A possible 2050 climate target for the EU

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Summary

- **The EU's 2050 greenhouse gas reduction target of 80% to 95% from 1990 levels adopted 10 years ago is outdated as its basis has changed substantially.** The global goal agreed in Paris in 2015 is more ambitious and global pathways to that goal are now steeper not only because of the more ambitious goal but also because global emissions have increased since then.
    - An 80% reduction of greenhouse gas emissions by 2050 compared to 1990 levels for the EU is not compatible with the long-term temperature limit of the Paris Agreement.
    - Also, the 95% reduction by 2050 is not in line with this limit for many interpretations of the long-term temperature limit of the Paris Agreement.
    - GHG neutrality by 2050 would by many interpretations also not be ambitious enough to be a fair contribution of the EU to the Paris Agreement.
- **The EU has essentially already spent its fair share of greenhouse gas emissions** and would need to reduce greenhouse gas emissions to zero almost immediately (by 2030 - 2040) to leave room for other countries with less historical responsibility and capability to emit the very limited remaining budget, which obviously would be technically challenging (Figure 1). This result is based on a comprehensive review of studies that allocate emissions to countries based on equity principles.
- **We therefore make two recommendations for the EU:**
    - **Set a domestic greenhouse gas emission reduction target** including international transport but excluding international offsets. It should "reflect its highest possible ambition" and be on the most ambitious end of the technically possible range to accommodate part of EU's responsibility and capability. It could be formulated as "reaching net-zero domestic greenhouse gas emissions well before 2050".
    - **Undertake a package of actions** that is fully in line with the higher responsibility and capability of the EU compared to other countries. It would comprise
        - Domestic emission reductions
        - Financial support to other countries
        - Innovation and greenhouse gas removal from the atmosphere and
        - Only very limited offsetting

      This package would need to lead to effective net-zero emissions for the EU by 2030 to 2040 and net-negative emissions of roughly 2.5 $GtCO_2e$ in 2050 to be fully in line with the responsibility and capability of the EU (Figure 1).

- **Strengthening the 2030 target is equally important.** The EU's target of at least 40% reduction by 2030 compared to 1990 is not in line with the long-term temperature limit of the Paris Agreement. Global net-CO_2 emissions would be 45% below 2010 levels in 2030 to be in line with the 1.5°C limit. Applying this global trend for CO_2 (and the related trend for other greenhouse gas emissions) would mean a 54% reduction of all greenhouse gases below 1990 in 2030 for the EU but would not yet take into account the higher responsibility and capability of the EU compared with other countries. Research suggests the potential of going even further.

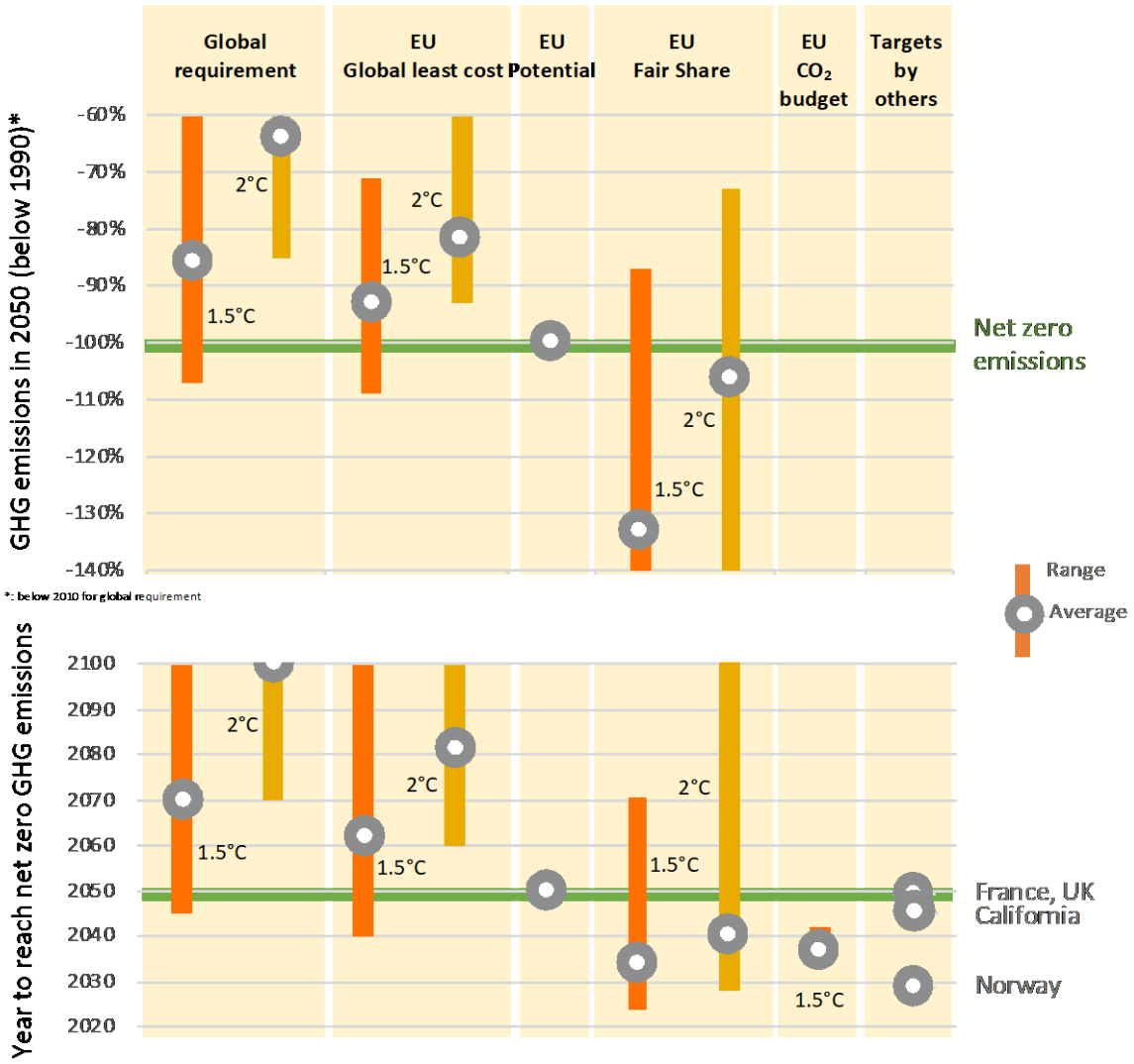

Figure 1. GHG emission levels in 2050 and net zero emission years

1 Why is a target of 80% to 95% reduction by 2050 outdated?

The EU's current 2050 climate change mitigation targets were set 10 years ago.

The EU adopted in 2009 the range of -80% to -95% by 2050 together with the need to cut global emissions in half by 2050 to be in line with the agreed 2°C limit. "The European Council calls upon all Parties to embrace the 2°C objective and to agree to global emission reductions of at least 50%, and aggregate developed country emission reductions of at least 80-95%, as part of such global emission reductions, by 2050 compared to 1990 levels" (European Council, 2009).

Already earlier, the EU committed to keep global temperature increase to 2°C with two decisions: In 1996 the Environment Council took a first decision (Environment Council, 1996) which was confirmed in 2005 by the heads of state (European Council, 2005).

The IPCC Fourth Assessment Report (IPCC, 2007) provided a translation of temperature goals to global emissions: for a limitation to 2°C, global GHG emissions need to be roughly cut in half by 2050. For developed countries ("Annex I countries"), the Working Group III report (Gupta *et al.*, 2007) provided ranges based on equitable sharing of effort, indicating that developed countries need to reduce faster

than other countries due to their higher responsibility for historical emissions and higher economic capability:

- -25% to -40% below 1990 levels by 2020
- -80% to -95% below 1990 levels by 2050

In 2010, 2°C was adopted as global limit in the Cancun Agreements (UNFCCC, 2010). Already at that point in time, it was tied to a review of the temperature limit taking also 1.5 °C into consideration ("also recognizes the need to consider, in the context of the first review, […] strengthening the long-term global goal on the basis of the best available scientific knowledge, including in relation to a global average temperature rise of 1.5°C").

Today's situation is significantly different compared to when the targets were set.

The basis under which the EU had set its 2050 target, i.e. halving global emissions by 2050 to be in line with 2°C, is outdated and no longer sufficiently ambitious.

First, the Paris Agreement states "well below 2°C" and "pursue efforts" to limit temperature increase to 1.5°C; this is more ambitious than the previously agreed "2°C" limit. Second, much of the remaining global budget has been depleted in the last 12 years; global CO_2 emissions are today 40% higher than at that time.

As a result, global emission reduction paths to keep warming below 1.5 °C are significantly steeper than they were at the time of the IPCC Fourth Assessment Report with the 2 °C warming limit 12 years ago. Global CO_2 emissions need to be net-zero by 2050 to be in line with 1.5°C (IPCC, 2018), Figure 2.

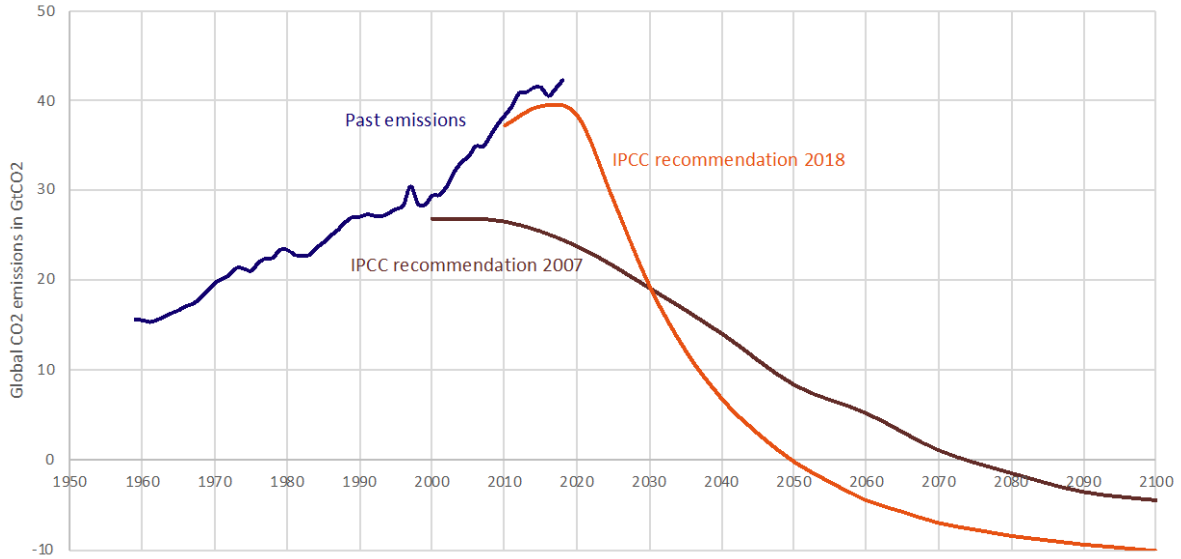

Figure 2. Pathways of global CO2 emissions recommended by IPCC in the Fourth Assessment Report of 2007 (445 to 490 ppmCO2e leading to 2°C –2.4°C) (IPCC, 2007) and by the IPCC special report on 1.5°C in 2018 for low and no overshoot scenarios leading to 1.5°C (IPCC, 2018) (only the averages of the ranges are shown)

Several countries have already set climate neutrality targets.

Given this scientific evidence, more and more countries are starting to define net-zero greenhouse gas emission targets or are considering them (Table 1). These targets vary in legal status, coverage of all greenhouse gases or only CO_2, the potential use of offsets and the inclusion of international transport.

Table 1. Overview of national neutrality targets (based on the UK Committee on Climate Change (2019) and own research)

Country	Legal status	Year	Coverage
Norway	Legally binding	2030	GHGs
Sweden	Legally binding	2045	Unclear
UK	Legally binding	2050	GHGs
France	Legally binding	2050	GHGs
Denmark	Legally binding under consideration	2050	GHGs
Germany	Legally binding under consideration	2050 (tbc)	(tbc)
EU28	Legally binding under consideration	2050 (tbc)	GHGs
New Zealand	Legally binding under consideration	2050 (tbc)	(tbc)
Chile	Legally binding under consideration	2050 (tbc)	CO_2
Ireland	Legally binding under consideration	2050	GHGs
Finland	Coalition agreement	2035	GHGs
Ethiopia	Announcement	"In the long term"	
Costa Rica	Announcement	2050	
Bhutan	Contribution to Paris Agreement	Achieved today	GHGs
Fiji	Contribution to Paris Agreement	2050	CO_2
Iceland	Announcement	2040	
Marshall Islands	Contribution to Paris Agreement	2050	GHGs
Uruguay	Contribution to Paris Agreement	2030	
Portugal	Announcement	2050	GHGs

19 countries have pledged carbon neutrality by 2050 as part of the Carbon neutrality coalition.[1]

In a world where all countries need to go to zero emissions and are pushed to the limits, only very few will have offsets to sell. This is why international offsetting cannot be an option in 2050 (Warnecke *et al.*, 2018) and may only be used a shorter period of time under certain conditions.

International transport is usually counted outside of the national responsibilities. However, the international community is slow in regulating these emissions. For the EU to be a leader, it should include international aviation and shipping within the scope of the 2050 target.

2 What would be a fair contribution of the EU to the Paris Agreement long-term temperature limit?

The Paris Agreement long-term temperature limit has several interpretations.

The Paris Agreement long-term temperature limit is: "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" Article 2.1(a) (UNFCCC, 2015).

[1] https://www.carbon-neutrality.global

The Paris Agreement long-term temperature goal is more ambitious than the 2009 Cancun Agreement 2°C limit.

Some scientific literature argues that the Paris Agreement states one single limit, i.e. the combination of well below 2°C and limit to 1.5°C, not two separate limits (either well below 2°C or 1.5°C). E.g. Schleussner et al. (2016) argue that "This identifies 1.5 °C as the limit within the LTTG [long term temperature goal]. The expression 'holding ... well below 2°C' is a strengthening of previous language and signals an increase in both the margin and likelihood by which warming is to be kept below 2°C compared to holding below 2°C [, the formulation of the Cancun Agreements]". The same argument is used by the authors also elsewhere (Wachsmuth, Schaeffer and Hare, 2018).

The German Federal Environment Agency (UBA) "strongly advises climate policy at all levels to recalibrate climate mitigation efforts towards limiting warming to 1.5°C, including the European Union (EU)." (German Federal Environment Agency, 2018).

The interpretation of a single temperature limit of the Paris Agreement leaning towards 1.5°C is not shared by all. Some interpret the "well below 2°C" analogous to the IPCC's 'likely chance' terminology, to mean a 66% probability of keeping temperature rise below 2°C.[2] This however was already the common interpretation of the "2°C" limit of the Cancun Agreements of 2010.

The European Commission in its strategic long-term vision (EC, 2018) aims for net zero emissions by 2050 as 1.5°C compatible but re-labels the -80% scenario as "well below 2°C". This is not correct for two reasons:

- The 80% is only the upper limit of the IPCC recommendation based on 2°C scenarios (see section 1).
- The level of global emissions in 2050 would now need to be much lower, due to the increased emissions in the last 12 years (see section 1).

On the basis of the above, we focus in this document on 1.5°C scenarios. 2°C scenarios are shown as well but are not considered Paris-compatible.

Target levels derived from technical options may be different to targets based on effort sharing.

Most integrated assessment models calculate global mitigation scenarios based exclusively on global cost efficiency taking into account possible changes in socioeconomic systems, replicated in the actually occurring emissions in the country. These usually assign emission reductions to sectors and countries where they are the cheapest. They do not take into account the relative differences in responsibility and capability of countries. These calculations will be further considered in section 3.

Alternatively, many studies assign values for GHG emission targets of countries based on equity considerations including responsibility and capability often called "effort sharing approaches". These calculations may lead to outcomes for developed countries that are more ambitious and not within the ranges of technical mitigation scenarios. E.g. some effort sharing approaches assume that the EU has already used most of its CO_2 budget and therefore should reduce emissions to zero immediately or compensate the overrun with negative emissions. These calculations will be considered further below in this section.

[2] http://energiogklima.no/articles-in-english/what-does-well-below-2c-mean/

Global emissions need to reach net-zero by 2070 (all gases) and by 2050 (CO_2 only) to be in line with 1.5°C.

The IPCC special report on 1.5°C (IPCC, 2018) provides a collection of up-to-date scenarios that are in line with keeping global temperature increase below 1.5°C and 2°C. In the model runs, emission reductions are shared across sectors and countries so that total global costs are minimised. We collected these scenarios from the IPCC 1.5 scenario database (IIASA, 2018) (Table 2 and Table 3 in the annex).

To keep global temperature increase below 1.5°C, the total global greenhouse gas emissions of all sectors and gases need to be roughly 90% below 2010 levels in 2050 (range from - 59% to -107%) and need to reach net zero by 2070 (range of 2045 to after 2100). CO_2 Emissions need to be reduced faster than all other emissions and need to reach net zero already by 2050 (Figure 1).

The fair contribution of the EU to 1.5°C would be essentially reduce emissions to zero immediately (2030 to 2040).

A range of studies allocate emission targets to countries based on effort sharing approaches. These approaches use equity principles such as historical responsibility, economic capability and equality to determine the "fair" contribution of a country. We collected such calculations from available studies, including the overview that we presented in the IPCC Fifth Assessment Report (Clarke *et al.*, 2014; Höhne, den Elzen and Escalante, 2014) and newer studies (Table 4 and Table 5 in the annex). A basic assumption of these results is usually that the country is free to achieve these reductions domestically or through international financing or offsets. These effort sharing results are independent from considerations of technical feasibility.

According to this wide range of available studies the fair contribution of the EU to the 1.5°C limit would be to reach net zero greenhouse gas emissions around 2030 to 2040 (full range 2024 to 2060) and to remove greenhouse gases from the atmosphere (net negative emissions) by 2050 of roughly -2.5 $GtCO_2e$ or -150% compared to 1990 levels (full range -62% to -244%) (Figure 1). The least ambitious end of the range would mean that the EU choses an approach that would be generous to the EU but tight to all other countries. If all countries would choose the one approach that is favourable to them, the total aggregate global emissions would exceed the limit. This is why the generous end of the range is NOT considered to be a fair contribution.

Several studies explicitly allocate the remaining 1.5 °C-consistent carbon budget (CO_2 only, not all greenhouse gases) to countries (Meyer-Ohlendorf *et al.*, 2018; Höhne *et al.*, 2019) (Table 6 in the annex). In such approaches, net zero emissions are reached earlier, because they allocate the remaining budget until it is depleted and do not take into account that negative emissions at a later date could compensate a potential budget overrun. According to these studies, the EU would have to reach zero CO_2 emissions between 2036 and 2042 to be in line with the 1.5°C temperature limit (Figure 1).

The results essentially show that the EU has already spent its fair share of greenhouse gas emissions and would need to reduce emitting greenhouse gas emissions to zero almost immediately (by 2030-2040) to leave room for other countries with less historical responsibility and capability to emit the very limited remaining global budget.

So, if the EU's fair contribution would be to essentially reduce its emissions to zero "from one day to the next", which obviously would be technically challenging, *how fast* could it then reduce its emissions in a way that is still technically feasible, i.e. what is the "highest possible ambition"? This will be considered in the next section.

3 What could be fastest, technically feasible pathways for the EU towards net zero emissions?

Two types of studies provide information on how fast the EU could reduce its emissions in a way that is still technically feasible to determine its "highest possible ambition".

First, models break down the global requirement of 1.5°C to regions. For example, the IPCC special report on 1.5°C includes results for the EU as a region (Table 7 and Table 8). They represent the path that the EU would have to take, if reductions are distributed to sectors and countries so that global costs are minimised. Some models show the EU only as part of a larger region.

According to these scenarios, the EU would need to reduce its greenhouse gas emissions drastically by 2030 and then slowly phase them out to roughly 90% below 2010 level in 2050; CO_2 emissions would have to be net-zero by then (Figure 1). All other emissions would then slowly be reduced to reach net-zero greenhouse gas emissions by around 2070 (full range 2040 to 2100) (Table 7).

Second, another set of studies backcasts and asks the question: *what would be needed to reach net zero greenhouse gas emissions in 2050?* The question here is *how* to achieve, not *can it* be achieved (Table 9 in the annex). These studies find that the transition towards net-zero emissions in 2050 is possible, if this transition is initiated immediately (Figure 1). One study even finds that the total energy system costs for a net-zero emissions scenario are lower than for the reference scenario, as initial investments pay back over time (Pestiaux *et al.*, 2018).

We would therefore conclude that the EU could technically feasibly reduce its domestic emissions to net zero emissions by the latest in 2050. This would not involve the use of offsets and would include international transportation.

4 What are the implications for 2030?

The target of at "least 40%" reduction by 2030 compared to 1990 is also not in line with the long-term temperature limit of the Paris Agreement. It is outdated as it originated from the information basis of 10 years ago. In the previous chapters, we showed the EU's fair share would be to reduce its emissions to zero almost immediately (2030 to 2040) and reducing them to net zero by 2050 is only possible if that transition is initiated immediately. This would require updating and enhancing the 2030 target as well.

Global net CO_2 emissions would be 45% below 2010 levels in 2030 to be in line with the 1.5°C limit (IPCC, 2018).[3] Applying this global trend for CO_2 (and the related trend for other greenhouse gas emissions) would mean a 54% reduction of all greenhouse gases below 1990 in 2030 for the EU but would not yet take into account the higher responsibility and capability of the EU compared with other countries. Research suggests the potential of going even further in the order of 60% (Cornet *et al.*, 2018). The position of the German Federal Environment Agency is "60% or more".

[3] Summary for policymakers of the IPCC 1.5°C report, paragraph C.1: "In model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO2 emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range)"

5 Conclusions and recommendations

We find that the current greenhouse gas emissions reduction targets of the EU are outdated and not compatible with the Paris Agreement long-term temperature limit.

Essentially, the EU has already spent its fair share of greenhouse gas emissions and would need to reduce greenhouse gas emissions to zero almost immediately (by 2030 - 2040) to leave room for other countries with less historical responsibility and capability to emit the very limited remaining budget, which obviously would be technically challenging (Figure 1).

We make two recommendations for the EU:

- **Set a domestic greenhouse gas emission reduction target** including international transport but excluding international offsets. It should "reflect its highest possible ambition" and be on the most ambitious end of the technically possible range to accommodate part of EU's responsibility and capability. It could be formulated as "reaching net-zero domestic greenhouse gas emissions well before 2050".
- **Undertake a package of actions** that is fully in line with the higher responsibility and capability of the EU compared to other countries. It would comprise
    - Domestic emission reductions
    - Financial support to other countries
    - Innovation and greenhouse gas removal from the atmosphere and
    - Only very limited offsetting

  This package would need to lead to effective net-zero emissions for the EU by 2030 to 2040 and net-negative emissions of roughly 2.5 $GtCO_2e$ in 2050 to be fully in line with the responsibility and capability of the EU (Figure 1).

As a consequence, the EU would have to update the 2030 target to be in line with the above. The EU's target of at least 40% reduction by 2030 compared to 1990 is not in line with the long-term temperature limit of the Paris Agreement. Global net-CO_2 emissions would be 45% below 2010 levels in 2030 to be in line with the 1.5°C limit. Applying this global trend for CO2 (and the related trend for other greenhouse gas emissions) would mean a 54% reduction of all greenhouse gases below 1990 in 2030 for the EU but would not yet take into account the higher responsibility and capability of the EU compared with other countries. Research suggests the potential of going even further.

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6 Annex

Table 2. Global requirements according to 1.5°C scenarios (all greenhouse gases, all sectors)

Publication name	Short description	Emission level in 2050 and % reduction below 2010	Zero year
IPCC 1.5 (IPCC, 2018)	Low and no overshoot (P1-3)	Global emissions of **6.7 $GtCO_2e$** (-3.5 $GtCO_2e$ to 24.2 $GtCO_2e$) in 2050 **-86%** (- 59% to -107%) compared to 2010 levels	by **2070** (2045 to after 2100)
	All (P1-4)	Global emissions of **7.3 $GtCO_2e$** (-3.5 $GtCO_2e$ to 24.2 $GtCO_2e$) in 2050 **-85%** (-59 to -107%) compared to 2010 levels (median: 85%)	by **2070** (2045 to after 2100)

Table 3. Global requirements according to 2°C scenarios (not Paris-compatible) (all greenhouse gases, all sectors)

Publication name	Short description	Emission level in 2050 and % reduction below 2010	Zero year
IPCC 1.5 (IPCC, 2018)	Lower 2°C scenarios (>66% likelihood of limiting warming to 2°C)	Global emissions of **18.2 $GtCO_2e$** (7.5 $GtCO_2e$ to 38.3 $GtCO_2e$) in 2050 **- 64%** (-25 to -85%) compared to 2010 levels	**After 2100** (by 2070 to after 2100)

Table 4. Target levels for the EU based effort sharing 1.5°C scenarios (all GHG, excluding LULUCF)

Publication name	Short description	Emission level in 2050 compared to 1990	Zero year
Climate Action Tracker (Climate Action Tracker, 2018a)	Synthesis of wide range of effort sharing studies starting from and complementing IPCC AR5 (December 2018 update)	**-166%** (-88% to -244%)	2034
IPCC AR5 (Clarke *et al.*, 2014)	Synthesis of effort sharing studies (figure 6.29) for region WEU	**-93%** (-87% to -99%)	~2060
Fraunhofer ISI et al., (forthcoming)	Based on Climate Action Tracker (April 2018 update).	-174%	2033
Paris Equity Check (Robiou du Pont, L. Jeffery, *et al.*, 2017; Robiou du Pont, M. L. Jeffery, *et al.*, 2017)	Five effort sharing approaches. Emissions allocations from global cost-optimal emissions scenarios are quantified following the five effort sharing categories from the IPCC AR5	**-101%** (-167% to -62%)	**2050** (2029 to 2071)
Climate equity reference calculator (Kemp-Benedict *et al.*, 2019)	Greenhouse development rights approach. Equity settings: 50% responsibility, 50% capacity	NA	2024 to 2025

Table 5. Target levels for the EU based effort sharing 2°C scenarios (not Paris-compatible) (all GHG, excluding LULUCF)

Publication name	Short description	Emission level in 2050	Zero year
Climate Action Tracker (Climate Action Tracker, 2018a)	Synthesis of wide range of effort sharing studies starting from and complementing IPCC AR5 (December 2018 update)	**-144%** (-73% to -214%)	2038
IPCC AR5 (Clarke *et al.*, 2014)	Synthesis of effort sharing studies (figure 6.29) for region WEU	**-84%** (-78% to -91%)	NA
Fraunhofer ISI et al. (forthcoming)	Based on Climate Action Tracker (April 2018 update)	-124%	2042
Paris Equity Check (Robiou du Pont, L. Jeffery, *et al.*, 2017; Robiou du Pont, M. L. Jeffery, *et al.*, 2017)	Five effort sharing approaches. Emissions allocations from global cost-optimal emissions scenarios are quantified following the five effort sharing categories from the IPCC AR5	**-89%** (-140% to -29%)	**2056** (2037 to 2106)
Climate Equity Reference calculator (Kemp-Benedict *et al.*, 2019)	Greenhouse development rights approach. Equity settings: 50% responsibility, 50% capacity	NA	2028

Table 6. Target levels for the EU based available carbon budget for 1.5°C (CO2 only)

Publication name	Short description	Zero year
1.5°C: Was Deutschland tun müsste (Höhne *et al.*, 2019)	Calculating the global zero year from the remaining budget for 1.5°C (not differentiating between countries)	2037
EU Greenhouse gas emission budget (Meyer-Ohlendorf *et al.*, 2018)	Calculating the remaining budget for the EU based on different ways to share it amongst countries	2036 to 2042

Table 7. Pathways for the EU based on global least costs 1.5°C scenarios (all greenhouse gases, all sectors)

Publication name	Short description	Emission level in 2050 compared to 1990	Zero year
IPCC 1.5 (IPCC, 2018)	Low and no overshoot (P1-3) "OECD1990 + EU Member States" region applied to the EU inventory	Emissions of **529 $MtCO_2e$** (-492 $MtCO_2e$ to 1,632 $MtCO_2e$) in 2050 **-91%** (-72 to -109%) compared to 2010 levels	by **2070** (by 2040 to after 2100)
IPCC 1.5 (IPCC, 2018)	All scenarios (P1-4) "OECD1990 + EU Member States" region applied to the EU inventory	Emissions of **528 $MtCO_2e$** (-492 $MtCO_2e$ to 1,636 $MtCO_2e$) in 2050 **91%** (-71 to -109%) reduction below 2010 levels	by **2070** (by 2040 to after 2100)
Fraunhofer ISI et al, (forthcoming)	Distribution of total emissions based on global economic efficiency using the POLES model	-95%	2054

Table 8. Pathways for the EU based on global least costs 2°C scenarios (not Paris-compatible) (all GHG, all sectors)

Publication name (ref)	Short description	Emission level in 2050 compared to 1990	Zero year
IPCC 1.5 (IPCC, 2018)	Lower 2°C scenarios (>66% likelihood of limiting warming to 2°C) "OECD1990 + EU Member States" region applied to the EU inventory	Emissions of **1285 $MtCO_2e$** (406 $MtCO_2e$ to 3,436 $MtCO_2e$) in 2050 **-78%** (-40% to -93%) compared to 2010 levels	**After 2100** (by 2060 to after 2100) (OECD 1990 + EU member states)
Fraunhofer ISI et al, (forthcoming)	Distribution of total emissions based on global economic efficiency using the POLES model	-86%	2063

Table 9. Studies with bottom-up mitigation potential for the EU

Publication name	Short description	Key messages
A Clean Planet for all. A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy (EC, 2018)	Assessment of eight scenarios aligned to the Paris Agreement that model different strength of current implemented policies, technology deployment, and end-user actions (i.e. Energy efficiency and circular economy)	- Europe can achieve **net-zero greenhouse gas emissions by 2050** through a socially fair transition in a cost-effective manner

Net zero by 2050: from whether to how (Pestiaux *et al.*, 2018)	Bottom up simulation of zero emission trajectories	- Reaching **net-zero greenhouse gas emissions in 2050 is feasible** - Net-zero greenhouse gas emissions in 2050 requires raising the 2030 ambition level - Net-zero pathways can cost less than business-as-usual
Climate Action Tracker: Scaling up climate action in the European Union (Climate Action Tracker, 2018b)	Assessment of different scenarios for three sectors (residential buildings, passenger transport, electricity generation). Incl. 1.5°C scenarios.	- The three analysed sectors fully decarbonise by 2050 in the 1.5°C scenarios. The emissions reductions earlier on are steep, **meaning that already around 2040, the sectors are close to decarbonisation**. - For electricity generation: The most ambitious scenario also yields highest employment benefits over time.
Achieving the Paris Climate Agreement Goals (Teske *et al.*, 2019)	Global and regional 100% renewable energy scenarios with non-energy GHG pathways for 1.5°C and 2°C	- The 1.5°C scenario **requires immediate action to realize all available options** - Efficiency and renewable potentials need to be deployed even more quickly than in the 2.0°C scenario - OECD Europe will shift 97% of its power sector investments to renewables and co-generation in the 1.5°C scenario. By 2030, the fossil fuel share of investments will be directed at gas power plants that can also be operated with hydrogen. - CO_2 emissions in OECD Europe are reduced to almost zero in 2050 in the 1.5°C scenario

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