Checking the consistency of the ZEAFOLU project’s modeling framework with the global warming target of 1.5°C

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**Budget of cumulative GHG emissions for the 1.5°C target**

<table>
<thead>
<tr>
<th>Type of GHG emissions</th>
<th>Remaining budget as of 2018</th>
<th>Uncertainty range</th>
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</thead>
<tbody>
<tr>
<td>Cumulative net GHG (with Land use)</td>
<td>770 Gt CO₂e</td>
<td>[570 – 1080] Gt CO₂e</td>
</tr>
<tr>
<td>Cumulative net CO₂ (with Land use)</td>
<td>580 Gt CO₂</td>
<td>[420 – 840] Gt CO₂</td>
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**Importance of cumulative GHG emissions:**

Historical observations indicate a linear relationship between the increase of global mean surface temperature from the pre-industrial level (the 1850 – 1900 average) and the cumulative net CO₂ emissions (accounted from 1876 onwards). Thus, future cumulative CO₂ emissions – a.k.a. carbon budget – are considered a good predictor for future warming.

**Derivation of the carbon budget for the 1.5°C warming target:**

- Assumptions: Global mean surface temperature (°C) reacts immediately to CO₂ emissions (no significant time delays in climate response), and (ii) stabilize at the time of zero net emissions (no runaway climate change).
- Carbon budget = cumulative CO₂ emissions corresponding to 1.5°C warming – cumulative CO₂ emissions to date.

**Caveats:**

- The warming potential of non-CO₂ GHG emissions is roughly equivalent to 1/3 of the warming potential of CO₂ emissions. It is estimated that the carbon budget must be reduced by 190 Gt CO₂ (with the uncertainty range of [150 – 240] Gt CO₂) to offset the temperature increase due to non-CO₂ emissions.

**Reference: downscaling the global GHG emissions budget**

**Importance of reference downscaling of global GHG emissions budget to regional GHG emissions budgets:**

A regional budget of GHG emissions obtained by a globally consistent method of downscaling the global GHG emissions budget 770 Gt CO₂e may be used as a reference for assessing compatibility of regional emissions reduction scenarios with the goal of limiting global warming to 1.5°C. If under a given scenario a region violates its reference budget, the global consistency allows to say how other regions should adjust their emissions reduction targets to compensate for this shortfall.

Below we present one possible way of downscaling the global GHG emissions budget for the 1.5°C target to the level of EU and Austria. It is based on setting up reference emissions reduction paths.

**Step 1. Reference paths for global GHG emissions reduction:**

Under these assumptions all emissions must be reduced to zero by 2046.

**Step 2. Reference emissions reduction path for the EU:**

Assumptions (following 1.5TECH / 1.5LIFE scenarios discussed on the panel on the right):

- Net GHG emissions are reduced linearly to zero so that the area under the path equals 770 Gt CO₂e.
- FFI CO₂ emissions are reduced linearly to zero.
- Land use, land-use change and forestry (LULUCF) CO₂ emissions are reduced to zero.
- No deployment of carbon dioxide removal (CDR) technologies.

**Step 3. Reference path for Austria’s GHG emissions reductions:**

Assumptions (in proportion to 2050 emissions in 1.5TECH / 1.5LIFE scenarios):

- Net GHG emissions are reduced linearly to zero by 2046, resulting in the net GHG emissions budget of 57 Gt CO₂e.
- FFI CO₂ emissions are reduced linearly to zero by 2046, resulting in the net GHG emissions budget of 1080 Mt CO₂e.
- Negative LULUCF CO₂ emissions compensate for 9 Mt CO₂e of residual GHG emissions in 2046 and beyond.

**Consistency check of EU’s 1.5°C scenarios**

The 1.5TECH and 1.5LIFE scenarios:

The ZEAFOLU project builds on the 1.5TECH and 1.5LIFE scenarios of reductions of EU’s GHG emissions through transformation of European economy and energy systems. They are presented in the report of European Commission „A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy".

The key features of these scenarios are:

- GHG-neutrality in 2050
- High energy efficiency post 2030
- Circular economy
- Significant improvements in the efficiency of transport sector
- Lifestyle and dietary changes
- Negative CO₂ emissions realized by enhanced LULUCF sink with weak to medium reliance on other CDR technologies like bioenergy with carbon capture and storage (BECCS) or direct air CO₂ capture and storage (DACCS)
- Low reliance on carbon credits to offset EU’s territorial emissions and on trading of GHG emissions permits with countries outside EU.

**Assessment of consistency of 1.5TECH/LIFE scenarios with global GHG emissions budgets:**

The 1.5TECH/LIFE scenarios achieve GHG-neutrality in 2050, which, according to the IPCC’s Special Report on Global Warming of 1.5°C, is in line with the goal of stabilizing the global mean surface temperature increase at 1.5°C above pre-industrial levels. Yet, it is the cumulative emissions rather than emissions in 2050 which is the critical factor in achieving the 1.5°C warming target. Unfortunately, „A Clean Planet for All” report does not relate the cumulative GHG emissions for 1.5TECH/LIFE scenarios to the global budget of GHG emissions for the 1.5°C warming target (discussed on the left panel). We use the reference downscaling method presented on the middle panel to assess consistency of cumulative GHG emissions for these scenarios with the global GHG emissions budget for 1.5°C target.

**Cumulative emissions**

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<tbody>
<tr>
<td>Reference</td>
<td>57</td>
<td>17</td>
<td>53</td>
<td>11</td>
<td>-13</td>
</tr>
<tr>
<td>Difference</td>
<td>3</td>
<td>-5</td>
<td>8</td>
<td>6</td>
<td>2</td>
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For the 1.5TECH/LIFE scenarios, non-CO₂ emissions are 4 Gt CO₂e lower compared to EU’s reference path while net CO₂ emissions are 8 Gt CO₂e higher. The discrepancy of 3 Gt CO₂e is partly explained by the different shapes of emission paths and is well within the uncertainty range. We conclude that the cumulative GHG emissions for 1.5TECH/LIFE scenarios are consistent with the global budget of GHG emissions for the 1.5°C warming target.