Achievability of the Paris agreements' targets in the EU – Implications From A Combined Bottom-Up Modelling And Budget Approach

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Overview

Net-decarbonization in the second half of this century is an integral part of the Paris Agreement to limit global warming to "well below 2°C above pre-industrial levels" and "pursue efforts to limit the temperature increase even further to 1.5°C". From a climate science perspective, emission budgets define the amount of emissions that are still available to meet a given temperature goal. In case of a 2°C target, the estimated global carbon budget is between 940 Gt and 390Gt (medium estimate 760 Gt), in case of a 1.5°C target, it is between 167 Gt and -48Gt (medium estimate 59 Gt) starting in 2017 (see MCC, 2017). In contrast, debates in the policy arena often focus on reduction targets for specific years, with a prominent example given by the target range expressed by the European Union of reducing emissions by 80 to 95% by 2050 (as discussed in EU COM 2011a) or the 2020 and 2030 targets of 20% and 30% GHG emission reductions below 1990 levels in the EU.

Due to the complexity of the models and topics, climate models lack a sufficient level of detail to answer the question what kind of transformation is necessary for the energy system as well as the non-energy sectors to stay within those budgets. Integrated assessment models are designed to include a certain level of detail of the energy and non-energy system while still being able to model the impacts - although in a much less complex way - of emissions on the climate. In contrast, techno-economic bottom-up models or macroeconomic models which are usually applied to analyse transformation pathways lack the information content to make predictions about the transformations' impacts on the extent of climate change.

In this paper, we combine analyses from techno-economic bottom-up models with emission budgets provided by climate and integrated assessment models and compare them with a focus on Europe. Our first aim is to identify consistencies and inconsistencies between the bottom-up analysis and the integrated assessment models. In a second step, based on this analysis and a more in-depth analysis of the sector abatement pathways, we identify sectors which could contribute to increasing the consistency between the bottom-up pathways and the budget approach, e.g. by providing for steeper mitigation pathways. In a final step, we discuss the role of negative emissions as can be provided by technologies such as bioenergy-based carbon capture and storage (BECCS) and which play a major role in integrated assessment models, but not – yet – in most of the bottom-up scenarios. This paper builds upon results from a companion paper by Wachsmuth and Duscha (2017).

Methods

The analysis builds upon in-depth analyses of bottom-up decarbonisation scenarios on the one hand and combines those with a budget approach based on complex climate science models on the other hand.

For the budget approach we build upon calculations by Gignac and Matthews (2015). Their budget approach is based on the most recent IPCC global carbon budgets (Collins et al. 2013) and applies Meyer's contraction and convergance framework for allocation of emission allowances (Meyer 2000). Gignac and Matthwes base their emissions on a global carbon budget of 1000 Gt from 2013 onwards which is compatible with the upper case for the 2°C target. We calculate further burden sharings based on their approach in order to be able to analyse scenarios compatible with a 1.5°C target.

For the analysis of bottom-up decarbonisation scenarios, we choose from a variety of studies available for Europe as a whole or for individual countries or regions within Europe. Major factor for including or excluding a study is a level of ambition compatible with the 2°C goal as well as the coverage of sectors and gases – the studies need to cover at least all emissions from the energy system, i.e. electricity, heat, industry and transport. Among others, the following studies are deemed to be sufficient for being included:

- EU COM (2011a+b): A Roadmap for moving to a competitive low-carbon economy in 2050;
- international mitigation scenarios from the databases of the projects AME, AMPERE and LIMITS (see the AR5 scenario database for links to the databases);
- national mitigation scenarios with a GHG reduction of 80 – 100 % for France, Germany, Italy and the UK (BMUB 2015, CAT 2013, negaWatt 2014, SDSN/IDDRI 2015).

For all studies, sector-specific results are being collected and analysed. Where studies do not focus on the EU as a whole, but rather on individual regions and countries, we apply the country's figures to construct rough estimates for reduction pathways for the EU as a whole. To be compatible with Gignac and Matthews, we look at CO_2 emissions only.

Results

Based on a first analysis, we find that the carbon budget for the EU as a whole is between 66 and 72Gt in case of a 2°C target (medium case) and between 5 and 6 Gt (15-16 Gt for the upper estimate) in case of a 1.5°C target. When assuming – in a first approximation – linear reduction pathways, carbon budgets required under the above bottom-up scenarios are between 26Gt (for a linear reduction to net-zero emissions in 2030 as in Zero Carbon Britain) and 88Gt (for the EU's low-carbon roadmap, lower reduction target). Accordingly, for meeting the 1.5°C target, the available budget - even for the most ambitious scenario found – covers no more than 50% of the emissions calculated to being emitted under the scenario. For the 2°C target, the available budget may prove to be sufficient in the medium case, if scenarios focus on reaching a reduction of 95% below 1990 levels by 2050 rather than only 80% below 1990 levels in the same year.

The spans of negative emissions from CCS in the EU and the share of BECCS are relatively similar in international IAM and bottom-up scenarios. While the bottom-up scenarios ramp up CCS before 2050, the IAM scenario only do so in the second half of the century, which results in a much higher level of negative emissions in 2100. The national scenarios with a time horizon avoid or make only very restricted use of CCS because of sustainability reasons. Analyses for sector reduction pathways will be be provided in the presentation and a working paper.

Conclusions

A first rough comparison between carbon budgets calculated based on integrated assessment and climate science models on the one hand and bottom-up mitigation scenarios on the other hand shows that most ambitious scenarios discussed today are likely not ambitious enough to meet the 1.5°C target, but may be sufficiently ambitious to meet the 2°C target. In particular, this is also the case for some of the evaluated national scenarios in spite of the fact that they avoid or make only very restricted use of negative emissions. That is, however, only possible, when a close-to-linear or even steeper reduction path is reached. Long delays in beginning to reduce emissions will reduce the likelihood of meeting the 2°C target even if a 95% reduction target is met by 2050. Based on sector reduction pathways, we will further develop and analyse non-linear reduction pathways and analyse their effects on the EU's carbon budget.

Our analysis implies that future studies should - in addition to providing detailed information on target points - also take into account transformation pathways and reduction speed to allow for informed decision making by policy makers. In contrast, policy making that focuses a lot on reaching specific targets in specific years may result in lock-ins that make future emission reductions extremely expensive and may hence decrease the chances of reaching the Paris Agreement goals.

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