Treatment of the topics
LUC, ISA and net negative CO2 emissions
in RM and ESPM tools

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Contents

Initial situation 2

Net negative CO2 emissions (overshoot) 2

LUC and ISA budgets 2

Orientation values 4

Potential net negative CO2 emissions 4

LUC budget 4

ISA budget 4

IPCC SR1.5 illustrative model paths 5

References 6

Initial situation

Here you will find an overview of our tools in which the following topics can play a role:

► https://www.climate-calculator.info.

Net negative CO2 emissions (overshoot)

In our tools, **net negative CO2 emissions** can usually also be taken into account. The minimum value of emissions by 2100 must be set in the tools (E_{min}).

If net negative CO2 emissions are allowed ($E_{min} < 0$), the budget may be temporarily exceeded. This **overshoot** is then offset by net negative CO2 emissions by 2100.[1]

The following should be noted:

- The **overshoot** can lead to **dangerous tipping points** in the climate system being **exceeded**.
- It should also be taken into account that the economic, technical, and sustainable **potential** of negative emissions is still very **uncertain**.
- According to recent findings, "*the century-scale climate–carbon cycle response to a CO2 removal from the atmosphere is not always equal and opposite to the response to a CO2 emission*" (IPCC, 2021, pp. 5 - 9). This potential **asymmetry** is not taken into account here.
- In order to achieve **climate neutrality**, negative CO2 emissions will be needed to compensate for the emissions of other greenhouse gases that cannot be completely avoided, such as methane and nitrous oxide from agriculture. These negative CO2 emissions are not considered here; they must therefore be generated additionally.

LUC and ISA budgets

The tools for the **R**egensburg **M**odel (Wolfsteiner & Wittmann, 2024d) and some tools within the Extended Smooth Pathway Model (ESPM) use the EU database EDGAR (EDGAR, 2024). This database contains the CO2 emissions of all countries in the world from the use of fossil fuels and the production of cement, with the exception of international shipping and aviation (ISA).

The results of the tools for all countries in the world therefore do not include CO2 emissions due to land-use change (LUC) and ISA.

For LUC emissions in particular, there are major substantive and methodological problems in estimating emissions for individual countries. Moreover, there are good reasons to doubt the sustainability of negative LUC emissions.

For ISA emissions, there are also problems in allocating to countries.

Therefore, separate global budgets for these two CO2 fractions (LUC and ISA) are set in the tools when using the EDGAR data. These budgets are subtracted from the total global CO2 budget to determine the global CO2 budget that is allocated to countries in these tools.[2]

Thus, national LUC emissions (whether net positive or net negative) are offset against the global LUC budget. This means that national negative CO2 emissions considered in the tools only refer to negative emissions in so far as they originate from the non-LUC sector.

[1] To determine E_{min}, most tools require a percentage to be applied to the base year emissions. This also determines the potential for net negative emissions. If a negative percentage is given, the minimum value is negative and thus represents the potential for net negative CO2 emissions.

[2] Thus, a negative LUC budget increases the budget to be distributed among countries.

A global LUC budget could also be divided among countries if, for example, data quality should be better. Then there would be two possibilities:

(1) At country level, two separate CO2 budgets resp. paths are calculated: one for fossil emissions and one for LUC emissions.

(2) Total CO2 emissions including LUC are considered.

Separate budgets could have the advantage that, in the event of continued major data uncertainty and doubts about sustainability for negative LUC emissions, compliance with targets could be well monitored on a relatively secure data basis, at least for fossil emissions.

However, especially with a negative LUC budget, the uncertainty regarding the actual potential and **sustainability** of **negative LUC emissions** must be taken into account. Furthermore, the approach of a generous negative LUC budget at the global level is problematic if no **responsibilities** are defined as to who should realise or finance it.

Orientation values

Potential net negative CO2 emissions

The illustrative 1.5°C model paths of the IPCC (cf. IPCC, 2018) can be used for orientation values (see Table 1).

For tools in which a LUC budget is reserved at the global level, negative emissions that can be taken into account can only come from the non-LUC area. In these tools, the rows labelled 3 in Table 1 are relevant. In tools that show total CO2 emissions, rows 2 are relevant.

Remark:

If the net negative emissions in the IPCC model paths (see Figure 1) also serve to **offset other greenhouse gases**, to be able to achieve climate neutrality, this would mean that the potential to offset an overshoot in CO2 emissions would be correspondingly lower.

LUC budget

The illustrative 1.5°C model paths of the IPCC (cf. IPCC, 2018) could be used as benchmarks for the LUC budget; see Table 1, row marked 1.

ISA budget

According to EDGAR, global ISA emissions in 2019 amounted to 1.3 Gt CO2 (EDGAR, 2024). These represented a 3.2% share of total global CO2 emissions of 40.9 Gt (GCP, 2024).

IPCC SR1.5 illustrative model paths

	IPCC SR15 illustrative model paths for possible guidance in the ESPM or RM (in Gt)						
A	global CO2 emissions 2019	40.2				source: Global Carbon Project	
B	fossil and cement	36.4					
	LUC	3.8					
	IPCC SR15 model paths	P1	P2	P3	P4	average P1 - P4	average P1 / P2
1	∑ 2020 - 2100 LUC	-169	-230	-178	140	-109	-199
2	global CO2 emissions 2100	-3.5	-4.5	-13.0	-21.3	-10.6	-4.0
	share of A	-9%	-11%	-32%	-53%	-26%	-10%
3	2100 excl. LUC	0.8	-0.9	-8.9	-20.1	-7.3	0.0
	share of B	2%	-2%	-24%	-55%	-20%	0%
	possible approaches for						
	a LUC budget 2020 - 2100	1	the potential for net negative emissions				3
							2

Table 1: IPCC SR15 model paths for possible guidance in the ESPM or RM[3]

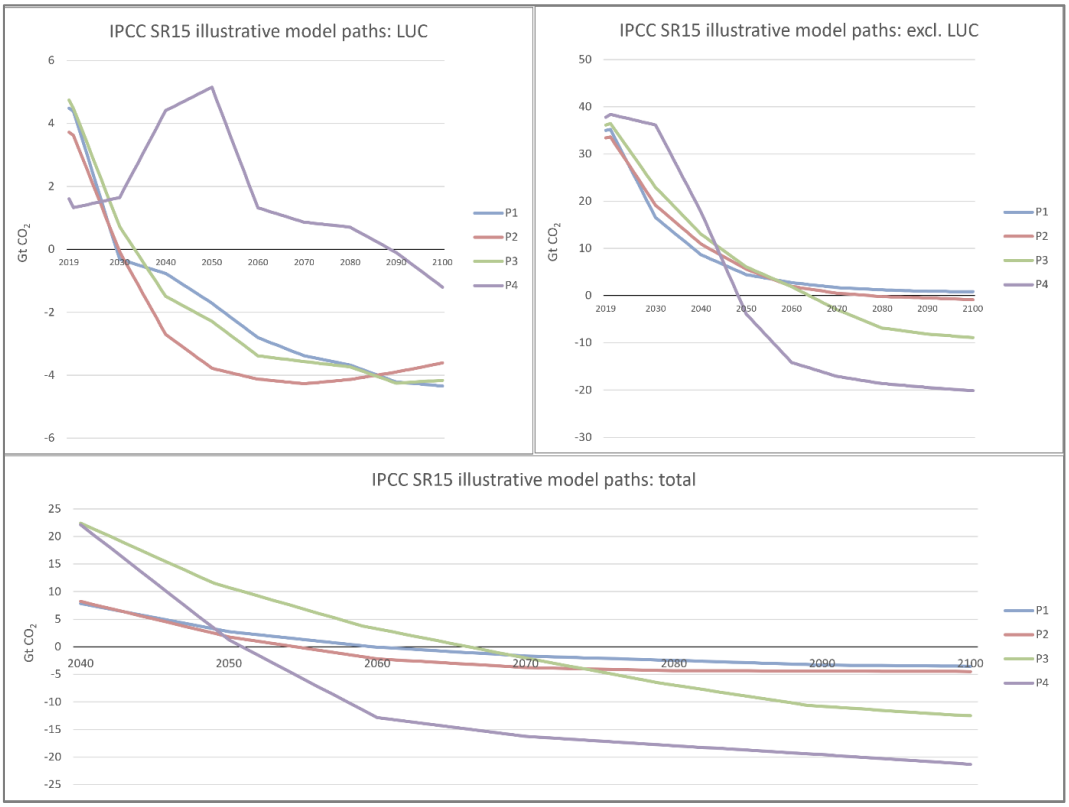

Figure 1: IPCC SR15 illustrative model paths[4]

[3] Sources: (Wolfsteiner & Wittmann, 2024c) and (GCP, 2024).

[4] Source: (Wolfsteiner & Wittmann, 2024c).

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