Wolfsteiner/Wittmann • www.save-the-climate.info • DOI 10.5281/zenodo.5837866 • tool is published on zenodo

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

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*):

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

where

$B \text{ or } B^i$	global CO2 budget or national CO2 budget of the country *i*
$E_{BY} \text{ or } E_{BY}^i$	global emissions or emissions of country *i* in the base year (*BY*)
$P_{BY} \text{ or } P_{BY}^i$	global population or population of country *i* in the base year (*BY*)
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 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 in the "all countries EDGAR" sheet or in the "EU EEA" sheet.

The national budgets from 2020 on are given with a distribution of the global budget (*B*) 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.

With our web app http://paths.climate-calculator.info or the corresponding Excel tool (Wolfsteiner & Wittmann, 2024a), 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, 2023).

We would also like to point out our Excel tool "ESPM", which can be used to calculate budgets and paths (Wolfsteiner & Wittmann, 2024b).

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[1] For further possible criteria, see the corresponding excursus in (Sargl, et al., 2024b).

[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.

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, 2024). 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.

Database used in this tool

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, 2023). 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.

For the EU, data from the European Environment Agency (EEA) can also be accessed (EEA, 2024), which provides total CO2 emissions including land use, land use change and forestry (LULUCF) and ISA (sales principle). For Germany, more recent figures from the Federal Environment Agency (UBA) are also used (UBA, 2024). To calculate the share of the EU or EU member states in global emissions, the emissions according to the EEA are set in relation to global CO2 emissions according to the Global Carbon Project (GCP, 2023). However, GCP reports CO2 emissions from land use change (LUC) instead of LULUCF. The tool thus makes the simplifying assumption that LULUCF = LUC. This simplification can lead to distortions in the results.

When calculating the IWP, it is important to ensure that the CO2 budget used corresponds to the content of the database (EDGAR or EEA).

Formulas for linear emission paths

In the tool, the year of emissions neutrality and the rate of change of emissions 2030 to 2019 are given on the basis of linear emission paths without net negative emissions. The following formulas are used:

$$\text{emissions in year } t \text{ of the country } i = E^i_t = -({E^i_{BY}}^2/(2 * B^i_{cor})) * (t - BY) + E^i_{BY}$$

$$\text{year emissions neutrality} = round\ up\ (BY + 0.5 + 2 * B^i_{cor}/E^i_{BY})$$

where:

$$B^i_{cor} = B^i + 0.5 * E^i_{BY}$$ [3]

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

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