Treatment of the topics
LUC and net negative emissions in the tools
'Regensburg Model' and 'Extended Smooth Pathway Model'

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Initial situation

The RM and ESPM Excel tools use the EU EDGAR database, which contains CO2 emissions from all countries in the world due to fossil fuel use and cement production except international shipping and aviation (ISA). The results of the tools for all countries in the world therefore do not include emissions due to land use change (LUC) and ISA.[1] 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 problems in allocating to countries.

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

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.

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.[3]

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.

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[1] LUC ≈ LULUCF ≈ (A)FOLU.

[2] A negative LUC budget is thus ultimately added.

[3] Budgets including LUC:

If a budget is to be used for a country that also covers LUC emissions, then the Excel tool 'Paths_RM_ST' (published on zenodo) or the web app http://espm.climate-calculator.info can be used. However, for this tools, the country's budget, and current emissions (including LUC) must be known. The tools can also be used for global paths. Especially for global paths the Excel tool 'global paths' (published on zenodo) can also be used.

In the web app for the EU http://eu.climate-calculator.info, data from the European Environment Agency (EEA) including LUC (LULUCF) and ISA for the EU were used. However, even there the range of uncertainty for LULUCF is relatively large.

When specifying the potential for net negative emissions, the IPCC's illustrative 1.5°C model pathways can be used as a guide here as well (see Table 1). However, with the same limitations regarding actual potential and sustainability of negative emissions.

These tools use the Regensburg Model Scenario Types (published on zenodo) to derive plausible emission paths that adhere to a predefined budget.

Orientation variables

LUC budget

The illustrative 1.5°C model paths of the IPCC could be used as orientation variables for the LUC budget (see Table 1).

However, especially with a negative LUC budget, the uncertainty regarding the actual potential and **sustainability** of **negative LUC emissions** must be taken into account.[4] 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.

Potential net negative emissions from the non-LUC sector

The minimum value of emissions until 2100 must be defined in the tools (E_{min}). For this purpose, a percentage must be specified that is applied to the emissions in the base year. 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 emissions.

Here again, the illustrative 1.5°C model paths of the IPCC can be used for orientation values (see Table 1). It should be noted that negative emissions in these Excel tools can only come from the non-LUC sector. Therefore, only row 3 in Table 1 would be relevant here.

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

However, it should be noted this excess amount (**overshoot**) can also 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** today.

[4] A forest that is newly afforested today can quickly disappear again tomorrow due to climate change, for example.

IPCC SR15 illustrative model paths

	IPCC SR15 illustrative model paths for possible guidance in the ESPM or RM (in Gt)						
A	2019 total	43.0				source: Global Carbon Project	
B	2019 excl. LUC	36.4					
	2019 LUC	6.6					
	IPCC SR15 model paths	P1	P2	P3	P4	average P1 - P4	average P1 / P2
1	∑ 2018 - 2100 LUC	-159	-222	-169	144	-102	-191
	∑ 2018 - 2100 net positive LUC	32	27	39	151	62	29
	∑ 2018 - 2100 net negative LUC	-191	-249	-208	-7	-164	-220
	2100 total	-3.5	-4.5	-13.0	-21.3	-10,6	-4,0
2	share of A	-8%	-10%	-30%	-50%	-25%	-9%
	2100 excl. LUC	0.8	-0.9	-8.9	-20.1	-7.3	0.0
3	share of B	2%	-2%	-24%	-55%	-20%	0%
	Possible approaches for						
	a LUC budget 2018 - 2100	1	potential for net negative emissions				3
	no separate LUC budget						2

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

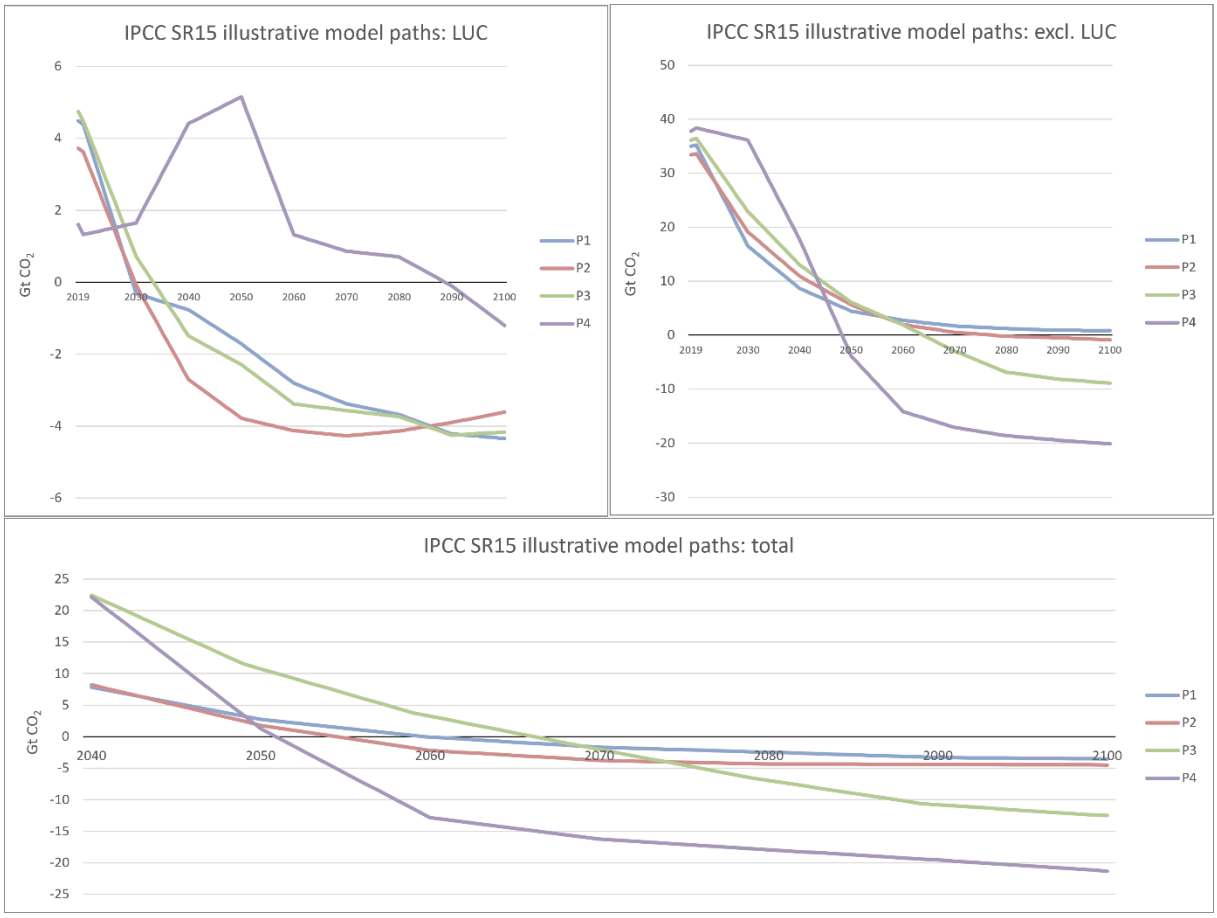

Figure 1: IPCC SR15 illustrative model paths

Source: Tool 'global_paths'; published on zenodo.