

Instructions for the Tool: Global Paths Based on RM Scenario Types

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The latest version of the tool can be downloaded at: <https://doi.org/10.5281/zenodo.4584562>

We would also like to point out our web applications: <http://climate-calculator.info>

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1 Basic idea behind the tool “Global Paths”

The tool offers the Regensburg Model Scenario Types RM 1 - 6 to derive plausible global paths to 2100 that adhere to a global budget 2020 - 2100 (Wolfsteiner & Wittmann, 2023). This scenario types cover the range of plausible possibilities well.

2 Brief introduction to the tool

In the **sheet 'base data'** you can set the basic conditions such as the budget, which is to be met, and the minimum value of global annual emissions (potential for net negative emissions).

For deriving **global paths**, the tool offers the scenario types **RM 1 - 6**. They differ in particular in terms of different assumptions on the trajectory of annual reduction rates resp. reduction amount.

When modifying input data (which the cells shaded in yellow are designated for), you must always execute the **macro** in the **sheet 'goal seek'** to adjust the free parameter in the scenarios such as to meet the global budget 2020 - 2100 which is set out in sheet 'base data'.

3 Entries in the sheet ‘base data’

- A. In a first step, a **global budget 2020 - 2100** is set that can be based on the remaining budgets according to the IPCC (cf. Wolfsteiner, 2024).
- C. **Global minimum emissions:**
Here you can specify which minimum the global paths can achieve in 2100 (E_{min}). If you specify a negative value, this means net negative emissions.

4 Determination of emission paths

4.1 Entries in the sheet ‘goal seek’

- RM 2 – 5: rates of change for the start year (RR_{SY})

Enter the starting change rate for the first year. This is the first year for which no actual emissions are known. The corresponding year is specified. Values from the past are given for orientation.

- RM 1; 2 – 5: threshold values (TV)

In scenarios RM 1 - 5, a constant reduction amount is applied from this threshold values for the transition to **net negative emissions**.

To specify the TV , enter a percentage that will be applied to the emissions in 2019.

Orientation values are given for a relatively low absolute value of E_{min} . If the absolute value of E_{min} is high, a higher TV is required.

4.2 Where and how the paths are determined

The paths are calculated in the **sheet ‘scenarios’**.

The emission paths are determined using the Regensburg Model Scenario Types RM 1 – 6 (see Chapter 5). The paths are essentially determined by **specifying** the **annual** rate of **change** (RM 1 - 5) or the annual constant reduction amount (RM-6). From the specified threshold value (TV), a constant reduction amount is used until the emissions reach the predefined minimum value (E_{min}).

In the **sheet 'goal seek'** the free parameter of the respective scenario is determined for each scenario type using an iterative solution method so that the budget is adhered to. The **'goal seek'**

macro in this sheet uses the target value search integrated in Excel for this purpose (see Chapter 4.4).

The actual emissions after the base year 2019 will be taken into account as soon as they have been published by the Global Carbon Project (GCP, 2023). You can see the years already available in the 'base data' sheet under point B.

4.3 Phases determining paths

This usually leads to the following **three phases** for determining the paths:

1. Application of the annual reduction rates (RM 1 - 5) or the annual reduction amount (RM-6).
2. Annual emissions less than or equal to TV : The last annual absolute reduction is continued in RM 1 - 5.
3. Minimum for the annual emissions (E_{min}) specified in the sheet 'base data'.

These three phases can be found in the formula for the annual emissions in the individual scenario types in the sheet 'scenarios'.

4.4 Macro in the sheet 'goal seek'

The **macro 'goal seek'** tries to determine the free parameter in the scenario (row 12 or 13) so that the global budget (row 16) is adhered to (► row 15 = row 16). The macro also ensures that the constraints for the free parameters are met.

If this does not succeed at first go, the macro tries to find a solution with a different rate of change for 2020 in the scenario types RM 2 - 5. The initial value you specify is changed by a maximum of 2.5 percentage points in both directions in 0.01 steps. The start value you specified will therefore be changed. If a solution cannot be found either, the macro will inform you and advise you to change the start value more significantly.

In the RM-1 scenario, the macro increases the threshold value (TV) if necessary to find a solution.

The macro also tries in scenario RM-1 that the minimum value (E_{min}) specified in the sheet 'base data' is reached (► row 18 = row 19). If this does not succeed straight away, the macro increases the threshold value (TV) in the RM-1. If E_{min} can still not be reached, the original TV will be reset.

4.5 Macro security

The macros are signed with a certificate from Sectigo. This also ensures that the code has not been changed subsequently.

Please use Microsoft's instructions to allow macros if they have been blocked.

In most cases, you can unblock macros by changing the properties of the file as follows:

- Open Windows File Explorer and go to the folder where you saved the file.
- Right-click on the file and select Properties from the context menu.
- At the bottom of the General tab, select the Unlock check box and then OK.

If you do not want to use the built-in macros, you can save the file as an xlsx file. This will remove all macros.

We have published the code of the key macro 'goal seek' here:

<https://doi.org/10.5281/zenodo.7494168>

This gives you the option of integrating the macro into your Excel file yourself.

5 RM Scenario Types 1 – 6

For a comprehensive mathematical description, we refer to our paper ‘Mathematical Description of the Regensburg Model Scenario Types RM 1 – 6’ (Wolfsteiner & Wittmann, 2023) published on [zenodo](#). [Here](#) is a further brief description of the RM Scenario Types.

6 Results

In the **sheet ‘graphs’** you can see the graphical **results**.

7 IPCC illustrative paths P1 – P4

In the sheet ‘IPCC SR15 graphs’ we show for comparison the illustrative model pathways that the IPCC published in its 2018 special report (IPCC, 2018a).

In the ‘IPCC SR15 Results’ sheet, results are shown that may be useful in the **Regensburg Model** or the **Extended Smooth Pathway Model**, which can be used to determine Paris-compatible national emission pathways (information on these models at www.save-the-climate.info).

The sheets are hidden by default. You can unhide the sheets in the ‘navi’ sheet.

References

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