Instructions for the Tool:

Calculation of Emission Paths Using the Regensburg Model Scenario Types

Version instructions: 16/04/2024

www.save-the-climate.info • save-the-climate@online.ms (mail to)

The latest version of the tool can be downloaded at the platform zenodo: https://doi.org/10.5281/zenodo.4568839.

Web app to calculate Paris-compatible national CO2 budgets using a weighting model:

http://national-budgets.climate-calculator.info.

Overview our tools: https://climate-calculator.info.

Contents

1 Basic idea of this tool

With this tool, with the help of the Regensburg Model Scenario Types (RM 1 - 6), global or national emission paths can be derived that meet a specified budget 2020 - 2100 (cf. Wolfsteiner & Wittmann, 2023).

Basically, only the budget and the current annual emissions have to be specified.

2 Entries in the sheet "base data"

The data for a country, global data or other unit can be specified here.

- Annual emissions:
    - Enter the actual emissions in the base year (2019), in 2018 and at least one reference year.
    - Enter the actual emissions after 2019 if available.
    - Enter the unit of emissions.

- **Budget 2020 – 2100**:
  Here you specify the budget that the paths should adhere to by 2100.

- **Minimum emissions** (E_{min}):
  Here you can specify which minimum the paths can achieve in 2100. If you specify a negative value, this means net negative emissions. The specification is made by entering a percentage that will be applied to emissions in 2019.
  If net negative emissions are allowed, the budget may be temporarily exceeded. This overshoot will then be offset by net negative emissions by 2100.

3 Data and budgets for all countries in the world

We offer an Excel tool that contains the emission data for all countries in the world (Wolfsteiner & Wittmann, 2024). Here we also offer a simplified web app for it: http://national-budgets.climate-calculator.info.

For the derivation of national budgets from a global budget, a weighted distribution key is offered in this tools that includes the share of global emissions and the share of global population in 2019.

For the EU, Germany and Global, the required data is offered in the corresponding sheets, which can be linked to the "base data" sheet using a macro. The data includes the total CO_2 emissions and was taken from the Excel tool (Wolfsteiner & Wittmann, 2024).

4 Determination of emission paths

4.1 Entries in the sheet "goal seek"

- RM 2 – 5: rates of change for 2020 (RR_{20})
  The actual RR_{20} cannot be used because of the temporary corona effect. Instead, a value should be used that would probably have been set without corona. The rate of change of 2019 is given as an indication.

- 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**.

4.2 Where and how the paths are determined

The **paths** are **calculated** in the **sheet "calculation"**.

Emission paths are be determined using the Regensburg Model Scenario Types RM 1 – 6 (see Chapter 4.3). The paths are essentially determined by **specifying** the **annual rates** 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).

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.

3. Minimum for the annual emissions (E_{min}) that you specify in the sheet "base data" will be applied until 2100.

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 4.4.1).

4.3 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'published on Zenodo (Wolfsteiner & Wittmann, 2023).

4.4 Macros in the sheet "goal seek"

4.4.1 Macro "goal seek"

The **macro "goal seek"** tries to determine the free parameter in the scenario (row 12 or 13) so that the budget (row 16) is adhered to (▶ row 15 = row 16). The macro also ensures that the constraints for the free parameter 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 for 2020 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.

4.4.2 Macros finding budget

Macro "target 2030"

With this macro you can set the emissions **target** for a certain scenario type for **2030** compared to 1990 and search for the **appropriate budget**. The 2030 emissions target to be specified must be less ambitious than the solution already found.

The use of this macro is particularly useful if a country specifies a lower level of ambition for 2030 in its NDC than would be necessary with the given framework data. This shows which budget NDC for 2030 corresponds to with otherwise the same framework data.

The scenario types RM-2, RM-4 and RM-6 are particularly suitable for this analysis. The scenario types RM-3 and RM-5 are less suitable if a country is not very ambitious when it comes to the 2030 emissions target, since in these scenario types a relatively rapid increase in the annual reduction rates is implemented right from the start. This characteristic does not come into play due to the less ambitious 2030 target. However, the later increase in the reduction rates is only possible to a limited extent with these scenario types. Therefore, a less ambitious target for 2030 requires a relatively high budget for these scenario types.

Before this macro can be executed, the normal target value search for the scenario types RM 2 - 6 must have been carried out successfully.

Macro "year emissions neutrality"

With this macro you can set the **year of emissions neutrality** for a certain scenario type and search for the **appropriate budget**. The year of emissions neutrality to be specified must be less ambitious than the solution already found.

The use of this macro is particularly useful if a country specifies a lower level of ambition in its NDC than would be necessary with the given framework data. This shows which budget NDC corresponds to with otherwise the same framework data.

Before this macro can be executed, the normal target value search for the scenario types RM 2 - 6 must have been carried out successfully.

4.4.3   Macro security

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 Paths and reference values

The resulting emission paths, reference values and sum of the net negative emissions (overshoots) are shown in the **sheet "results"**.

Above this sheet you will see whether the target value search must be carried out in the sheet "goal seek".

6 References

Sargl, M., Wiegand, D., Wittmann, G. & Wolfsteiner, A., 2021. Berechnung Paris-kompatibler Emissionsziele für die sechs größten Emittenten mit dem ESPM. *Zeitschrift für Umweltpolitik & Umweltrecht*, Issue 3/2021, pp. 269 - 286.

Sargl, M., Wiegand, D., Wittmann, G. & Wolfsteiner, A., 2024a. *Berechnung Paris-kompatibler Emissionspfade mit dem ESPM am Beispiel Deutschlands und der EU.* [Online]
Available at: https://doi.org/10.5281/zenodo.5678717

Sargl, M., Wiegand, D., Wittmann, G. & Wolfsteiner, A., 2024b. *Calculation of Paris-compatible emission targets for the six largest emitters with the ESPM.* [Online]
Available at: https://doi.org/10.5281/zenodo.4764408

Wiegand, D. et al., 2021. Berechnung Paris-kompatibler Emissionspfade mit dem ESP-Modell am Beispiel der EU. *Wirtschaftsdienst*, 2, pp. 127 - 133.

Wolfsteiner, A. & Wittmann, G., 2023. *Mathematical Description of the Regensburg Model Scenario Types RM 1 – 6.* [Online]
Available at: https://doi.org/10.5281/zenodo.4540475

Wolfsteiner, A. & Wittmann, G., 2024. *Tool: Implicit and explicit weighting of the population in the allocation of a global CO2 budget.* [Online]
Available at: https://doi.org/10.5281/zenodo.5837866