Achievability Of the Paris agreements' targets in the EU – Comparison Of Energy And Emission Intensities In International and National Mitigation Scenarios

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Overview

The Paris agreement includes pursueing "efforts to limit the global temperature rise to 1.5°C" for the first time. A key prerequisite for the identification of mitigation strategies and policies in accordance with a 1.5°C and 2°C target are answers to the following questions:

- What do reduction pathways look like that are found to be compatible with the 1.5°C and the 2°C target?
- How do they differ and what are the implications for the speed and the extent of transformation processes?

The EU's previous climate change target of reducing emissions of greenhouse gases (GHG) by 80 – 95 % compared to 1990 is based on the findings of the Intergovernmental Panel on Climate Change on 2 °C compatible emission pathways. For compatibility with the 1.5° C target, it can only be said that emission reductions by the year 2050 at the lower end of the range of 80 – 95% are very likely to be insufficient. In the international context, the questions above are usually addressed by Integrated Assessment Models (IAMs), which are based on top-down assumptions on the emission dynamics of already aggregated sectors. At the level of individual economies, it is imperative to complement these findings with an analysis of bottom-up models for the purpose of plausibility and measure identification, as these allow for much more detailed statements about the technologies used and structural changes. Our aim is to compare the reduction of the energy and emission intensities within the EU in decarbonisation scenarios, both based on integrated-assessment models and on bottom-up models. There are already ambitious bottom-up scenario studies for the EU and the four member states with highest emissions (France, Germany, Italy, UK). We evaluate these to determine sector-specific decarbonisation rates on the basis of bottom-up scenarios and compare them to the rates in the historic developments and in scenarios based on IAMs. From this, we derive conclusions on the achievability of a 1.5°C-compatible mitigation strategy for the EU.

Methods

Tom compare the energy-related GHG emissions, we separate the impacts of demographic and economic development from the reductions of emission and energy intensities. To evaluate the relative contributions to absolute reductions, we apply an index-decomposition (cf. Capros et al. 2014) based on Kaya identities for each sector (industry, buildings, transport, energy supply).

The evaluated scenarios are required to be at least compatible with the 2°C-target and to provide specific data for the EU as well as on the sectoral level. Hence, the evaluated data is chosen from the following sources:

- 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 the international mitigation scenarios, we only select scenarios that have a likelihood of more than 2/3 to keep temperature rise below 2 °C (no overshoot of 2°C-target). Within this set, we pay special attention to the scenarios that also have a likelihood of 1/2 to keep temperature rise below 1.5 °C.

Results

The development of emission and energy intensities of the EU in the international mitigation scenarios span a wide range, with the development depending on the scenario assumptions and less on the type of model (IAM vs. Bottom-up). For the national mitigation scenarios, the emission and energy intensities start out at differing values depending on the individual economies' conditions. E.g. emission intensities are lower in France because of the high nuclear share. With regard to the emission intensities, there remain differences that reflect the different levels of ambition of the national mitigation scenarios. On the contrary, the energy intensities move to rather similar levels in all evaluated national mitigation scenarios in the long-run.

When we compare the developments in international and national mitigation scenarios until 2050, the results also differ between energy and emission intensities. On the supply side, we find that the broad spectrum of emission intensities per final energy use strongly overlap for national and international mitigation scearions in 2050. Still, the

the spectrum in the national mitigation scenarios is mainly at the lower end of the spectrum for the EU. On the demand side, we find that energy intensities in the majority of national mitigation scenarios are lower than the lower limit in the international mitigation scenarios. This effect is particularly strong for the buildings sector, where the energy intensity in all evaluated national mitigation scenarios reaches a level below the EU's minimal level in international mitigation scenarios. An aggregated overview of the results is given in the following table.

Energy + emission intensities in 2°C compatible scenarios in 2050	**Unit**	**IAM scenarios EU**	**Bottom-up scenarios EU**	**German scenario**	**French scenario**	**Italian scenario**	**UK scenario**
Energy-related CO_2 emissions p.c.	tCO_2 p.c.	0.6 – 4.2	0.3 – 2.9	0.4	0.3	1.3	0.1
CO_2 emissions per final energy	tCO_2 / TJ	6.8 – 39.5	3.4 – 32.2	7.0	8.9	28.7	2.6
Final energy demand per capita	GJ p.c.	67 – 106	54 – 99	57.3	37.9	46.2	40.3

More sectoral details of the results and the attribution of absolute emission reductions to the different factors via an index compensation will be provided in the presentation and a working paper. The implications of different intensity levels will also be evaluated with regard to its impact on the EU's emission budget. The latter is investigated in the context of the Paris agreement in a companion paper (see the abstract by Duscha et. al).

Conclusions

While global warming can be limited to below 2 °C until 2100 with a likelihood of 2/3 in many IAM scenarios, there are only very few scenarios that achieve a 1.5 °C limit with a probability of 1/2. These include, in particular, so-called "overshoot" scenarios in which the 1.5 ° C target is achieved by strongly negative emissions in the second half of the century (see Rogelj et al., 2015). In these scenarios, there is the risk that corresponding technologies may not be able to provide negative emissions to the extent required (Kartha & Dooley 2016). In this context, it is important to note that national mitigation scenarios based on bottom-up modeling exercises provide evidence that more ambitious reductions of energy intensities may be possible. This suggests that the high amounts of negative emissions in the international mitigation scenarios can at least be significantly reduced by highly ambitious demand-side mitigation strategies. In the literature (see e.g. Peters et al. 2017), it is often argued that the reduction of emission intensities play a more important role than the reduction of energy intensities in highly ambitious decarbonisation scenarios. Our results suggest that scenarios based on integrated assessement models may at least partly underestimate the contributions of reductions of energy intensities. Moreover, the standard approaches in index decomposition may be misleading when applied to scenarios with emissions close to net zero or even below. For they do not reflect that emission intensities are likely to be much higher in case of higher energy intensities, too.

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