www.oeko.de

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

Targets for the non-ETS sectors in 2040 and 2050

Report prepared for Transport & Environment

Berlin, 7.12.2016

Author

Jakob Graichen
Öko-Institut e.V.

Head Office Freiburg
P.O. Box 17 71
79017 Freiburg
Street address
Merzhauser Strasse 173
79100 Freiburg
Tel. +49 761 45295-0

Office Berlin
Schicklerstrasse 5-7
10179 Berlin
Tel. +49 30 405085-0

Office Darmstadt
Rheinstrasse 95
64295 Darmstadt
Tel. +49 6151 8191-0

info@oeko.de
www.oeko.de

Table of Contents

List of Figures 3
List of Tables 3
Summary 5
1. Background 6
2. 2050 GHG targets 6
2.1. Global carbon budgets and pathways after the Paris Agreement 6
2.2. The EU's climate targets 2030 and 2050 7
3. Possible ESR budget in 2040 and 2050 10
3.1. Split ETS – ESR in 2040 and 2050 10
3.2. Different ETS and ESR budgets in 2040 and 2050 10
References 12
Annex 13

List of Figures

Figure 1: Global GHG emission pathways 7
Figure 2: EU's GHG targets and reduction pathways based on global emissions 9
Figure 3: Range of ESR targets in 2040 and 2050 11

List of Tables

Table 1: EU's GHG targets and reduction pathways based on global emissions 8
Table 2: ESR budget in 2050 13

Summary

The paper explores different options to calculate a target for the Effort Sharing sectors in 2050 which could be considered in line with the Paris Agreement and with the agreed EU's overall target range. While there is no objective best option there are a few constraints and considerations for each option:

- To remain in line with most global emission pathways the EU's 2040 emissions would need to be below a mere interpolation between the 2030 and 2050 targets.
- The EU's agreed 2050 targets are in line with global pathways which rely (i) on large scale negative emissions in the second half of the century to compensate exceeding the permissible budget before and (ii) without taking into account historic responsibilities for climate change. The feasibility and likelihood of net negative emissions on a scale of several Gt CO2/yr as required for these pathways is rather uncertain. This approach based on reliance on negative emissions and without taking historic emission into account might therefore not be in line with Art. 191 of the Lisbon Treaty which requires that environmental policy "shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay" (European Council 2007).
- Pathways which do not rely on negative emission would require net zero emissions as of 2050 at the latest.
- Pathways which are based on equal cumulative per capita emissions for the period 1990-2050 would require massive negative emissions in the EU before 2040.

To reflect the precautionary principle and the polluter pays principle emissions in 2050 should at least be at the lower range of the EU target, i.e. 95% below 1990. For the ESR this also translates to a reduction of at least 95% below 2005 levels or no more than 170 Mt CO_2eq.

1. Background

Since the adoption and implementation of the Kyoto Protocol the EU and its Member States have set both international GHG targets as well as domestic targets. The EU emissions trading scheme (ETS) limits emission from many stationary installations and started in 2005. As of 2013 the non-trading sectors (mainly surface transport, buildings, agriculture, small industry and waste) are addressed with obligatory emission pathways under the Effort Sharing Decision (ESD or Effort Sharing Regulation (ESR) from 2021 onwards) as well. For 2030 the EU has committed itself to reduce emission by 40% below 1990 and broke that target down into reduction pathways for the ETS and the non-ETS sectors. For the period 2030 to 2050 only an overall mitigation corridor has been adopted so far: the EU intends to reduce emissions by 80-95% compared to 1990 until 2050.

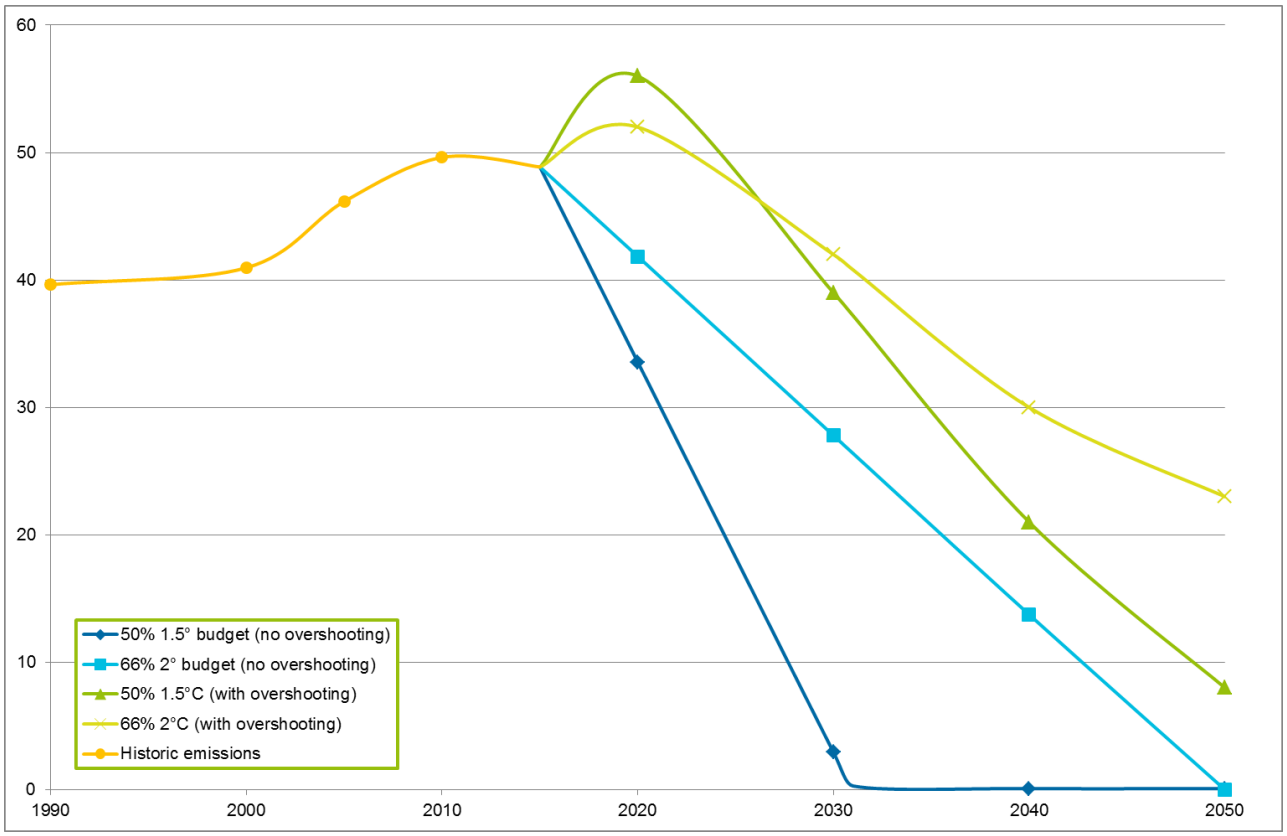
The purpose of this paper is to estimate emission targets for the Effort Sharing sectors in 2050. To do so, firstly different global emission limits in that year are discussed based on the objective of Paris Agreement. The EU's share of these emission budgets or targets is then calculated based on different approaches. In a final step the split between the ETS and ESR sectors is calculated and the emission targets determined. The output is a range of possible quantities depending on the assumptions and choices made in the first three steps.

2. 2050 GHG targets

2.1. Global carbon budgets and pathways after the Paris Agreement

In the Paris Agreement Parties agreed to 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* (UNFCCC 2015). Achieving these targets requires substantial emission reductions until 2050. The remaining cumulative GHG budget from 2015 onwards to remain below 1.5°C with a probability of 50% is 390 Gt CO_2eq compared to current yearly emissions of about 49 Gt CO_2eq; to stay below 2°C with a 66% probability limits, permissible cumulative emissions can go up to 850 Gt CO_2eq (IPCC 2014; van Vuuren, D. P. et al. 2011). At constant current emission levels that budget would be used up in 9 years and 20 years respectively. Assuming a linear reduction path from 2015 onwards global emissions would have to reach net zero around 2030 to reach the 1.5°C target; for the 2°C target zero emission would need to be achieved by 2050 (Figure 1, blue pathways). To allow for a slower phase-out of GHG emissions many scenarios foresee an overshooting of the total budget until 2050. Overshooting means that the budget will be exceeded in the short term but achieved until 2100 through net negative emissions in the second half of the century. Net negative emissions occur when absorption of CO_2 through land-use, CCS and other processes is higher than the remaining emissions. The green pathways in the figure show scenarios with net negative emissions in the second half of the century.

Figure 1: Global GHG emission pathways



Source: own calculations based on van Vuuren, D. P. et al. (2011), IPCC (2014), UNEP (2016)

Notes: Blue pathways are based on the total permissible budget with a linear reduction until net zero emissions are reached. The green pathways overshoot the budget by 2050 and require net negative emissions in the second half of the century. For the 1.5° pathway the net sink would need to be 550 Gt CO_2eq between 2050 and 2100. This is equivalent to the emission between 2015 and 2030; the pathway also allows global temperatures to increase above 1.5°C during some period before 2100. In the 2° case the net sink 2050-2100 would need to be 220 Gt CO_2eq (UNEP 2016).

2.2. The EU's climate targets 2030 and 2050

In the run-up to the 2009 Copenhagen Climate Conference the Council of the European Union set an mitigation range of 80% - 95% below 1990 levels for 2050 for the EU (Council of the European Union 2009). This ranged was based on global mitigation pathways compatible with limiting the temperature increase to 2°C and reduction ranges for industrialised countries published by the IPCC. In 2014 the Council also adopted a target of 40% below 1990 for the year 2030; this target is broken down into a target for the sectors covered by the EU ETS and a target for the sectors not covered by the trading scheme which will be addressed by the Effort Sharing Regulation (European Council 2014)[1].

These targets adopted by the Council can be compared to the global reduction pathways shown in Figure 1. To do so, the EU's share of the global permissible emissions needs to be determined. For this paper 3 different approaches have been used:

[1] International aviation is included in the EU's target in the scope of the EU ETS (EU 2015). As the aviation ETS is currently under revision it is not yet clear what the scope will be after 2020. For the purposes of this paper the half scope is used, i.e. all flights departing at an EU airport independently of destination. This is closely related to fuel sales for aviation in the EU. This approach is consistent with assessments done in other EU reports (e.g. EEA (2016b)).

- **Share of global population:** The underlying assumption in this approach is per capita emissions in 2050 should be equal. They can be calculated either based on the current population or on the expected population in that year. In 2015 6.9% of the global population lived in the EU; until 2050, the EU's share is projected to decline to 5.4% (Eurostat 2013; UN DESA 2015).
- **Share of global emissions:** In the grandfathering approach the remaining budget/share of the annual pathway is divided based on current emission share, i.e. favouring countries with high per capita emissions. In 2015 the EU was responsible for 8.8% of global GHG emissions (EEA 2016a; van Vuuren, D. P. et al. 2011).
- **Historic responsibility:** In this approach equal cumulated per capita emissions 1990-2050 are used to calculate the EU's emission budget. The calculation reflects that countries with high historic emissions have a stronger obligation to reduce their emissions than countries which have had low emissions in the past. Until 2030 the adopted EU target path is used together with the population data for 2015 to calculate total emissions, i.e. it is assumed that the targets until 2030 will not be changed anymore.[2]

Table 1: EU's GHG targets and reduction pathways based on global emissions

		1990	2010	2020	2030	2040	2050
Target based upon population 2015	1.5° (50%, no overshooting)			-59%	-96%	-100%	-100%
	2° (66%, no overshooting)			-49%	-66%	-83%	-100%
	1.5° (50%, with overshooting)			-32%	-53%	-75%	-90%
	2° (66%, with overshooting)			-37%	-49%	-64%	-72%
Target based upon population 2050	1.5° (50%, no overshooting)			-68%	-97%	-100%	-100%
	2° (66%, no overshooting)			-60%	-74%	-87%	-100%
	1.5° (50%, with overshooting)			-47%	-63%	-80%	-92%
	2° (66%, with overshooting)			-51%	-60%	-72%	-78%
Target based upon grand-fathering	1.5° (50%, no overshooting)			-46%	-95%	-100%	-100%
	2° (66%, no overshooting)			-33%	-56%	-78%	-100%
	1.5° (50%, with overshooting)			-11%	-38%	-66%	-87%
	2° (66%, with overshooting)			-17%	-33%	-52%	-63%
Target based upon historic responsibility	1.5° (50%, no overshooting)			-20%	-40%	-180%	-180%
	2° (66%, no overshooting)			-20%	-40%	-152%	-152%
	1.5° (50%, with overshooting)			-20%	-40%	-132%	-132%
	2° (66%, with overshooting)			-20%	-40%	-122%	-122%
Adopted EU targets		0%	-8%	-20%	-40%		-80-95%

Source: Own calculations based on van Vuuren, D. P. et al. (2011), IPCC (2014), UNEP (2016), UN DESA (2015), Eurostat (2013), EEA (2016a).

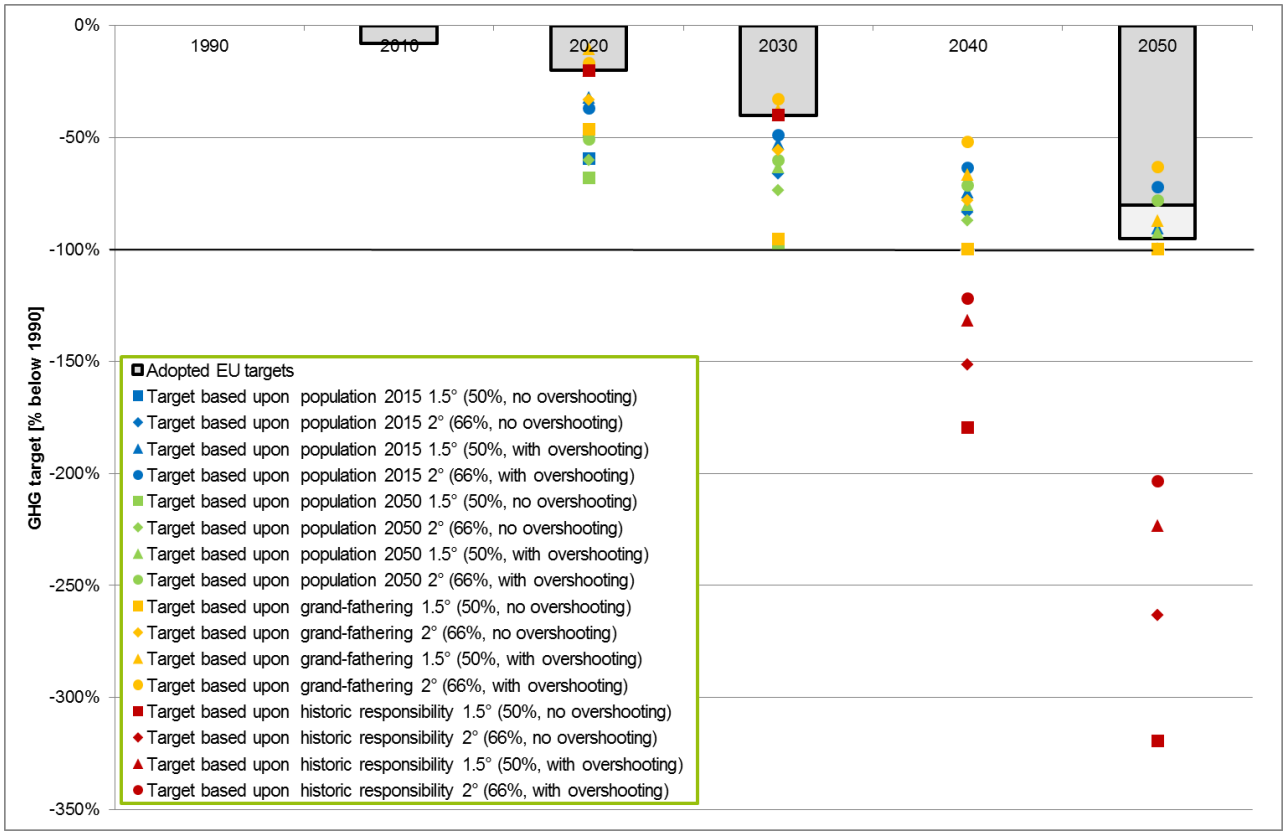
Notes: For an explanation of the approaches used to calculate the EU targets see the text above the table.

[2] An alternative would be to aim for equal per capita emissions in the period 1990-2100. This would lead to significantly reduced obligations in 2050.

Table 1 and Figure 1 show the results of the calculations. The data shows, that

- the 2020 and 2030 targets are only adequate under the assumption, that the EU's budget should be based on grandfathering and that global emissions will become negative (net sink) after 2050. Under all other approaches the short- to mid-term targets are not adequate to limit climate change to well below 2°C.
- any approach based on historic responsibility requires that the EU would become a net sink before 2040 with negative emissions in 2050 at least as high as emissions were in 1990.
- the EU's 2050 targets are in the range of possible targets required to achieve the objective of the Paris Agreement if overshooting is allowed, i.e. if global emissions after 2050 will become net negative. Under the 1.5°C scenario with overshooting, the emission budget 2015-2050 is 780 Gt CO2eq while the negative emissions between 2050 and 2100 need to remove 550 Gt CO2 from the atmosphere again.
- independently of the approach used to calculate the EU's share of the 1.5°C pathway without overshooting the EU would have to reach net zero emissions before 2035. In the 2°C pathway without overshooting zero emissions would need to be achieved by 2050.

Figure 2: EU's GHG targets and reduction pathways based on global emissions



Source: own calculations based on van Vuuren, D. P. et al. (2011), IPCC (2014), UNEP (2016), UN DESA (2015), Eurostat (2013), EEA (2016a)

3. Possible ESR budget in 2040 and 2050

3.1. Split ETS – ESR in 2040 and 2050

Based on the EU's emission targets for 2040 and 2050 it is then possible to calculate the emission limit for the ESR sectors in those years. To do so assumptions on the split between the trading- and non-trading sectors need to be made. Several approaches were used for

- **Difference between the target and the ETS sectors:**
  Under the ETS a linear reduction factor until 2030 has been established. This factor can applied to all years until 2050 and used to calculate the ETS budget (850 Mt CO_2eq in 2040 and 365 Mt CO_2eq in 2050). The ESR budget would then be the difference between the ETS and the overall target.
- **Constant shares:**
  In this approach the split between ETS and ESR is kept constant and applied to all subsequent years. In 2030 the split is approx. 40% ETS and 60% ESR[3].
- **Non-energy emissions:**
  For emissions from energy use the full deployment of renewable energies is a viable mitigation strategy. Remaining emission budgets will only be made available for sectors where mitigation is more difficult, i.e. emissions from industrial processes (covered by the ETS) and agriculture (covered by the ESR). Emissions from the waste sector and use of fluorinated gases would also need to decline to zero in 2050.
  Between 1990 and 2008 both sectors had more or less equal emissions: In 2009 emissions from industrial processes dropped and emissions from the agriculture sector are 15% higher (EEA 2016a). This value is used to determine the respective shares of the EU's total emissions in 2040 and 2050.

3.2. Different ETS and ESR budgets in 2040 and 2050

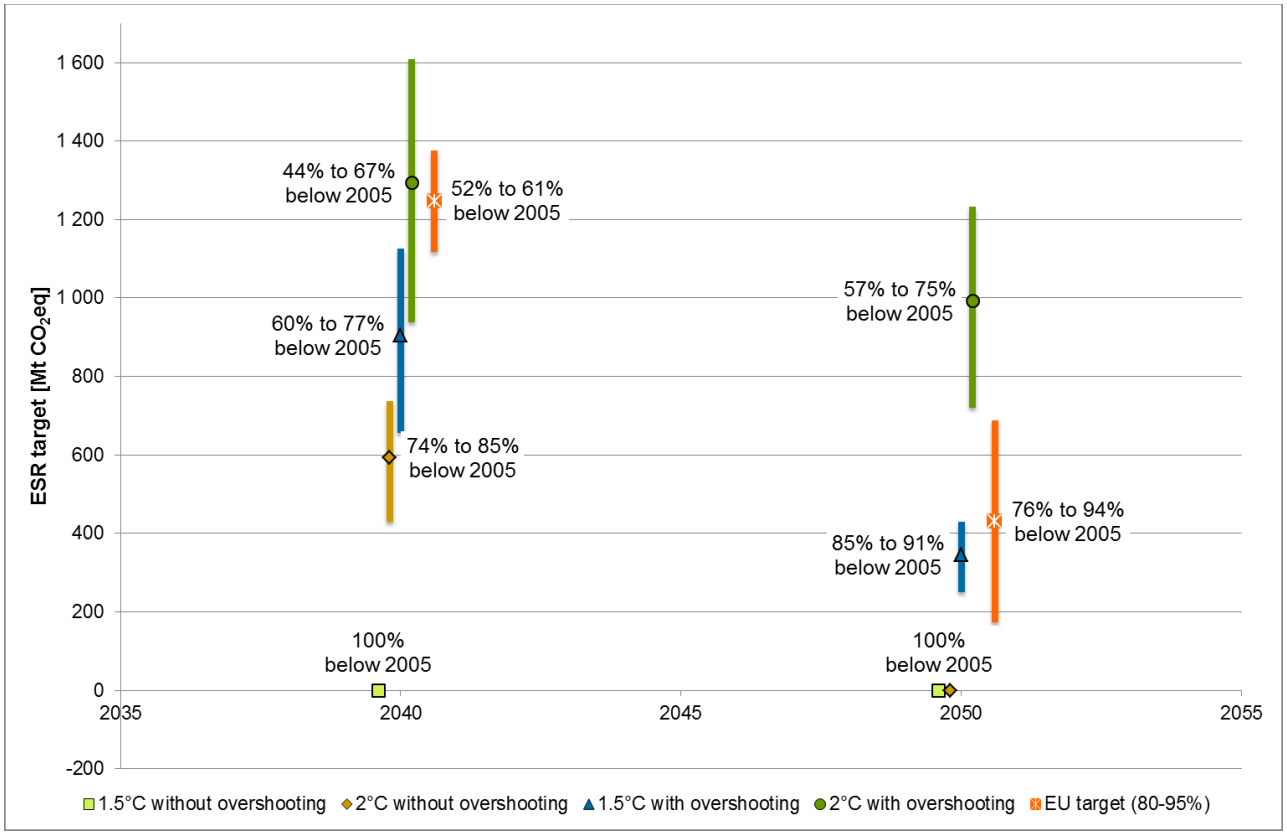
Based on the different approaches to estimate a fair emission target for the EU in 2040 and 2050 and the different options to divide the target between the ETS and the ESR a vast range of targets can be calculated. The full results are included in Table 2 in the Annex. Out of these many do not seem likely, desirable or with limited additional value:

- **Targets based on historic responsibility**
  Targets based on a fair share of the cumulated emissions 1990-2050 require negative emissions of 3-13 Gt CO_2 in 2050 from the ESR sectors alone.
- **Constant LRF**
  The LRF was developed with a specific GHG target for 2050 in mind. Only in the context of the 80% below 1990 target is the resulting relationship between ETS and ESR emissions realistic. Even then, the ESR share drops from approx. 60% in 2030 to 45% in 2050. Under more ambitious targets the ESR would need to become a net sink to compensate the unchanging ETS emissions.
- **Constant shares or non-energy emissions**
  The difference between the two approaches to split total emissions between ETS and ETS are rather small compared to the overall spread.

[3] The exact value depends on the scope of the aviation ETS.

Figure 3 therefore only shows the potential ESR emission targets for 2040 and 2050 based on the constant shares split and only for the 1.5°C/2°C scenarios with and without overshooting. Without overshooting the ESR sectors would need to become emission neutral in 2050 at the latest. If overshooting is allowed and historic responsibilities are not taken into account the EU's targets (orange bars) are within the range of necessary emission reductions in 2050 if – and only if – global emissions would become negative shortly thereafter. To reach the 1.5°C target massive negative emissions would be required in the second half of the century.

Figure 3: Range of ESR targets in 2040 and 2050



Source: own calculations

Notes:
- The split ETS/ESR is based on constant shares after 2030.
- The EU target in 2040 is calculated by a linear interpolation between the 2030 and 2050 targets. It is not formally adopted but seems a likely step between the agreed targets.
- The bars show the range of the targets based on the following approaches to determine the EU's share of global emissions: population 2015, population 2050 and emissions 2015. The approach including historical emissions is not included but would require substantial negative emissions in 2050 from the ESR sectors.

References

Council of the European Union (2009). Council Conclusions on EU position for the Copenhagen Climate Conference. Available at http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/envir/110634.pdf, last accessed on 26 Sep 2015.

European Council (2007). Consolidated Reader-Friendly Edition of the Treaty on European Union (TEU) and the Treaty on the Functioning of the European Union (TFEU) as amended by the Treaty of Lisbon (2007) ().

European Council (2014). Conclusions on 2030 Climate and Energy Policy Framework. Brussels. Available at http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/145397.pdf, last accessed on 09 Sep 2015.

European Environment Agency (EEA) (2016a). EEA greenhouse gas data viewer. Available at http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer, last accessed on 28 Jun 2016.

European Environment Agency (EEA) (2016b). Trends and projections in the EU ETS in 2016: The EU Emissions Trading System in numbers. Available at http://www.eea.europa.eu/publications/trends-and-projections-EU-ETS-2016, last accessed on 01 Nov 2016.

European Union (EU) (2015). Intended Nationally Determined Contribution of the EU and its Member States: Submission by Latvia and the European Commission on behalf of the European Union and its Member States. Available at http://www4.unfccc.int/submissions/INDC/Published%20Documents/Latvia/1/LV-03-06-EU%20INDC.pdf, last accessed on 18 May 2016.

Eurostat (2013). EUROPOP2013 - Population projections at national level: Main scenario - Population on 1st January by age and sex [proj_13npms]. Available at http://ec.europa.eu/eurostat/data/database?node_code=proj, last accessed on 30.11.16.

IPCC (2014). AR5 Synthesis Report - Climate Change 2014. Available at http://ar5-syr.ipcc.ch/ipcc/ipcc/resources/pdf/IPCC_SynthesisReport.pdf, last accessed on 23 Jul 2015.

UN Department of Economic and Social Affairs (UN DESA) (2015). World Population Prospects: Key findings & advance tables. New York. Available at https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf, last accessed on 30 Nov 2016.

UNEP (2016). The Emissions Gap Report 2016: A UNEP Synthesis Report. Nairobi. Available at http://wedocs.unep.org/bitstream/handle/20.500.11822/10016/emission_gap_report_2016.pdf, last accessed on 30 Nov 2016.

UNFCCC (2015). Adoption of the Paris Agreement: Decision 1/CP.21. Available at http://unfccc.int/documentation/documents/advanced_search/items/6911.php?priref=600008831, last accessed on 20 Jan 2016.

van Vuuren, D. P.; Stehfest, E.; den Elzen, M. G. J.; Kram, T.; van Vliet, J.; Deetman, S.; Isaac, M.; Klein Goldewijk, K.; Hof, A.; Mendoza Beltran, A.; Oostenrijk, R. & van Ruijven, B. (2011). RCP2.6: exploring the possibility to keep global mean temperature increase below 2°C. Climatic Change (Climatic Change), 109(1-2), pp. 95–116. doi:10.1007/s10584-011-0152-3.

Annex

Table 2: ESR budget in 2050

		ESR emissions calculated as											
		difference to ETS (LRF)				constant ETS/ESR shares				share of non-energy emissions			
		2040		2050		2040		2050		2040		2050	
		[Mt CO_2eq]	[below 2005]	[Mt CO_2eq]	[below 2005]	[Mt CO_2eq]	[below 2005]	[Mt CO_2eq]	[below 2005]	[Mt CO_2eq]	[below 2005]	[Mt CO_2eq]	[below 2005]
Target based upon population 2015	1.5° (50%, no overshooting)	-850	-130%	-850		0	-100%	0	-100%	0	-100%	0	-100%
	2° (66%, no overshooting)	58	-98%	-850		545	-81%	0	-100%	485	-83%	0	-100%
	1.5° (50%, with overshooting)	611	-79%	-293		877	-69%	334	-88%	782	-73%	298	-90%
	2° (66%, with overshooting)	1 237	-57%	750		1 252	-56%	960	-66%	1 116	-61%	856	-70%
Target based upon population 2050	1.5° (50%, no overshooting)	-850	-130%	-850		0	-100%	0	-100%	0	-100%	0	-100%
	2° (66%, no overshooting)	-141	-105%	-850		426	-85%	0	-100%	379	-87%	0	-100%
	1.5° (50%, with overshooting)	292	-90%	-415		685	-76%	261	-91%	611	-79%	233	-92%
	2° (66%, with overshooting)	781	-73%	400		979	-66%	750	-74%	872	-69%	669	-77%
Target based upon grand-fathering	1.5° (50%, no overshooting)	-850	-130%	-850		0	-100%	0	-100%	0	-100%	0	-100%
	2° (66%, no overshooting)	309	-89%	-850		695	-76%	0	-100%	620	-78%	0	-100%
	1.5° (50%, with overshooting)	1 015	-64%	-139		1 119	-61%	426	-85%	998	-65%	380	-87%
	2° (66%, with overshooting)	1 815	-36%	1 193		1 599	-44%	1 226	-57%	1 425	-50%	1 093	-62%
Target based upon historic responsibil	1.5° (50%, no overshooting)	-5 416	-290%	-13 423		-2 740	-196%	-7 544	-365%	-2 442	-186%	-6 725	-336%
	2° (66%, no overshooting)	-3 807	-234%	-10 204		-1 774	-162%	-5 613	-297%	-1 582	-156%	-5 003	-276%
	1.5° (50%, with overshooting)	-2 669	-194%	-7 929		-1 092	-138%	-4 248	-249%	-973	-134%	-3 787	-233%
	2° (66%, with overshooting)	-2 097	-174%	-6 784		-748	-126%	-3 560	-225%	-667	-123%	-3 174	-211%
EU targets	80% target	1 444	-49%	297		1 376	-52%	688	-76%	1 227	-57%	613	-78%
	95% target	1 014	-64%	-563		1 118	-61%	172	-94%	997	-65%	153	-95%

Source: Own calculations

Notes: A negative sign means net negative emissions, i.e. the Effort Sharing sectors would need to remove CO_2 from the atmosphere.