the ratio Management Interface

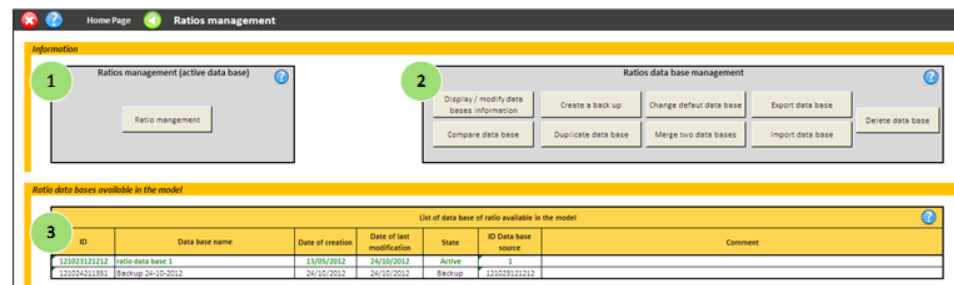


Figure 52: Screenshot of the *Ratio Management Interface*

The *Ratio Management Interface* is organised, as the others, in 3 parts:

- 1 A control button to manage ratio values (like modifying values) from the active database
- 2 A set of control buttons to manage the different databases stored in the model and which will allow the user to:
 - Display/modify general information on databases.
 - Create a backup of the active database.
 - Change the active (default) database.
 - Copy a database.
 - Compare databases.

- Merge databases.
- Import/export databases.
- Delete a database.

3

A table listing all the databases available in the model. The database highlighted in green is the active database used as default in the model.

The next sections give a detailed description of the different functionalities available here.

6.2.2 Modification/update of ratio values

The user may want to update ratios used for the calculation of emissions or modify their geographical scale of definition.

Note: the user can only modify ratios from the active database.

To modify ratios, click the button ratio management on the *Ratio Management Interface*. A pop up window will open. The user has the possibility to select ratios either

- By choosing a SIC in which the ratio is used (useful for ratios specific to a single SIC).
- Or by choosing a set of ratios (useful when ratios are common to several SICs).

Once this is done, select either a SIC or a set of ratios. The corresponding list of ratios will appear in the pop up window. The user can choose what information about ratios should be displayed, for clarity purpose.

A set of buttons (selection tools) has been created to help the user easily select several ratios at one time.

Select the ratios to be checked or modified manually or by using the selection tools, and click Confirm.

A new pop up will appear on which the user can modify each³ value of the ratio, by clicking **Modify – Info** (if a data is already taken into account) or **Enter a value** (if no data has been defined yet). A pop up will open; click **Modify**, change the value that should be updated and click **Confirm modification**.

³ One value per geographical level (Europe, NUTS 0, NUTS 1, NUTS 2).

Figure 53: Pop up window used to modify values and save comment for a given ratio.

6.2.3 Database management

For one given region, several ratio databases can be stored in the model. This can be useful if the user wants to make a modification in a database and still have a backup of the default one, to be able to reload it, in case of any problem.

Display/modify databases information

When clicking this button, a pop up window opens where the user can access information on the selected database, like:

- The ID and name of the database.
- Dates of creation of last modification.
- State of the database (active or backup).

The name of the database can be modified and comments can be stored here. To do so, click **Modify** and then **Save modifications**. The new name of the database will automatically be updated in the database list.

Copy a database

Select the database to be copied and click **Select**. Rename the new database to be created, enter comments if necessary and click **Create database**. The name of the new database created will automatically appear in the database list on the *Database Management Interface*.

Delete a database

Select the database to be deleted and click **Delete**.

Export a database

Select the database to be exported and click **Select**. Rename the database to be exported and write down comments if needed, and click Export database. Select the folder in which to store the database on the computer and click **Save**.

Import a database

Click **Select** file and select the database (.pkg) to be loaded. Click **Open**. A pop up window will appear. Click **Confirm Import** to save the database in the model.

Compare databases

The user has the possibility to compare the ratios of two different databases, by clicking **Compare databases**. A pop up will appear where the user has to select the two databases that should be compared and click **Confirm**. A new interface will open, listing all the ratios and corresponding values from both databases, as shown on the figure below.

Ratio ID	Ratio name	Territory ID	Territory name	level	Data Base 1 - Value	Data Base 2 - Value	Unit	Equality 7
0	Multiply by 1	-1	EUROPE	NUTS-1	1	1	None	VRAI
1	Multiply by -1	-1	EUROPE	NUTS-1	-1	-1	None	VRAI
2	Divide by 100	-1	EUROPE	NUTS-1	0.01	0.01	None	VRAI
3	Multiply by 100	-1	EUROPE	NUTS-1	100	100	None	VRAI
4	Divide by 1 000	-1	EUROPE	NUTS-1	0.001	0.001	None	VRAI
5	Multiply by 1 000	-1	EUROPE	NUTS-1	1000	1000	None	VRAI
6	Divide by 1 000 000	-1	EUROPE	NUTS-1	0.000001	0.000001	None	VRAI
7	Multiply by 1 000 000	-1	EUROPE	NUTS-1	1000000	1000000	None	VRAI
100	EF - Gas	-1	EUROPE	NUTS-1	0.0002037	0.0002037	t CO2 eq / kWh FE	VRAI
101	EF - Oil	-1	EUROPE	NUTS-1	0.0002589	0.0002589	t CO2 eq / kWh FE	VRAI
102	EF - Coal	-1	EUROPE	NUTS-1	0.0003114	0.0003114	t CO2 eq / kWh FE	VRAI
103	EF - Biomass	-1	EUROPE	NUTS-1	0.0000268	0.0000268	t CO2 eq / kWh FE	VRAI
104	EF - LPG	-1	EUROPE	NUTS-1	0.0002252	0.0002252	t CO2 eq / kWh FE	VRAI
105	EF - Waste incineration	-1	EUROPE	NUTS-1	0	0	t CO2 eq / kWh FE	VRAI
106	EF - Geothermal Energy	-1	EUROPE	NUTS-1	0	0	t CO2 eq / kWh FE	VRAI
110	EF - Electricity (average mix)	-1	EUROPE	NUTS-1	0.0003960731358	0.000396073	t CO2 eq / kWh FE	FALX
110	EF - Electricity (average mix)	2	BELGIQUE-BELGIE	NUTS0	0.0002390377603	0.000239038	t CO2 eq / kWh FE	FALX
110	EF - Electricity (average mix)	3	BULGARIE	NUTS0	0.000497829548131	0.00049783	t CO2 eq / kWh FE	FALX
110	EF - Electricity (average mix)	4	REPUBLIQUE TCHÈQUE	NUTS0	0.000629937485418	0.000629937	t CO2 eq / kWh FE	FALX
110	EF - Electricity (average mix)	4	DANMARK	NUTS0	0.000328940887669	0.00032884	t CO2 eq / kWh FE	FALX
110	EF - Electricity (average mix)	5	ALLEMAGNE	NUTS0	0.00050415308001	0.000504153	t CO2 eq / kWh FE	FALX

Figure 54: Screenshot of the interface allowing comparing two databases

This table is presenting, for each ratio listed:

- The ID and name of the ratio.
- The ID and name of the region for with the ratio applies, and the geographical scale of the region.
- The values of the ratio in each database.
- The unit of the ratio.
- And a **comparison indicator**: TRUE means ratios are the same, FALSE means ratios are different.

Merge 2 databases

In a database, one ratio can have up to 4 values stored in the model, according to its geographical definition (Europe=NUTS -1, NUTS 0, NUTS 1, NUTS 2). For the calculation, the model uses the value at the smallest geographical scale available. For instance, if no value is entered for NUTS 2, the model will consider the value at NUTS 1 scale (or at NUTS 0 if not NUTS 1, or at Europe scale if no NUTS 0).

When merging two databases, the respective values of the ratios, at a single geographical level can be:

- Complementary: for instance, database 1 has a value for ratio 500 at NUTS 0, database 2 does not. So only one value exists for ratio 500 at NUTS 0.

- The same: DB 1 and DB 2 have the same value for ratio 500 at NUTS 0. So only one value exists for ratio 500 at NUTS 0.
- Or different: DB 1 and DB 2 have different values for ratio 500 at NUTS 0. So two values exist for ratio 500 at NUTS 0. The user will thus have to define which value the model should save. For each geographical level, the user will be able to choose which database the value of ratios should be imported from.

To merge two databases, click **Merge databases** on the *Ratio Management Interface* and select the two databases to be merged. Then select for each geographical level the database that should be taken as reference for the import of ratios in case the two databases have two different values for a single ratio at a given geographical level, as shown on the figure below.

Figure 55: Pop up window used for merging databases

Create a backup

This function allows the user to make a copy of the active database, so as to save a functional database to be reloaded later for instance. Simply click the button, write down the name of the backup and click **Create backup**.

Change active database

To enable another database, i.e. load ratios from another database, click the corresponding button, select the database that should be activated and click confirm.

Note: Only one database can be activated at one time. All the ratios of the databases will be automatically loaded in the model and thus used for the calculation of the carbon impact of the programmes.

6.3 SIC Management

Standardized Investment Components are the core of the model calculation process. For each of them, a calculation algorithm has been defined. The user can see these algorithms through the *SIC Management Interface*, but cannot modify them.

For all SICs, emission impacts for both construction and operation phase have been distinguished. Operation emissions are estimated on a yearly basis. Therefore, to analyse cumulated emissions on lifetime projects, emissions are multiplied by an estimation of the duration of operation phase. Durations are dependent on the SICs and thus can be different from one SIC to another. For SICs that have an operation impact, the model specifies their lifetime duration and gives the user the possibility to modify it.

6.3.1 Presentation of the SIC Management Interface

The screenshot shows the 'SICs & Ratios management' interface. It is divided into three main sections:

- Information:** Contains a 'General information' box (1) with fields for 'SIC ID' and 'SIC name' (currently 'Road construction'). To its right are 'Control buttons' (2) for 'Select a SIC', 'Modify SIC duration', and 'Ratios management'.
- SIC's algorithm used in the model:** A large table (3) with columns: Order, Output, ID Ratio, Input 1, Input 2, and ID Ratio. It lists various inputs like 'Investment for studies', 'Investment for construction', and 'Length of road constructed', along with their corresponding ratios and formulas.

Figure 56: Screenshot of the *SIC Management Interface* after having selected a SIC

1 The first box is simply listing general information on the SIC that has been selected.

By clicking this symbol, the user has access to the description of the SIC (what is considered in the calculation, and what type of outputs are calculated).

2 Three functionalities are supported by this interface. The user can:

- Select the SIC to be opened (algorithm to be shown in table 3).
- See/modify SIC parameters (like the duration of the operation phase considered in the calculation of emissions).
- See/modify ratios from the active database. This button is the same as the one on the *Ratio Management Interface*. Refer to Section 6.2.2 for more details.

3 The first table shows the complete calculation algorithm of the SIC selected. For a better understanding of the structure of the algorithm, see Section 6.3.2.

The second one gives information on the ratio involved for the corresponding calculation line:

ID number + name of the ratio

Value of the ratio considered + unit

Geographical level of definition of the ratio (for which geographical level is the value valid?)

To display the algorithm of a SIC, simply select one by using the corresponding button.

6.3.2 Understanding of the algorithm

The algorithm should be read line by line. Each line corresponds to one calculation and the "order" indicates in which order the calculation is done.

For instance, for the SIC road construction, the algorithm is:

Step	Output	Ratio	Input
0	Investment for studies	= 506 X	Investments in road construction
0	Investment for construction	= 507 X	Investments in road construction
1	Investments in local roads construction	= 7001 X	Investments in road construction
1	Investments in national roads construction	= 7002 X	Investments in road construction
1	Investments in highways construction	= 7003 X	Investments in road construction
2	Length of local road constructed	= 7004 X	Investments in local roads construction
2	Length of national road constructed	= 7005 X	Investments in national roads construction
2	Length of highway constructed	= 7006 X	Investments in highways construction
3	Length of road constructed	= 0 X	Length of local road constructed
3	Length of road constructed	= 0 X	Length of national road constructed
3	Length of road constructed	= 0 X	Length of highway constructed
3	Bituminous concrete needed	= 7007 X	Length of local road constructed
3	Bituminous concrete needed	= 7008 X	Length of national road constructed
3	Bituminous concrete needed	= 7009 X	Length of highway constructed
3	Raw aggregates needed	= 7010 X	Length of local road constructed
...

Table 1: Extract of the algorithm of the SIC 'road construction'

Step

This means the investment is first split into budget spent for pre-construction studies and road construction in itself (order 0).

Then, the model uses the former output "investment for road construction" as an input to calculate the division of the investment among the different types of road being

constructed (order 1), and so on until it calculates emissions, as shown on the diagram below.

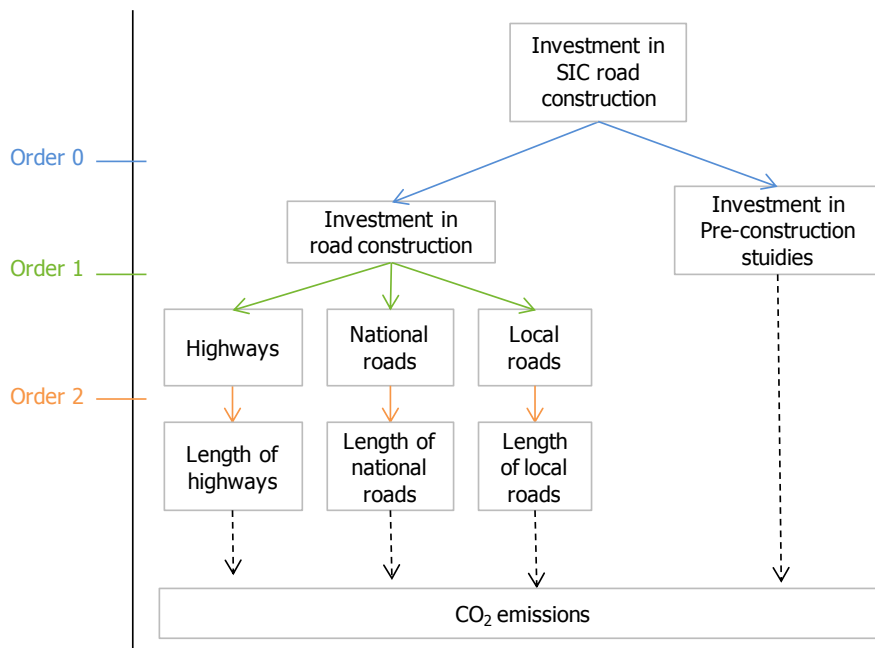


Figure 57: Diagram of the calculation process

Ratios

For clarity purpose, the ratios are defined by an identification number (ID) in the algorithm, but are detailed next to each line in a table giving:

- the ID,
- the name,
- the value and unit,
- and the geographical level of definition of the ratio.

Ratios from 0 to 999 are ratios that are common to several SICs whereas ratios starting from 1000 are ratios that are specific to each SIC.

When used at a same order, for a same output, the ratio 0 means inputs are summed.

For instance, in the extract of algorithm below,

length of road constructed (output) = length of local road constructed + length of nation road constructed + length of highways constructed

Step	Output	Ratio	Input
3	Length of road constructed = 0	X	Length of local road constructed
3	Length of road constructed = 0	X	Length of national road constructed
3	Length of road constructed = 0	X	Length of highway constructed

Table 2: Extract of the algorithm of the SIC 'road construction'

For a more detailed technical description of the algorithms, see the technical guidance document.

6.3.3 See/modify SIC parameters

Emissions impacts of SICs are calculated for both the construction phase and the operation phase. In the model calculations, the construction phase is assumed to last only one year. The operation phase is assumed to last longer, depending on the SIC. For instance, the operation phase of the SIC rail construction is 40 years whereas the one of the SIC port infrastructure is 50 years. For the operation phase, emissions are calculated on a yearly basis and then summed over the SIC duration. Changing these durations thus directly impacts the calculation of results.

If the default durations do not seem accurate enough to the user, they can be easily changed, as explained hereafter.

To modify SIC duration, click See/modify SIC parameters. Choose the SIC to be modified and click select. A new pop up window will open where the user can directly enter the duration for both phases (construction and operation) and write comments. Click **Confirm** to save the changes. Select another SIC to be modified or click **Quit** to go back to the *SIC Interface*. Changes are automatically taken into account in the model.

Modify SIC duration

SIC ID:

SIC name:

Duration state:

Construction phase duration: year(s) Default value: year(s)

Operation phase duration: year(s) Default value: year(s)

Uncertainty: % (with a 97% confidence interval)

Comments

SIC's description:

Road renovation SIC describes materials and related emissions of road renovation for 3 types of road :

- Highway: typical highway infrastructure (2x3 lanes)
- National roads: Main network (excluding highways)
- Local roads: Regional network (2 lanes road)

Renovation emissions depend on the size of the infrastructure (quantity of materials used, crash barrier). We

Figure 58: Pop up window for SIC characteristics modifications

In this pop up, the user can also modify the default uncertainty level attributed to the SIC selected.

Note: Initially, the comment box is filled in with the description of the corresponding SIC

6.3.4 Changing ratio values

When looking at the algorithm of a given SIC, the user also has access to the different ratios used in the calculation of emissions. If ratios need to be updated or set at another geographical level, the user has the possibility to modify them by clicking on the **Ratio Management** button.

A pop up window will open through which the user can modify ratios. This pop up is the same as presented in Section 6.2.2.

6.3.5 SIC descriptions

SIC descriptions defining what is considered under each SIC are available in this document in Appendix A. Sic descriptions are also available directly in the model, via the help button on the navigation bar (see description of the *Scenario Management Interface*, Section 4.1.1).

7

Glossary

7.1 Model

Generic model:

A generic model is the raw version of the model, in which ratios for estimating carbon emissions (emissions factors, cost, etc.) are mainly at European scale. It gives a first approximation of carbon emissions but isn't precise enough to compare scenarios.

Regionalized model:

A regionalized model is a generic model in which most European scale ratios have been changed using values provided by regional experts. Carbon emissions assessment and comparison of scenarios are possible when the model has been sufficiently regionalized.

Scenario:

User defined set of choices with regard to the allocation of the budget over the various themes in the studied Programme architecture. Different scenarios may have different budgetary schemes, or different descriptions of their themes in terms of Standardized Investment Components.

Operational Programme:

A document submitted by a Member State and adopted by the Commission setting out a development strategy with a coherent set of priorities, known in Council Regulation (EC) No 1083/2006 as 'priority axes', to be implemented with the aid of a Cohesion Policy fund. Priority axes comprise a group of operations which are related and have specific measurable goals. They are usually further broken down into measures. Measures provide for a project or group of projects, which are selected by the managing authority (according to criteria laid down by the monitoring committee) and implemented by one or more beneficiaries.

Programme Architecture:

The existing or intended pattern of investments in various theme elements that reflects the development strategy of a region.

Main programme theme:

First level of definition of the architecture of an Operational Programme. The main programme themes define the general guidelines of the political strategy expressed in an Operational Programme. For example, the 2007-2013 classification has 17 main themes: (1) *research and technological development (R&TD)*, (2) *information society*, (3) *transport*, (4) *energy*, (5) *environmental protection and risk prevention*, (6) *tourism*, etc.

Theme element:

Each main programme theme is divided in subthemes, which can again be divided. The finest level of classification of the architecture is called a theme element.

For example, the 2007-2013 main programme theme “tourism” is divided in 3 theme elements: (6.55) *protection of natural assets*, (6.56) *protection and development of natural heritage* and (6.57) *other assistance to improve tourist services*.

Standardized Investment Component (SIC):

Specific type of activity that is executed within a theme element. The same type of Standardized Investment Component may be undertaken in multiple theme elements. There are 26 different SICs.

For example, the SIC *Building construction* describes the construction of buildings and can be financed using budget of many different theme elements.

Characterization:

Specification of the activity of a SIC, used to calculate emissions more precisely.

For instance, for the SIC *Building construction*, one of the characterizations is the type of building being constructed: group housing, offices, health building, education, etc.

Determinant:

Structural data generally expressed in physical units which characterises a specific target activity and is used as an intermediary of calculation to assess carbon emissions from financial inputs.

Total main determinant:

For each SIC, one determinant is highlighted in order to create a carbon efficiency indicator but can also be used as a coherence test. This determinant is called the Total Main Determinant (TMD).

For example, the TMD of *Building Construction* is the total surface constructed in m². It helps to check total emissions and investment per m².

Carbon content indicator:

Carbon content is an indicator made to assess how close the programme is to compensate its own emissions.

Carbon content = (total emissions) ÷ (|positive emissions| + |negative emissions|)

Its minimum and maximum values are -100 (purely compensating programme) and 100 (purely emitting programme). The closer this carbon indicator is to 0, the more carbon neutral it is.

Financial leverage:

Financial leverage = [All other financial contribution (€)] / [ERDF contribution (€)]

For example, if 1M€ of ERDF contribution is allocated to an architecture line and all other contributions (public and private) represent 2M€, the financial leverage effect is $2M€ / 1M€ = 2$. Generally the value of the leverage effect varies from 0,5 to 5.

7.2 Emissions

Direct emissions: emissions from sources that are owned or controlled by the entity. It includes emissions from fossil fuels burned on site, commuting by workers.

Indirect emissions: emissions resulting from the generation of electricity (generated off site but purchased by the entity), modal shift for transport projects (called non embedded emissions) and emissions from the production and distribution of materials used for both construction and operation phases (called embedded emissions).

Appendix A. SIC descriptions

A.1. Building

A.1.1 Building construction

SIC Description

Building construction SIC describes emissions from building construction for different types of building (group housing, individual housing, offices, health building, education building, leisure and culture building, industrial building, farm, warehouse, other building).

For each type of building, 3 energy efficiency classes (low, medium and high energy efficiency) have been considered.

Emissions include embedded emissions (approx 85%), emissions from freight (approx 10%) and machinery (approx 5%) during construction phase and emissions from heat and electric consumption during operation phase.

For each type of building and each energy efficiency class, the surface of building constructed is determined based on the investment. These surfaces are then associated to energy consumption from actual national rules, and to medium national emission factors, that allow calculating emissions for the operation phase.

To evaluate the yearly impact of the operation phase, both electric and heat consumption are taken into account.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 25 years.
- Uncertainty range: Medium ($\pm 50\%$).

Literature

Prezzi tipologie edilizie, 2007, DEI - Tipografia del Genio Civile

Bilan Carbone appliqué au bâtiment - Guide méthodologique, ADEME & CSTB, 2011

A.1.2 Building demolition

SIC description

Building demolition SIC describes emissions from building demolition for different types of building (group housing, individual housing, offices, health building, education

building, leisure and culture building, industrial building, farm, warehouse, and abandoned building).

For the construction phase, demolition emissions are computed as a share (15%) of the construction emissions per square meter per type of building. For the operation phase, avoided emissions resulting from heat and electricity consumption avoided are computed. For abandoned buildings, no emissions are evaluated in the operation phase.

Remember that if the demolished building is going to be replaced by a new one, the share of investment for the new building has to be allocated to the Building Construction SIC.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 0.
- Uncertainty range: Low ($\pm 20\%$).

Literature

Prezzi tipologie edilizie, 2007, DEI - Tipografia del Genio Civile.

Rapporto efficienza energetica, 2011, ENEA.

A.1.3 Building refurbishment

SIC description

Building refurbishment SIC describes emissions from building refurbishment for 10 types of building (group housing, individual housing, offices, health building, education building, leisure and culture building, industrial building, farm building, warehouse building, other building).

For each type of building, 3 energy efficiency classes (low, good and high energy efficiency) are considered. Emissions include embedded emissions (approx 85%), freight (approx 10%) and machinery (approx 5%) during construction phase and from heat and electric consumption during operation phase.

For each type of building, the lower energy efficiency class has been taken as the baseline for energy consumption. Refurbished building energy consumption is defined according to three energy efficiency classes (low, medium and high). The difference in energy consumption (before and after refurbishment) define saved energy, and at the end of the algorithm, the avoided CO₂ emissions.

For each type of building, we evaluate how many square meters will be refurbished with the investment amount (for each class of efficiency).

These surfaces are then associated to energy consumption from actual national rules, and to medium national emission factors, that allow calculating emissions for the operation phase.

Emissions associated with the construction phase are computed by using an average emission factor for each type of building. To evaluate yearly emissions from operation phase, energy consumption, both electric and heat are evaluated.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 25 years.
- Uncertainty range: Medium ($\pm 50\%$).

Literature

Prezzi tipologie edilizie, 2007, DEI - Tipografia del Genio Civile.

Italian national regulation D. Lgs. 192/2005 + D. Lgs. 311/2006 by 2002/91/CE.

A.2. Energy

A.2.1 Renewable centralised energy

SIC description

The Renewable centralised energy SIC describes power generation (electricity, thermal energy, cogeneration) from renewable energy sources (wind, solar, geothermal, hydro, and biomass). It includes the construction of new large-scale power plants (more than 1MW installed capacity) and the subsequent operation phase (excluding maintenance).

For the construction phase, direct emissions include studies and commuting by construction site employees. Indirect emissions include the emissions related to energy consumption at the construction site, and the emissions embodied in materials.

For the operation phase, direct emissions from power generation are generally assumed to be nil. Indirect emissions are given by avoided (negative) emissions with respect to the national energy mix (assumed to be the baseline).

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 30 years.
- Uncertainty range: Low ($\pm 20\%$).

Literature

'Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport', Commission of the European Communities, Commission Staff Working Document for the Second Strategic Energy Review, 2008

A.2.2 Renewable decentralised energy

SIC description

The Renewable decentralised energy SIC describes power generation (electricity, thermal energy, cogeneration) from renewable energy sources (wind, solar,

geothermal, hydro, and biomass). It includes the construction of new small-scale power plants (less than 1MW installed capacity) and the subsequent operation phase (excluding maintenance).

For the construction phase, direct emissions include studies and commuting by construction site employees. Indirect emissions include the emissions related to energy consumption at the construction site, and the emissions embodied in materials.

For the operation phase, direct emissions from power generation are generally assumed to be nil. Indirect emissions are given by avoided (negative) emissions with respect to the national energy mix (assumed to be the baseline).

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 25 years.
- Uncertainty range: Low ($\pm 20\%$).

Literature

'Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport', Commission of the European Communities, Commission Staff Working Document for the Second Strategic Energy Review, 2008

A.2.3 Energy efficiency

SIC description

Energy efficiency (EE) SIC describes emissions due to investments in the following types of projects:

- Energy efficiency improvement of public lighting infrastructures.
- Thermal energy efficiency in SMEs (Small and Medium Enterprises), including high efficiency boilers, energy recovery from thermal processes, insulation improvement and systems optimization.
- Electric energy efficiency in SMEs, including substitution of conventional engines with high efficiency ones, installation of high efficiency devices and new transmission systems.
- Electricity network renovation, including the reduction of electricity losses and the construction of smart grid segments.
- Rational use of energy, including projects aiming at modifying behaviours towards less energy intensive end-users lifestyles.
- Other energy efficiency projects.

Energy efficiency measures in building refurbishment are not considered in this SIC since they are treated in the SIC Building – building refurbishment.

The following emission categories are considered:

- Indirect emissions (+) of the construction phase, which contains emissions due to home to work travels.
- Direct emissions (-) of the operation phase regarding avoided emissions due to investments in thermal energy efficiency.

- Indirect emissions (-) of the operation phase regarding avoided emissions due to investments in electric energy efficiency.

NB: Other emissions in the construction phase are assumed to be not relevant.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 20 years.
- Uncertainty range: Low ($\pm 20\%$).

Literature

'Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport', Commission of the European Communities, Commission Staff Working Document for the Second Strategic Energy Review, 2008
Piano di Sviluppo della rete elettrica di trasmissione nazionale, TERNA (Italy), 2012

A.2.4 Energy switch equipment

SIC description

Energy Switch Equipment SIC is used to calculate emissions impacts of innovative energy efficient projects, which details are known by the user (e.g. electrical car terminals, GNL Buses, etc.). Per default, this SIC is similar to the Equipment SIC (i.e. only construction emissions). By modifying the characterization of operation, the user is able to describe the project in terms of annual energy avoided and/or switched through using the equipment.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 30 years.
- Uncertainty range: Low ($\pm 20\%$).

Literature

Other SICs.

A.2.5 Fossil fuel energy

SIC description

Fossil fuel energy SIC describes the new construction or modernization of existing fossil energy plants. Investments are considered according to the fossil source used (coal, oil or gas) and to the production of electricity generation or cogeneration. The construction of new fossil energy plants are usually not financed by ERDF since only modernizations are eligible.

Indirect emissions comprise the emissions related to production of materials used in the construction phase of plants, such as concrete, steel etc. It also includes emissions for freight.

Direct emissions comprise studies and commuting by construction site employees. 10% of the total cost is devoted to studies.

For the operation phase, emissions are determined according to the fossil fuel source used. For the modernization of existing plants, we consider the avoided emissions due to the use of cleaner technologies compared with the baseline.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 50 years.
- Uncertainty range: Low ($\pm 20\%$).

Literature

Implant di generation, TERNA System electric - Data Statistic, 2010.
'Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport', Commission of the European Communities, Commission Staff Working Document for the Second Strategic Energy Review, 2008.

A.3. Transport

A.3.1 Road construction

SIC description

Road construction SIC describes emissions induced by the construction of new roads for 3 types of roads:

- Highway: basic highway infrastructure (2x3 lanes).
- National roads: main network (excluding highways).
- Local roads: regional network (2 lanes road).

Emissions of the construction phase are mainly caused by materials (production and freight) and a percentage of recycled materials are considered. Operation phase emissions are only related to induced passenger and freight traffic. It is indeed assumed that creation of a new road infrastructure will increase road traffic.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 30 years.
- Uncertainty range: High ($\pm 100\%$).

Literature

Statistical pocketbook 2011, European commission Mobility and Transport, 2011.
Incidence des poids lourds sur les coûts de construction des chaussées neuves, SETRA, 2009.
La route écologique du futur, Colas, 2003.

A.3.2 Road renovation

SIC description

Road renovation SIC describes materials and related emissions of road renovation for 3 types of road:

- Highway: typical highway infrastructure (2×3 lanes).
- National roads: Main network (excluding highways).
- Local roads: Regional network (2 lanes road).

Renovation emissions depend on the size of the infrastructure (quantity of materials used, crash barrier). It is assumed that for every euro spent in road renovation, material needed is the same than for road construction. A certain percentage of materials comes from recycling and isn't taken into account for carbon embedded emissions

SIC parameters

Construction phase duration: 1 year

Operation phase duration: -

Uncertainty range: Medium ($\pm 50\%$)

Literature

Statistical pocketbook 2011, European commission Mobility and Transport, 2011.

La route écologique du futur, Colas, 2003.

A.3.3 Rail construction

SIC description

Railway construction SIC describes emissions from railway construction for classic rail and high speed rail. It includes direct and indirect emissions induced by the construction of railways and indirect emissions related to the operation phase (electricity consumption, modal shift).

Construction emissions don't depend on the type of infrastructure, but on the density of bridges and tunnels. Operational emissions are caused by the new traffic induced and modal shift from personal cars (high speed and classic rail) or airplanes (high speed rail only).

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 40 years.
- Uncertainty range: Medium ($\pm 50\%$).

Literature

Comparing the Environmental Impact of Conventional and High-Speed Rail, European Network rail, 2009.

A.3.4 Rail renovation

SIC description

Railway renovation SIC describes emissions from railway renovation. It includes emissions due to ballast and catenaries replacement. Specific electric equipment is not taken into account.

Renovation emissions include the carbon embedded in new construction materials and freight emissions. Energy consumption by machinery is not considered. No operation phase is considered since it is assumed that railway renovation has no impact on traffic.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: -.
- Uncertainty range: Medium ($\pm 50\%$).

Literature

Modernisation des infrastructures ferroviaires, SETRA, 2010.
Rail traffic statistics, Eurostat, 2008.

A.3.5 Rail electrification

SIC description

Railway electrification SIC describes emissions from railway electrification process. It includes emissions due to infrastructures layouts and due to change of engine propulsion during operation phase.

It is assumed that electrification has no impact on traffic and only switches the propulsion method of trains from diesel to electricity.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 40 years.
- Uncertainty range: Medium ($\pm 50\%$).

Literature

Engineering Traction energy metrics, Roger KEMP, 2007.
Rail traffic statistics, Eurostat, 2008.

A.3.6 Public transportation infrastructure

SIC description

Public transportation infrastructure SIC describes the construction or extension of a transport infrastructure devoted to urban public transportation. Types of urban transport considered are: Subway, Tramway, Bus Rapid Transit (BRT) and conventional bus.

In the baseline considered, no infrastructure is built and the modal share of local transport remains unchanged. Depending on type of infrastructures and lifetime, this action can have a positive or negative CO₂ impact. If the impact on modal share is sufficient to compensate construction emissions (which can be very high), the project emissions become negative.

Embedded emissions in the construction phase comprise the emissions related to production of concrete, bitumen, steel for rails and aggregates needed for each type of public transportation infrastructure. It also includes emissions for producing these materials and for freight. For conventional bus, the model does not consider any construction impacts.

Direct emissions comprise studies and commuting of construction site employees. 10% of the total cost is devoted to studies.

For operation phase, it is assumed that public transportation does not induce more transport. It only creates modal shift from other public transportation and individual cars. For each type of public infrastructure, modal shift from cars are different.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 50 years.
- Uncertainty range: High ($\pm 100\%$).

Literature

French Tramway, Subway, bus and BRT infrastructure case studies, Various authors, 2005-2010.

Les chiffres 2005, STIF, 2005.

A.3.7 Cycling infrastructure

SIC description

SIC cycling infrastructure describes construction of new bike roads, whether shared or segregated. Creation of a new shared bike road simply consists in painting a part of an existing road, while segregated roads are newly constructed road. Bike roads induce new mobility demand and a direct or indirect modal shift from personal cars. Modal shift from public transportation modes is not taken into account.

For construction phase, shared and segregated bike roads generate carbon embedded emissions and freight emissions: only painting for shared bike road, painting and new road construction for segregated bike road.

During operation phase, new bikers demand and modal shift from personal cars are evaluated. Emissions are negative and represent avoided emissions from car use.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 15 years.
- Uncertainty range: High ($\pm 100\%$).

Literature

London Cycling Design Standards Chapter 7, Transport for London, 2005
Coûts occasionnés par la construction des infrastructures de mobilité douce les plus courantes, KONTEXTPLAN AG, Markus Hofstetter, Christian Farner, 2010

A.3.8 Airport infrastructure

SIC description

The SIC Airport comprises the construction and operation of an airport mainly for passenger transport and to a smaller extent, for cargo transport. Transformation of non-defined area into an airport area, including excavation works and material use for the airport construction, has been incorporated into this SIC. Energy use for passenger and cargo transport to and from the airport by plane plus the passenger and cargo transport to and from the airport by other transport modes as pre- and post-transport, are included in this SIC.

The types of airports in the considered Operational Programmes are mainly for passenger transport. Therefore, this SIC is designed to address the construction of airports for passenger transport. Via fuel shifts and so on, other types of projects for airports can be addressed. This SIC is in principal meant only for the construction and operation of an airport.

SIC parameters

Construction phase duration: 2 years.

Operation phase duration: 50 years.

Uncertainty range: High ($\pm 100\%$).

Literature

Transport Services Data v2.0 - Ecoinvent Report, no 14, Spielmann, M, Bauer, C, Dones, R, Paul Scherrer Institut, Villigen, 2007 *and others*.

A.3.9 Port infrastructure

SIC description

Port infrastructure SIC comprises the construction and operation of a deep seaport or a barge port, mainly for cargo transit and storage. To that purpose, a (non-defined) area is assumed to be converted into a port area, including the construction of basins, quays and jetties. The associated energy-consumption with good supply and removal within the region via different transport modes, either sea ships, barge ships, trains and road transport, have been incorporated here together with idling of the ships in the port.

The types of ports in the considered Operational Programmes are mainly of economic importance. Therefore, this SIC is designed to address the construction of ports for cargo transit, either as deep sea port or as inland port. Probably, fishery ports or recreational ports cannot be addressed properly using this SIC. If desired, one can address such ports by designing a new SIC. Projects in ports, which are devoted to e.g. the construction of shore power or the renovation of the surrounding built environment

of a port, should be addressed via e.g. fuel shift or renovation of buildings. This SIC is not appropriate to address such projects.

SIC parameters

- Construction phase duration: 2 year.
- Operation phase duration: 50 years.
- Uncertainty range: High ($\pm 100\%$).

Literature

Website of Maasvlakte 2 (Facts&Figures), 2012.

Transport Services Data v2.0 - Ecoinvent Report, no 14, Spielmann, M, Bauer, C, Dones, R, Paul Scherrer Institut, Villigen, 2007.

A.3.10 Maritime and inland-waterway infrastructure

SIC description

Maritime and inland-waterway infrastructure SIC comprises the construction of a canal or artificial waterway, including excavation works and material use for sluices and required energy for the operation of the sluices. The canal type is mainly devoted for use by barge ships and the energy use of barge ships is taken into account as well. Many data are based on an LCA study, which uses statistics obtained from the construction and operation of the Main-Donau canal in Germany. This canal passes substantial differences in altitude and has a substantial amount of sluices. It is on average 4 m deep and 42 m wide.

The transport performed on the canal has been assumed to be purely additional and therefore all emissions from the barge ships are taken into account here. It is assumed that the construction of a canal initiates activities on each side of the canal end, which drives the use of the canal by barge ships.

SIC parameters

- Construction phase duration: 2 year.
- Operation phase duration: 50 years.
- Uncertainty range: High ($\pm 100\%$).

Literature

'Aéroport du Grand Ouest' and 'Berlin Brandenburg Airport' websites, 2012.

Transport Services Data v2.0 - Ecoinvent Report, no 14, Spielmann, M, Bauer, C, Dones, R, Paul Scherrer Institut, Villigen, 2007.

A.4. Waste and Water

A.4.1 Waste management infrastructure

SIC description

Waste management SIC leads to an increase in waste incineration and/or recycling capacity within the region. The user can decide how the investment is to be split between these two investment options. Emission impacts are calculated against a baseline in which the waste is transported to a landfill.

Direct emission impacts of operation follow mainly from material transport and combustion of fossil fuel related material (plastics). Indirect operation related emissions reflect changes in the balance of energy production and use as well as life cycle emission impacts of different waste management strategies (e.g. whether plastic is combusted, recycled and stored at the landfill).

Material and energy needs for the construction phase are also considered.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 40 years.
- Uncertainty range: Low ($\pm 20\%$).

Literature

Municipal Waste Composition: A Review of Municipal Waste Component Analyses, Julian Parfitt, Resource Futures, 2010.

Waste Reduction Model (WARM), EPA, 2012.

A.4.2 Wastewater treatment

SIC description

Wastewater treatment SIC represents Investments in generic wastewater treatment facilities. The new plant is assumed to replace small scale solutions (e.g. cesspools, septic tanks) in a given area and its emission impacts are therefore compared against these small scale solutions.

As no non- CO₂ greenhouse gases are considered, emissions during the operation phase are caused by the net energy use (electricity, fuel oil and natural gas) of the plant during operation. Emissions from construction phase reflect the embodied emissions of the construction materials as well as the emissions caused by the transport of the materials to the building site. Also electricity use during the construction phase is included.

SIC parameters

Construction phase duration: 1 year.

Operation phase duration: 30 years.

Uncertainty range: Low ($\pm 20\%$).

Literature

Life cycle Inventories of waste treatment services, G.Doka ecoinvent report No.13 (Swiss Centre for Life Cycle Inventories), 2009.

A.4.3 Drinking water treatment

SIC description

Water treatment SIC describes investments in potable water production. The chosen representative treatment plant is a conventional surface water treatment facility.

Operational emissions relate to the energy and material use during operation, while the construction related emissions reflect the indirect emissions related to material production and transport to the construction site.

SIC parameters

Construction phase duration: 1 year.

Operation phase duration: 60 years.

Uncertainty range: Low ($\pm 20\%$).

Literature

Comparative life cycle assessment of water treatment plants, Alexandre Bonton, Christian Bouchard, Benoit Barbeau, Stéphane Jedrzejak, 2012.

Inventory of carbon and energy (ICE), version 1.6a, Department of Mechanical Engineering, University of Bath, 2008.

A.5. Others

A.5.1 Civil engineering

SIC description

Civil Engineering SIC describes emission implications from 6 civil engineering activities:

- Works of engineering related to bridges and tunnels.
- Earthworks / embankments and demolition.
- Small road systems (streets, etc.).
- Public utilities.
- Maritime and fluvial engineering.
- Other civil engineering activities.

Emissions considered are:

- Direct emissions generated by commuting of construction site employees and studies.
- Indirect emissions related to materials (production and freight).

NB: direct emissions related to construction site activities have been neglected, since the impact is relatively low compared to the other sources of emissions already mentioned.

SIC parameters

- Construction phase duration: 1 year(s).
- Operation phase duration: -.
- Uncertainty range: Low ($\pm 20\%$).

Literature

Structural Business statistics (sbs_na_1a_se_r2), EUROSTAT 2008.

L'acier en France en 2008 (FFA, 2008), Le marché des granulats en 2008 (UNPG, 2008), Infociment 2008 - L'essentiel (SFIC, 2008).

A.5.2 Equipment

SIC description

Equipment SIC describes emissions induced by the purchase of equipment. 4 types of equipment are taken into account:

- Research and Technological Development (RTD) equipment.
- Machinery.
- Small equipment.
- Small computing equipment.

Emissions considered are embedded emissions related to the production and transport of these equipments. They are classified under “indirect emissions”.

Emissions induced by the energy consumption for using equipment are not taken into account. Thus, no operation phase is considered.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: - .
- Uncertainty range: Low ($\pm 20\%$).

Literature

UN Comtrade database, 2008.

EcolInvent v2.2, Swiss Centre for Life Cycle Inventories, 2009.

A.5.3 Immaterial services

SIC description

The SIC Immaterial services refer to immaterial projects such as studies, training, research, etc.

Emissions related the SIC Immaterial services refer to:

- Commuting of mobilised employees.
- Building and equipment used by mobilised employees.

Note that this SIC refers to immaterial projects only. For projects such as building construction that include a study phase, the dedicated SIC already takes into account the needed studies.

SIC parameters

Construction phase duration: 1 year.

Operation phase duration: -.

Uncertainty range: Medium ($\pm 50\%$).

Literature

Structural Business statistics, EUROSTAT, 2008.

ODYSSEE Indicator (Emission in tertiary sector per employee), Enerdata, 2008.

A.5.4 Reforestation

SIC description

Reforestation SIC describes the plantation of a new forest for any reason (after storm, for carbon sinks, etc.). Trees planted will absorb carbon during their growth, and therefore have negative emissions. This kind of project is normally financed by EAFRD, not by ERDF.

Emissions impact of the SIC includes those from planting and operation of the newly planted forest. The model considers that the forest planted corresponds to the actual mix of species in the country. All forests do not absorb the same amount of CO₂.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 30 years.
- Uncertainty range: Medium ($\pm 50\%$).

Literature

Boisement/Reboisement, French Agriculture Department, 2003.

National Inventory Submissions 2012, UNFCCC, 2012.

A.5.5 Configurable SIC

SIC description

The configurable SIC is different to all others. Per default, its impact is carbon neutral but it enables an expert user to declare specific CO₂ emissions that aren't calculated elsewhere.

It is possible to define various impacts for both construction and operation phase: employment for construction, construction materials used, energy consumed for construction, permanent employment during operation, energy consumed or avoided during operation.

SIC parameters

- Construction phase duration: 1 year.
- Operation phase duration: 30 years.
- Uncertainty range: Low ($\pm 20\%$).

Literature

Other SICs.

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