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Explicit and implicit weighting of the population in the allocation of a global CO2 budget

National CO2 budgets for all countries in the world

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Content

Weighting model

The tool is based on the distribution of a global CO2 budget using a weighted distribution key.

The weighted distribution key takes into account the share of the global population and the share of global emissions of the selected country in a base year (*BY*):

$$B^i = \left(\boldsymbol{C} * \frac{P_{BY}^i}{P_{BY}} + (1 - \boldsymbol{C}) * \frac{E_{BY}^i}{E_{BY}} \right) * \boldsymbol{B}$$

where

$\boldsymbol{B}$ or B^i	global CO2 budget or national CO2 budget of the country *i*
E_{BY} or E_{BY}^i	global emissions or emissions of country *i* in the base year (*BY*)
P_{BY} or P_{BY}^i	global population or population of country *i* in the base year (*BY*)
$\boldsymbol{C}$	weighting of the population

This distribution key can thus map the two most important factors:[1]

- current reality
- climate justice

You specify the remaining global CO2 budget (*B*) from and including 2020 in the 'base data global budget' sheet.

Explicit Weighting Population

With this tool, national CO2 budgets can be calculated for any country in the world by explicitly specifying the population weighting.

You specify the weighting of the population (*C*) in the 'all countries EDGAR', 'all countries GCP', 'EU EEA' or 'GER UBA' sheets.

The national budgets (B_i) from 2020 on are given with a distribution of the global budget from and including 2016 (*BY* = 2016) and from and including 2020 (*BY* = 2019).[2]

See also our simplified **web app** for calculating Paris-compatible national CO2 budgets and corresponding linear emission paths: http://national-budgets.climate-calculator.info.

Emission paths and further information

With our web app http://paths.climate-calculator.info or the corresponding Excel tool (Wolfsteiner & Wittmann, 2025a), emission paths can be derived from these national budgets. To determine the paths, six scenario types are offered there that cover the entire range of plausible possibilities, including the possibility of a temporary overshoot (Wolfsteiner & Wittmann, 2024).

The data required in the web app and in the Excel tool are provided in the **'Data export'** sheet.

[1] For further possible criteria, see the corresponding excursus in (Sargl, et al., 2025b). For a comparison of Resource Sharing Models, see: (Sargl, et al., 2024). For examples of how this weighting model is applied, see: (Sargl, et al., 2025a; Sargl, et al., 2025b).

[2] A distribution from 2016 is offered, as the German Advisory Council on the Environment, for example, is in favour of this (cf. German Advisory Council on the environment (SRU), 2020). A distribution from 2020 onwards is recommended, as this date has long been discussed as a necessary turning point for global CO2 emissions.

We would also like to point out our Excel tool "ESPM", which can be used to calculate budgets and paths (Wolfsteiner & Wittmann, 2025b).

The 'graphs EDGAR' sheet shows the results for the six major emitters, while the 'PDF results' sheets shows the results for all countries in the world.

Implicit Weighting Population (IWP)

Given a national and a global budget, the implicit weighting of the population can be calculated:

$$C = \frac{B^i - B * \frac{E^i_{BY}}{E_{BY}}}{B * (\frac{P^i_{BY}}{P_{BY}} - \frac{E^i_{BY}}{E_{BY}})} = \mathrm{IWP}$$

The national budget can be derived, for example, from an NDC or national climate change legislation (cf. Wolfsteiner, 2025). The IWP can thus be used to evaluate national targets.

The base year is 2019 and the budget period is 2020 - 2100 when calculating the implicit weighting.

When calculating the IWP, care must be taken to ensure that the content of the national CO2 budget used matches the global CO2 budget used.

The IWP can also be calculated for any country in the world using this web app:

http://ib-iwp.climate-calculator.info

Database used in this tool

EDGAR

With the EDGAR database, the EU provides the emissions of all countries in the world due to the use of fossil fuels (excluding international shipping and aviation; ISA) and cement production (EDGAR, 2025).

Budgets are reserved here at global level for the missing emissions ISA and land-use change (LUC). The corresponding entries are made in the 'base data global budget' sheet.

Population figures were calculated from the data on per capita emissions on EDGAR.

GCP

GCP provides national CO2 emissions due to the use of fossil fuels (excluding ISA), cement production (excluding cement carbonation sink; CeCS) and including land-use change (LUC) (GCP, 2025).

Therefore, an ISA budget must be reserved at global level (entry in the 'base data global budget' sheet).

GCP refers to three sources for LUC emissions, which differ significantly. As with global emissions, the average of the three sources was used.

The population figures are generally based on EDGAR (see above).

EEA

For the EU and the EU Members, data from the European Environment Agency (EEA) can also be accessed (EEA, 2025), which provides total CO2 emissions including land use, land use change and forestry (LULUCF) and ISA (sales principle).

Two options are offered for calculating the share of the EU or EU member states in global emissions:

1. Global Carbon Project (GCP, 2025)

   GCP reports CO2 emissions from land-use change (LUC) instead of LULUCF. Accordingly, the simplifying assumption is made here that LULUCF = LUC (see Chapter "Relationship between LUC and LULUCF").

2. EDGAR (EDGAR, 2025)

   EDGAR does not provide LULUCF emissions at the country level, but it does provide them for macro-regions. From this, global LULUCF CO2 emissions can be derived. These can be added to the global CO2 emissions from the use of fossil fuels and cement production according to EDGAR to obtain the global CO2 emissions, which are the basis here for the shares of the individual EU members and the EU respectively.

The population figures for the EU and its members were determined from the per capita emissions according to the EEA. These differ slightly from the figures according to EDGAR. The global population is taken from the data according to EDGAR (see above).

UBA

For Germany, data from UBA can also be accessed (UBA, 2025), which provides total CO2 emissions including land use, land use change and forestry (LULUCF) and ISA (sales principle). The Global Carbon Project is used as a reference point for global emissions (see Chapter "Relationship between LUC and LULUCF").

The population figures for Germany were determined from the per capita emissions according to the EEA. These differ slightly from the figures according to EDGAR. The global population is taken from the data according to EDGAR (see above).

Relationship between LUC and LULUCF

Using CO2 emissions including LUC (as defined by the GCP) is more appropriate for comparing against the IPCC remaining carbon budgets than using EDGAR/EEA/UBA values including LULUCF.

The GCP data represent exclusively the anthropogenic CO2 sources — fossil fuel and industrial emissions plus emissions from land-use change — which is exactly the definition used in the IPCC budget framework. In contrast, EDGAR/EEA/UBA’s LULUCF category includes large management-related sinks (e.g. forest management, soils under continuous use, harvested wood products). These sinks are accounted for separately as part of the natural land sink in the IPCC carbon budget framework. Using EDGAR/EEA/UBA LULUCF would therefore double-count these removals and lead to an overestimation of the remaining carbon budget.

Nevertheless, calculations based on LULUCF in accordance with EDGAR/EEA/UBA are also provided, as national LUC emissions in GCP are based on three different sources that can vary significantly. As with GCP's approach to global LUC emissions, the average value is used at national level. This means that LUC is more appropriate in terms of content, but that LULUCF at national level, provided by the EEA or UBA, represents the more reliable data basis.

Global budgets

The tool also provides updated global remaining budgets (Forster, P.M. et al., 2025) compared to the budgets published by the IPCC in 2021 (IPCC, 2021).

Formulas for linear emission paths[3]

In the tool, the year of emissions neutrality and reduction targets are given on the basis of linear emission paths without net negative emissions.

The following formulas are used:

$$\text{emissions in year } t \text{ of the country } i = E_t^i = -\left({E_{BY}^i}^2/(2 * B_{cor}^i)\right) * (t - BY) + E_{BY}^i$$

$$\text{year emissions neutrality} = round\ up\ (BY + 0.5 + 2 * B_{cor}^i / E_{BY}^i)$$

where:

$$B_{cor}^i = B^i + 0.5 * E_{BY}^i$$

[3] This correction produces approximately the exact results (cf. Wittmann & Wolfsteiner, 2023, SLPM).

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