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# Working Paper

## Implementing New GWP Values in the EU: A Quantitative Analysis

Oeko-Institut Working Paper 3/2019

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# Abstract

At the 2018 climate change conference in Katowice, Poland, Parties decided that new Global Warming Potential (GWP) values from the 5th Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) will be used to report national greenhouse gas (GHG) emissions under the Paris Agreement. At the same time, countries may for their first nationally determined contribution (NDC) continue to use different GWP values to track progress and account for their NDCs. The EU communicated in its first NDC that it will use AR4 values for its first NDC and current EU legislation for reporting of GHG inventories and the EU's Emissions Trading System (ETS) also uses AR4 values. This raises the questions whether the EU should continue to use AR4 values to account for its first NDC or update its NDC to AR5 and which values the EU should use under its domestic legislation and regulations, including the reporting of national GHG inventories under the EU Governance Regulation, the allocation of allowances and the reporting of emissions under its ETS, the allocation of emission budgets to member states under the Effort Sharing Regulation (ESR), and the EU LULUCF Regulation. This working paper aims to inform the ongoing discussions on this matter by quantitatively assessing the impacts of changing GWP values.

The quantitative analysis for the EU-28 and all member states indicates that a change of GWP values from AR4 to AR5 would have very small effects. Based on the emission reductions achieved so far as well as projections by member states for 2030, the EU-28 would have to conduct slightly smaller emission reductions to achieve its NDC (about 0.1 percentage points considering current progress). The same holds true for the achievement of the ESR targets. Even at member state level, the differences in emission reductions with AR4 and AR5 values are small for national totals (between +/-0.5 percentage points) but somewhat larger for the effort sharing sector. This is mainly because the increase in the GWP value of methane partially levels out with the decrease in the GWP value of nitrous oxide. If the EU internally adopted an approach where ESR target levels are determined using AR4 values but emissions are reported using AR5 values, there is a larger, and opposite, effect: in this case, the EU-28 would need to implement more emission reductions to achieve the ESR targets (in aggregate about 1 percentage point). Under this approach the impact on member states also differs more strongly as compared the situation that AR5 values were used for both ESR target levels and reporting of emissions.

A change of the EU's NDC to AR5 would make tracking progress towards its NDC simpler and could considerably facilitate accounting for international carbon market mechanisms under Article 6. In this context, it would be important that all countries that are part of, or link to, the EU ETS would update their NDC to AR5 values. For the reporting of GHG inventories and other GHG data under the Governance Regulation, it is important to avoid double-reporting and the associated additional efforts and sources of error, and to aim at using one single set of GWPs, to the extent possible. Using AR5 values would ensure consistency with GHG inventories reported under the Paris Agreement and avoid such double-reporting. A switch to AR5 would affect member states in different ways with respect to their ESR targets. With regard to the EU ETS, it has to be taken into account that the reporting and the setting of benchmarks are currently based on data expressed in AR4. Approaches are needed which are consistent with current legislation but address the reporting requirements at international level and ensure consistency with the systems of non-EU countries which participate in or are linked to the EU ETS. Lastly, it is important to consider that the systems of the EU ETS, the ESR and the LULUCF regulation are not independent but that transfers may take place between these systems. Comparability would be best ensured if the same GWP values were used consistently, at least for reporting of GHG emissions and removals.

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# 1. Introduction

At the 2018 climate change conference in Katowice, Poland, Parties adopted a comprehensive rulebook for implementing the Paris Agreement. A central part of this rulebook is the modalities, procedures and guidelines (MPGs) for implementing the enhanced transparency framework established under Article 13 of the Paris Agreement (Annex of decision 18/CMA.1). The framework requires all Parties to prepare biennial transparency reports (BTRs) which includes a national inventory report as well as all information necessary to track the country's progress in implementing and achieving its nationally determined contribution (NDC). The first BTR is to be submitted at the latest by 31 December 2024.

The MPGs include many new reporting requirements. One new element is that all Parties must use the new Global Warming Potential (GWP) values from the 5$^{th}$ Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) to report their national greenhouse gas (GHG) emissions as part of their national inventory reports (Paragraph 37 of the MPGs). The Katowice decisions further specify that countries shall apply these values (or any future update if agreed by the CMA) to account for their **second and subsequent** NDCs, while they **may** elect to apply this accounting approach for their **first** NDC (paragraph 13 and 14 of decision 4/CMA.1, and paragraph 1a of Annex II to decision 4/CMA.1). This means that countries can choose for the first NDC whether they continue to use the values in their current NDC or whether they move to AR5 values. In their first NDCs, most developed countries currently use AR4 values while most developing countries use AR2 values.

The EU communicated in its first NDC that it will use the values from the AR4 to account for its 2030 target. Currently, the EU legislation for reporting of GHG inventories and the Emissions Trading System (ETS) also uses AR4 values.

This raises several questions of how the EU should implement the decisions taken in Katowice:

1. At **international level**, the EU could:

   Option 1: Continue to use AR4 values to account for its first NDC, which implies that national inventory reports would have to prepared in AR5 values whereas information to track progress in implementing and achieving the EU's NDC would be reported in AR4 values; or

   Option 2: Update its first NDC and move towards the use of AR5 values to account for its 2030 target.

2. At **domestic level**, the EU has to decide which GWP values to use under its domestic legislation and regulations. This includes several aspects, including the reporting of national GHG inventories under the EU Governance Regulation (EU Regulation 2018/1999), the allocation of allowances and the reporting of emissions under its ETS, the allocation of emission budgets to member states under the ESR (EU Regulation 2018/842) for emissions not covered by the ETS, and the EU LULUCF Regulation (EU Regulation 2018/841).

The use of GWPs is currently being discussed, for example, between the European Commission and the member states, as the Commission plans to adopt GWP values under the Governance Regulation, as mandated by Article 26(6) of that Regulation. This working paper aims to inform these ongoing discussions by quantitatively assessing the impacts of changing GWP values.

## 2. Quantitative implications of switching to AR5

This section analyses the quantitative implications of changing GWP values from AR4 to AR5 for the EU-28 and all member states. A change from AR4 to AR5 would imply that the GWP of methane ($CH_4$) increases from 25 to 28[1] while the GWP for nitrous oxide ($N_2O$) decreases from 298 to 265. The GWP of $SF_6$ increases from 22 800 to 23 500, for $NF_3$ it decreases from 17 200 to 16 200. For HFCs and PFCs the changes are diverse.[2] In our analysis, the changes of the GWP values for HFCs and PFCs have not been taken into account, as these constitute only a minor share in total emissions and include a large group of gases with specific GWPs that change in different directions.[3]

To understand the implications of a change in GWP values, this paper conducts a number of quantitative analyses. We first analyse the impact on the calculated emission reductions that countries have achieved so far. This includes a comparison of current emissions with 1990 levels (section 2.1) and a comparison of current emissions covered by the Effort Sharing Directive (ESD) sector in relation to the base year 2005 (section 2.2). These comparisons allow understanding how the reporting of progress achieved so far is affected by a change in GWP values. This is followed by an assessment of the implications on the effort sharing targets for 2030 (section 2.3) and on the projected emission reductions in 2030 (section 2.4). Lastly, section 3 provides brief conclusions from this quantitative analysis.

### 2.1. Impact on reported reductions since 1990

Table 2-1 illustrates the impact of GWP values for the progress by countries in reducing emissions since 1990. The results under “Difference of change” show that the impact of a change from AR4 to AR5 is small with up to ± 0.5 percentage points for the EU and all member states individually. This is because in most countries the increase in the GWP value for $CH_4$ partially levels out with the decrease in the GWP value for $N_2O$.

On EU level the calculated reduction achieved between 1990 and 2017 using GWP from AR5 is higher by 0.1 percentage point. With this, the difference to the NDC reduction target of -40 %, if calculated with GWP from AR5, is slightly smaller than with GWP from AR4.

[1] The Fifth Assessment Report of the IPCC provides, in chapter 8, two GWPs for some gases (with and without carbon feedback). It is expected that in the inventory reporting tables to be adopted by the CMA in 2020, the GWPs will be listed explicitly. We assume for this paper that the value of 28 will be used for Methane.

[2] https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

[3] To give an estimation of the size of this omission, the right column of Table 2-1 shows the percentage of these gases on total GHG in all countries. In most countries the share of these “unconverted” gases is not higher than 3 %. For Malta this share is considerably higher at 14 %, especially due to its HFC emissions.

**Table 2-1: Total GHG emission reduction for 1990 to 2005, 2016 and 2017 in AR4 and AR5 (without LULUCF and without indirect $CO_2$)**

| | With AR4 | | | With AR5 | | | Difference of change | | | Share of non-converted F-Gases |
|---|---|---|---|---|---|---|---|---|---|---|
| | Reduction of total GHG compared to 1990 | | | | | | Percentage points | | | |
| | 2005 | 2016 | 2017 | 2005 | 2016 | 2017 | 2005 | 2016 | 2017 | 2017 |
| EU28 (Convention) | -7,5% | -23,8% | -23,5% | -7,6% | -23,9% | -23,6% | -0,1% | -0,1% | -0,1% | 3% |
| EU (KP) | -7,4% | -23,8% | -23,4% | -7,6% | -23,9% | -23,5% | -0,1% | -0,1% | -0,1% | 3% |
| Austria | 17,7% | 1,2% | 4,6% | 17,2% | 0,7% | 4,1% | -0,5% | -0,5% | -0,5% | 2% |
| Belgium | -0,9% | -21,0% | -21,9% | -1,0% | -21,0% | -21,9% | -0,1% | 0,0% | 0,0% | 3% |
| Bulgaria | -37,3% | -42,0% | -39,7% | -37,3% | -42,3% | -40,1% | 0,0% | -0,3% | -0,3% | 3% |
| Croatia | -5,8% | -23,5% | -21,5% | -5,8% | -22,9% | -21,0% | 0,0% | 0,5% | 0,4% | 2% |
| Cyprus | 64,6% | 54,2% | 57,8% | 64,4% | 54,2% | 57,7% | -0,3% | 0,0% | 0,0% | 3% |
| Czechia | -25,3% | -34,3% | -34,8% | -25,4% | -34,3% | -34,9% | -0,1% | -0,1% | -0,1% | 3% |
| Denmark | -5,2% | -27,9% | -31,2% | -4,8% | -27,6% | -30,9% | 0,4% | 0,3% | 0,3% | 1% |
| Estonia | -52,5% | -51,4% | -48,4% | -52,4% | -51,4% | -48,4% | 0,1% | 0,0% | 0,0% | 1% |
| Finland | -1,9% | -18,4% | -22,2% | -2,2% | -18,6% | -22,4% | -0,3% | -0,2% | -0,2% | 2% |
| France | 1,2% | -16,0% | -15,2% | 1,5% | -15,7% | -15,0% | 0,2% | 0,3% | 0,2% | 4% |
| Germany | -20,6% | -27,2% | -27,5% | -20,8% | -27,4% | -27,8% | -0,2% | -0,2% | -0,2% | 1% |
| Greece | 32,2% | -11,1% | -7,4% | 32,2% | -10,8% | -7,2% | 0,0% | 0,2% | 0,3% | 7% |
| Hungary | -19,5% | -34,7% | -31,9% | -19,6% | -34,6% | -31,8% | 0,0% | 0,1% | 0,1% | 3% |
| Iceland | 9,7% | 28,9% | 32,1% | 10,0% | 29,0% | 32,1% | 0,3% | 0,1% | 0,0% | 6% |
| Ireland | 25,4% | 10,6% | 9,6% | 24,9% | 10,4% | 9,5% | -0,5% | -0,1% | -0,1% | 2% |
| Italy | 12,1% | -16,5% | -17,4% | 12,0% | -16,4% | -17,2% | -0,1% | 0,2% | 0,2% | 4% |
| Latvia | -56,6% | -57,1% | -56,9% | -56,7% | -57,2% | -57,1% | 0,0% | -0,1% | -0,1% | 2% |
| Liechtenstein | 15,7% | -18,0% | -15,4% | 15,7% | -17,9% | -15,4% | -0,1% | 0,1% | 0,1% | 6% |
| Lithuania | -52,6% | -58,1% | -57,7% | -53,0% | -58,2% | -57,7% | -0,4% | -0,1% | -0,1% | 3% |
| Luxembourg | 2,1% | -21,2% | -19,8% | 2,1% | -21,1% | -19,7% | 0,0% | 0,1% | 0,1% | 1% |
| Malta | 38,3% | -9,9% | 2,3% | 38,8% | -9,3% | 2,8% | 0,5% | 0,5% | 0,5% | 14% |
| Netherlands | -2,9% | -11,5% | -12,5% | -3,4% | -11,7% | -12,7% | -0,4% | -0,2% | -0,2% | 1% |
| Norway | 8,1% | 4,7% | 2,9% | 7,9% | 4,7% | 3,0% | -0,2% | 0,0% | 0,0% | 3% |
| Poland | -15,0% | -15,9% | -12,8% | -15,1% | -16,0% | -13,0% | -0,1% | -0,2% | -0,2% | 2% |
| Portugal | 44,9% | 11,6% | 19,4% | 44,7% | 11,6% | 19,3% | -0,2% | 0,0% | -0,1% | 5% |
| Romania | -39,0% | -53,9% | -54,1% | -39,0% | -53,9% | -54,1% | 0,0% | 0,1% | 0,0% | 2% |
| Slovakia | -30,3% | -42,5% | -41,0% | -30,2% | -42,4% | -40,8% | 0,1% | 0,2% | 0,2% | 2% |
| Slovenia | 10,1% | -5,1% | -6,4% | 9,9% | -5,3% | -6,6% | -0,2% | -0,2% | -0,2% | 2% |
| Spain | 52,9% | 13,1% | 17,9% | 52,7% | 13,2% | 18,0% | -0,2% | 0,1% | 0,0% | 2% |
| Sweden | -6,6% | -25,8% | -26,1% | -6,7% | -26,0% | -26,4% | -0,1% | -0,2% | -0,3% | 2% |
| United Kingdom (Convention) | -13,0% | -39,2% | -40,8% | -13,2% | -39,5% | -41,1% | -0,2% | -0,3% | -0,3% | 3% |

Source: (EEA 2019a), own calculation

## 2.2. Impact on reported ESD reductions since 2005

The effects of changes in the Effort Sharing Decision (ESD) sector are larger than for total national emissions because the share of non-$CO_2$ gases in the ESD sector is considerably higher than in the EU ETS. Information on the share of non-$CO_2$ emissions covered under the EU ETS is, however, not publicly available by country. To approximate the impact of a change of GWP values for the ESD sector, we assume here, as a simplification, that all ETS emissions are $CO_2$ emissions. This simplification does not have a large impact because the share of PFC and $N_2O$ emissions in the EU ETS is relatively small. The ESD emissions are calculated here based on ETS emissions from the EUTL as of 2 May 2019 (EEA 2019b).

**Table 2-2: Emission reductions in the ESD sector from 2005 to 2016 and 2017 in AR4 and AR5 (without LULUCF and without indirect $CO_2$)**

| | Reduction of ESD emissions compared to 2005 | | | | | |
|---|---|---|---|---|---|---|
| | With AR4 | | With AR5 | | Difference of change | |
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| EU-28 | -10,6% | -10,1% | -10,7% | -10,2% | -0,1% | -0,1% |
| Austria | -10,4% | -8,5% | -10,6% | -8,6% | -0,1% | -0,1% |
| Belgium | -8,3% | -10,1% | -8,1% | -9,9% | 0,2% | 0,2% |
| Bulgaria | -1,4% | 1,6% | -2,5% | 0,4% | -1,1% | -1,3% |
| Croatia | -8,3% | -5,3% | -7,5% | -4,6% | 0,9% | 0,7% |
| Cyprus | -3,5% | 0,7% | -3,3% | 0,9% | 0,2% | 0,2% |
| Czechia | 1,4% | 0,54% | 1,2% | 0,3% | -0,2% | -0,2% |
| Denmark | -16,5% | -16,8% | -16,6% | -16,9% | -0,1% | -0,1% |
| Estonia | -1,8% | -2,0% | -2,3% | -2,5% | -0,5% | -0,6% |
| Finland | -9,6% | -11,4% | -9,5% | -11,3% | 0,2% | 0,1% |
| France | -10,5% | -10,9% | -10,5% | -10,9% | 0,0% | 0,0% |
| Germany | -4,2% | -1,9% | -4,4% | -2,2% | -0,2% | -0,2% |
| Greece | -27,5% | -26,8% | -27,2% | -26,5% | 0,3% | 0,3% |
| Hungary | -8,9% | -5,8% | -8,8% | -5,7% | 0,1% | 0,1% |
| Ireland | -6,6% | -6,0% | -6,4% | -5,7% | 0,2% | 0,2% |
| Italy | -16,7% | -18,2% | -16,4% | -17,9% | 0,3% | 0,3% |
| Latvia | 6,6% | 8,7% | 6,2% | 8,4% | -0,4% | -0,4% |
| Lithuania | 23,9% | 24,9% | 25,1% | 26,0% | 1,2% | 1,1% |
| Luxembourg | -15,4% | -13,5% | -15,4% | -13,4% | 0,0% | 0,1% |
| Malta | 40,2% | 52,1% | 39,1% | 50,8% | -1,0% | -1,3% |
| Netherlands | -17,3% | -17,0% | -16,8% | -16,6% | 0,5% | 0,5% |
| Poland | 10,4% | 16,2% | 10,1% | 15,7% | -0,3% | -0,5% |
| Portugal | -15,2% | -14,7% | -15,2% | -14,7% | 0,0% | 0,0% |
| Romania | -6,2% | -8,0% | -6,8% | -8,6% | -0,6% | -0,6% |
| Slovakia | -5,4% | -3,8% | -5,2% | -3,5% | 0,2% | 0,3% |
| Slovenia | -4,8% | -7,5% | -5,1% | -7,7% | -0,3% | -0,2% |
| Spain | -15,5% | -15,1% | -15,4% | -15,0% | 0,1% | 0,1% |
| Sweden | -23,1% | -23,6% | -23,4% | -23,9% | -0,3% | -0,3% |
| United Kingdom | -19,1% | -19,7% | -19,7% | -20,3% | -0,6% | -0,5% |

Note: Red coloured changes mark countries with emissions increases between 2005 and 2016 or 2017. Violet marked changes show positive differences between the AR5 and AR4 results, i.e. lower reductions or higher increases if GWPs from AR5 are used instead of AR4.

Source:(EEA 2019a, 2019b); own calculation

Table 2-2 shows the impact of a change from AR4 to AR5 for the ESD sector. The results show that the impact would be small at EU level: the reduction in ESD emissions at EU level is 10.1 % between 2005 and 2017 with AR4 and 10.2 % with AR5. At national level, the differences between AR4 and AR5 vary more strongly than for total national emissions, between 1.1 (Lithuania) and

-1.3 percentage points (Bulgaria and Malta). These three countries are among the Member States experiencing ESD emission increases in this timeframe (highlighted in red in Table 2-2). For Lithuania this increase would be higher with GWP values from AR5, while for Bulgaria and Malta the increase would be lower. Apart from these countries, the changes are between -0.6 (Estonia, Romania) and +0.7 percentage points (Croatia). This means that with AR5 GWP values, under the assumptions made, Croatia would, for example, have a slightly lower historical emission reduction between 2005 and 2017 than with AR4 GWP values (-4.6 % instead of -5.3 %).

Theoretically, it is also perceivable that the future ESR emissions are reported with AR5 GWP values but that the emission reduction is compared with historic 2005 emissions determined with AR4 GWP values. For illustrative purposes, Table 2-3 shows the results for this approach. Overall, the EU would report with this approach a lower emission reduction (only a 9.1% reduction in 2017 compared to 2005 levels, rather than a 10.1% or 10.2% reduction with consistent use of either AR4 or AR5 values respectively). At member state level, the differences are also larger, ranging from -0.1 (Latvia) to 3.3 percentage points (Romania). For Latvia the increase of emissions would be slightly lower, while for all other countries the reductions would be lower or the increases would be higher. This means that under this approach more mitigation would need to be implemented to achieve the same targets.

**Table 2-3: Emission reductions in the ESD sector from 2005 to 2016 and 2017 with a mixed AR4 and AR5 approach (without LULUCF and without indirect $CO_2$)**

| | Reduction of ESD emissions compared to 2005 | | | |
|---|---|---|---|---|
| | With 2005 in AR4, 2016 and 2017 in AR5 | | Difference of change | |
| | 2016 | 2017 | 2016 | 2017 |
| EU-28 | -9,6% | -9,1% | 1,0% | 1,0% |
| | | | | |
| Austria | -9,7% | -7,7% | 0,7% | 0,7% |
| Belgium | -7,9% | -9,7% | 0,4% | 0,4% |
| Bulgaria | -0,4% | 2,5% | 1,0% | 0,9% |
| Croatia | -6,4% | -3,6% | 1,9% | 1,7% |
| Cyprus | -1,9% | 2,4% | 1,6% | 1,7% |
| Czechia | 3,0% | 2,1% | 1,6% | 1,6% |
| Denmark | -15,9% | -16,2% | 0,6% | 0,6% |
| Estonia | -1,4% | -1,5% | 0,5% | 0,4% |
| Finland | -9,5% | -11,3% | 0,2% | 0,1% |
| France | -9,9% | -10,3% | 0,6% | 0,5% |
| Germany | -3,7% | -1,4% | 0,6% | 0,5% |
| Greece | -26,4% | -25,6% | 1,1% | 1,1% |
| Hungary | -8,1% | -5,0% | 0,8% | 0,8% |
| Iceland | 33,5% | 36,3% | 1,9% | 1,8% |
| Ireland | -4,6% | -3,9% | 2,0% | 2,0% |
| Italy | -15,8% | -17,2% | 1,0% | 1,0% |
| Latvia | 6,5% | 8,7% | -0,1% | -0,1% |
| Liechtenstein | -23,6% | -21,3% | 0,5% | 0,4% |
| Lithuania | 24,5% | 25,4% | 0,5% | 0,5% |
| Luxembourg | -15,1% | -13,1% | 0,4% | 0,4% |
| Malta | 42,0% | 54,0% | 1,9% | 1,9% |
| Netherlands | -16,3% | -16,1% | 1,0% | 1,0% |
| Norway | 4,5% | 0,4% | 1,3% | 1,3% |
| Poland | 12,5% | 18,2% | 2,1% | 2,0% |
| Portugal | -13,5% | -13,0% | 1,7% | 1,7% |
| Romania | -2,9% | -4,7% | 3,3% | 3,3% |
| Slovakia | -4,0% | -2,2% | 1,5% | 1,5% |
| Slovenia | -3,3% | -6,0% | 1,5% | 1,5% |
| Spain | -14,3% | -13,9% | 1,2% | 1,2% |
| Sweden | -23,0% | -23,5% | 0,1% | 0,0% |
| United Kingdom | -18,1% | -18,8% | 1,0% | 1,0% |

Note: Red coloured changes mark countries with emissions increases between 2005 and 2016 or 2017. Violet marked changes show positive differences between the AR5 and AR4 results, i.e. lower reductions or higher increases if GWPs from AR5 are used in 2016 and 2017 instead of AR4.

Source: (EEA 2019a, 2019b); own calculation

## 2.3. Impact on 2030 effort sharing targets

For the period 2021 to 2030, the ESR establishes an emission reduction target for each member state in relation to 2005 emissions. A budget of Annual Emission Allocations (AEAs) is calculated based on a trajectory from 2016-2018 levels to 2030 levels. We estimate the impact of a switch from AR4 to AR5 using the following assumptions:

- For estimating the absolute 2030 targets, 2005 ESD emissions are converted to AR5 using the latest GHG inventory and making the same assumptions on ETS emissions, HFCs and PFs as described above. Emissions reductions pursuant to ESR Annex I have been applied to these 2005 levels.
- To calculate the AEAs for the period 2021 to 2029 average 2016-2018 ESD emissions have to be quantified. For this, emissions for the years 2016 and 2017, as calculated with above assumptions, are used. To allow for the comparison of GWP from AR4 and 5, in the following calculation ESD emissions 2018 are assumed to be equal to 2017 ESD emissions.

With these assumptions absolute ESR target emission levels can be calculated until 2030. Table 2-4 illustrates the impacts of a switch from AR4 to AR5 for absolute 2030 effort sharing targets as well as for the number of AEAs allocated in the period 2021 to 2030.

At EU level, a switch from AR4 to AR5 would lead to higher ESD emissions in 2005. This results in slightly higher absolute target levels in 2030 (2 032 instead of 2 008 Mt $CO_2$eq). This is an increase of 1.2% related to emissions in AR4. At member state level, differences range from -1% (Lithuania) to +4% (Romania). The total number of estimated AEAs 2021-2030 differs in similar ranges.

## Table 2-4: Estimated AEAs for the period 2021 to 2030 with GWP values of AR4 and AR5 (without LULUCF and without indirect $CO_2$)

| | Baseyear emissions for AEA calculation | | | | | | | | 2030 targets | | | | AEA 2021-2030 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | With AR4 | | | | With AR5 | | | | | | | | | | |
| | 2005 | 2016 | 2017 | average 2016-2018 with 2018=2017 | 2005 | 2016 | 2017 | average 2016-2018 with 2018=2017 | ESR target | AR4 | AR5 | Difference compared to AR4 | AR4 | AR5 | Difference compared to AR4 |
| | Mt CO2 eq | | | | | | | | % of 2005 | Mt CO2 eq | | % | Mio. AEA | | % |
| EU-28 | 2.869 | 2.564 | 2.580 | 2.575 | 2.903 | 2.593 | 2.608 | 2.603 | -30% | 2.008 | 2.032 | 1,2% | 22.493 | 22.761 | 1,2% |
| Austria | 56 | 51 | 52 | 51 | 57 | 51 | 52 | 52 | -36% | 36 | 36 | 1% | 426 | 429 | 1% |
| Belgium | 79 | 72 | 71 | 71 | 79 | 72 | 71 | 72 | -35% | 51 | 51 | 0% | 597 | 599 | 0% |
| Bulgaria | 26 | 26 | 26 | 26 | 27 | 26 | 27 | 26 | 0% | 26 | 27 | 2% | 260 | 264 | 2% |
| Croatia | 18 | 16 | 17 | 16 | 18 | 16 | 17 | 17 | -7% | 16 | 17 | 1% | 164 | 166 | 1% |
| Cyprus | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | -24% | 3 | 3 | 1% | 36 | 37 | 2% |
| Czechia | 61 | 62 | 62 | 62 | 62 | 63 | 63 | 63 | -14% | 53 | 54 | 2% | 566 | 576 | 2% |
| Denmark | 39 | 33 | 32 | 32 | 39 | 33 | 33 | 33 | -39% | 24 | 24 | 1% | 275 | 277 | 1% |
| Estonia | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | -13% | 6 | 6 | 1% | 58 | 58 | 1% |
| Finland | 34 | 31 | 30 | 30 | 34 | 31 | 30 | 30 | -39% | 21 | 21 | 0% | 247 | 247 | 0% |
| France | 396 | 354 | 353 | 353 | 398 | 356 | 355 | 355 | -37% | 249 | 251 | 1% | 2.935 | 2.953 | 1% |
| Germany | 476 | 456 | 467 | 463 | 480 | 459 | 469 | 466 | -38% | 295 | 297 | 1% | 3.666 | 3.691 | 1% |
| Greece | 62 | 45 | 45 | 45 | 63 | 46 | 46 | 46 | -16% | 52 | 53 | 1% | 491 | 497 | 1% |
| Hungary | 46 | 42 | 43 | 43 | 46 | 42 | 44 | 43 | -7% | 43 | 43 | 1% | 426 | 430 | 1% |
| Ireland | 47 | 44 | 44 | 44 | 47 | 44 | 45 | 45 | -30% | 33 | 33 | 2% | 373 | 381 | 2% |
| Italy | 330 | 275 | 270 | 272 | 333 | 278 | 273 | 275 | -33% | 221 | 223 | 1% | 2.427 | 2.452 | 1% |
| Latvia | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | -6% | 8 | 8 | 0% | 85 | 85 | 0% |
| Lithuania | 11,32 | 14 | 14 | 14 | 11,26 | 14 | 14 | 14 | -9% | 10,3 | 10,2 | -1% | 119 | 119 | 0% |
| Luxembourg | 10 | 9 | 9 | 9 | 10 | 9 | 9 | 9 | -40% | 6 | 6 | 0% | 72 | 72 | 0% |
| Malta | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | -19% | 1 | 1 | 2% | 10 | 10 | 2% |
| Netherlands | 123 | 101 | 102 | 102 | 124 | 103 | 103 | 103 | -36% | 79 | 79 | 1% | 884 | 892 | 1% |
| Poland | 182 | 201 | 211 | 208 | 186 | 205 | 215 | 212 | -7% | 169 | 173 | 2% | 1.857 | 1.894 | 2% |
| Portugal | 47 | 40 | 40 | 40 | 48 | 41 | 41 | 41 | -17% | 39 | 40 | 2% | 393 | 401 | 2% |
| Romania | 79 | 74 | 73 | 73 | 83 | 77 | 76 | 76 | -2% | 78 | 81 | 4% | 758 | 788 | 4% |
| Slovakia | 22 | 21 | 21 | 21 | 22 | 21 | 22 | 21 | -12% | 19 | 20 | 1% | 202 | 204 | 1% |
| Slovenia | 12 | 11 | 11 | 11 | 12 | 11 | 11 | 11 | -15% | 10 | 10 | 2% | 104 | 106 | 2% |
| Spain | 237 | 200 | 201 | 201 | 240 | 203 | 204 | 204 | -26% | 175 | 177 | 1% | 1.861 | 1.886 | 1% |
| Sweden | 42 | 33 | 32 | 33 | 43 | 33 | 32 | 33 | -40% | 25 | 26 | 0% | 285 | 286 | 0% |
| United Kingdom | 414 | 335 | 332 | 333 | 422 | 339 | 336 | 337 | -37% | 261 | 266 | 2% | 2.913 | 2.959 | 2% |

Source: : (EEA 2019a, 2019b), own calculation

Lastly, Table 2-5 illustrates the implications of a theoretical scenario where the ESR target levels are determined using AR4 values but the emissions are reported using AR5 values (values are taken from Table 2-4). The table shows that the necessary emission reduction over the period 2017 to 2030 would then be about 1 percentage point higher for the EU-28. At member state level the differences are somewhat larger, varying between -3.3 percentage points for Romania and +0.1 percentage point for Latvia.

**Table 2-5: Estimation of the necessary ESR emission reductions over the period 2017 to 2030 using AR4 values for the target value and AR5 values for emissions monitoring (without LULUCF and without indirect $CO_2$)**

| | AR4 | | | | Partial switch | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | AR5 | AR4 | AR4/5 | |
| | ESD emissions 2005 | ESD emissions 2017 | ESR emission target 2030 | Necessary reduction 2017-2030, related to emissions 2005 | ESD emissions 2017 | ESR emission target 2030 | Necessary reduction 2017-2030, related to emissions 2005 (AR4) | Difference to AR4 only calculation |
| | Mt CO2 eq | | | % | Mt CO2 eq | | % | % points |
| EU-28 | 2.869 | 2.580 | 2.008 | -19,9% | 2.608 | 2.008 | -20,9% | -1,0% |
| Austria | 56 | 52 | 36 | -27,5% | 52 | 36 | -28,3% | -0,7% |
| Belgium | 79 | 71 | 51 | -24,9% | 71 | 51 | -25,3% | -0,4% |
| Bulgaria | 26 | 26 | 26 | -1,6% | 27 | 26 | -2,5% | -0,9% |
| Croatia | 18 | 17 | 16 | -1,7% | 17 | 16 | -3,4% | -1,7% |
| Cyprus | 4 | 4 | 3 | -24,7% | 4 | 3 | -26,4% | -1,7% |
| Czechia | 61 | 62 | 53 | -14,5% | 63 | 53 | -16,1% | -1,6% |
| Denmark | 39 | 32 | 24 | -22,2% | 33 | 24 | -22,8% | -0,6% |
| Estonia | 6 | 6 | 6 | -11,0% | 6 | 6 | -11,5% | -0,4% |
| Finland | 34 | 30 | 21 | -27,6% | 30 | 21 | -27,7% | -0,1% |
| France | 396 | 353 | 249 | -26,1% | 355 | 249 | -26,7% | -0,5% |
| Germany | 476 | 467 | 295 | -36,1% | 469 | 295 | -36,6% | -0,5% |
| Greece | 62 | 45 | 52 | 10,8% | 46 | 52 | 9,6% | -1,1% |
| Hungary | 46 | 43 | 43 | -1,2% | 44 | 43 | -2,0% | -0,8% |
| Iceland | 2 | 3 | 2 | -34,6% | 3 | 2 | -36,3% | -1,8% |
| Ireland | 47 | 44 | 33 | -24,0% | 45 | 33 | -26,1% | -2,0% |
| Italy | 330 | 270 | 221 | -14,8% | 273 | 221 | -15,8% | -1,0% |
| Latvia | 9 | 9 | 8 | -14,7% | 9 | 8 | -14,7% | 0,1% |
| Liechtenstein | 0 | 0 | 0 | 21,8% | 0 | 0 | 21,3% | -0,4% |
| Lithuania | 11 | 14 | 10 | -33,9% | 14 | 10 | -34,4% | -0,5% |
| Luxembourg | 10 | 9 | 6 | -26,5% | 9 | 6 | -26,9% | -0,4% |
| Malta | 1 | 1 | 1 | -71,1% | 1 | 1 | -73,0% | -1,9% |
| Netherlands | 123 | 102 | 79 | -19,0% | 103 | 79 | -19,9% | -1,0% |
| Norway | 26 | 26 | 26 | 0,9% | 27 | 26 | -0,4% | -1,3% |
| Poland | 182 | 211 | 169 | -23,2% | 215 | 169 | -25,2% | -2,0% |
| Portugal | 47 | 40 | 39 | -2,3% | 41 | 39 | -4,0% | -1,7% |
| Romania | 79 | 73 | 78 | 6,0% | 76 | 78 | 2,7% | -3,3% |
| Slovakia | 22 | 21 | 19 | -8,2% | 22 | 19 | -9,8% | -1,5% |
| Slovenia | 12 | 11 | 10 | -7,5% | 11 | 10 | -9,0% | -1,5% |
| Spain | 237 | 201 | 175 | -10,9% | 204 | 175 | -12,1% | -1,2% |
| Sweden | 42 | 32 | 25 | -16,4% | 32 | 25 | -16,5% | 0,0% |
| United Kingdom | 414 | 332 | 261 | -17,3% | 336 | 261 | -18,2% | -1,0% |

Source: : (EEA 2019a, 2019b), own calculation

## 2.4. Impact on projected emissions reductions by 2030

In this section, we use emission projections by member states for the year 2030 to illustrate how a switch from AR4 to AR5 is expected to affect the projected emission changes until 2030.

The analysis is based on emission projections for each greenhouse gas, as reported by member states in 2017 and 2018 under the under the MMR. As projections by gas are not separately available for ETS and ESR emissions, assumptions have been made to split ETS and ESR emissions by gas and by ESR sector. This is especially relevant for CRF sectors 1 and 2. For $CO_2$, the split of ETS and ESD emissions on total GHG by sector has been applied. $CH_4$ emissions only occur in the ESR sector. The same holds for $N_2O$, except for $N_2O$ emissions in sector 2. There, the overall split of ETS and ESD emissions on total GHG has been applied. F-Gases only occur in sector 2. Percentages of the share of F-gases under the Effort Sharing Legislation are estimated based on an analysis of GHG emissions in source categories by Member States. The sum of gases is not totally equal to total projected ESR emissions in 2030. The sums are on average slightly higher than projected total ESR emissions in 2030; the differences vary between -0.2 to 5.4 %. This method aims to take into account the amounts of non-$CO_2$ gases covered under the EU ETS, different to the assumption made above in the previous sections. Moreover, different to the calculation in the previous sections, the GWP values for $SF_6$ emissions have not been converted here.

Table 2-6 shows that projected total EU emissions from 1990 to 2030 would change only by about 0.2 percentage points due to a switch from AR4 to AR5. The EU would report with AR5 values a slightly larger projected emission reduction than it does with AR4 values. With emission reductions calculated with GWP from AR5, the difference to the EU NDC target of -40 % is slightly reduced. At member state level, the differences are somewhat higher, varying by ± 0.5 percentage points. The results are thus similar to the changes in emission reductions over the period 1990 to 2017 (section 2.1).

## Table 2-6: Projected national emission reductions from 1990 to 2030 in AR4 and AR5 (without LULUCF and without indirect $CO_2$)

| | **AR4** 1990 emissions | **AR5** 1990 emissions | **AR4** 2030 emissions | **AR5** 2030 emissions | **AR4** Change 2030/1990 | **AR5** Change 2030/1990 | **Difference in change between AR5 and AR4** |
|---|---|---|---|---|---|---|---|
| | kt CO2eq | | | | Reduction compared to 1990 | | Percentage points |
| EU28 | 5.646.080 | 5.690.047 | 3.824.420 | 3.844.216 | -32,3% | -32,4% | -0,2% |
| Austria | 78.690 | 79.458 | 69.767 | 70.050 | -11,3% | -11,8% | -0,5% |
| Belgium | 146.654 | 146.993 | 114.134 | 114.275 | -22,2% | -22,3% | -0,1% |
| Bulgaria | 103.989 | 104.912 | 55.500 | 55.865 | -46,6% | -46,8% | -0,1% |
| Croatia | 31.894 | 32.101 | 24.677 | 24.975 | -22,6% | -22,2% | 0,4% |
| Cyprus | 5.591 | 5.637 | 9.402 | 9.474 | 68,2% | 68,1% | -0,1% |
| Czech Republic | 197.476 | 199.252 | 108.821 | 109.510 | -44,9% | -45,0% | -0,1% |
| Denmark | 69.245 | 69.277 | 50.923 | 51.076 | -26,5% | -26,3% | 0,2% |
| Estonia | 40.398 | 40.470 | 17.033 | 14.851 | -57,8% | -63,3% | ( -5.5% ) |
| Finland | 71.143 | 71.367 | 48.798 | 48.731 | -31,4% | -31,7% | -0,3% |
| France | 546.369 | 547.312 | 396.138 | 398.277 | -27,5% | -27,2% | 0,3% |
| Germany | 1.251.635 | 1.258.861 | 734.525 | 736.050 | -41,3% | -41,5% | -0,2% |
| Greece | 103.101 | 103.586 | 86.036 | 86.719 | -16,6% | -16,3% | 0,3% |
| Hungary | 93.797 | 94.296 | 58.834 | 59.178 | -37,3% | -37,2% | 0,0% |
| Ireland | 55.490 | 56.421 | 63.889 | 64.728 | 15,1% | 14,7% | -0,4% |
| Italy | 518.363 | 521.226 | 392.100 | 394.370 | -24,4% | -24,3% | 0,0% |
| Latvia | 26.430 | 26.513 | 12.195 | 12.189 | -53,9% | -54,0% | -0,2% |
| Lithuania | 48.108 | 48.365 | 22.136 | 22.059 | -54,0% | -54,4% | -0,4% |
| Luxembourg | 12.786 | 12.824 | 9.504 | 9.545 | -25,7% | -25,6% | 0,1% |
| Malta | 2.102 | 2.109 | 1.683 | 1.700 | -19,9% | -19,4% | 0,5% |
| Netherlands | 220.604 | 222.476 | 171.136 | 172.325 | -22,4% | -22,5% | -0,1% |
| Poland | 467.280 | 471.938 | 358.849 | 361.571 | -23,2% | -23,4% | -0,2% |
| Portugal | 59.825 | 60.646 | 55.847 | 56.669 | -6,6% | -6,6% | 0,1% |
| Romania | 246.748 | 251.901 | 126.330 | 128.564 | -48,8% | -49,0% | -0,2% |
| Slovakia | 73.980 | 74.347 | 40.744 | 40.999 | -44,9% | -44,9% | 0,1% |
| Slovenia | 18.627 | 18.837 | 16.251 | 16.386 | -12,8% | -13,0% | -0,3% |
| Spain | 287.656 | 289.808 | 330.454 | 332.445 | 14,9% | 14,7% | -0,2% |
| Sweden | 71.515 | 71.793 | 45.603 | 45.585 | -36,2% | -36,5% | -0,3% |
| United Kingdom | 796.582 | 807.322 | 403.110 | 406.049 | -49,4% | -49,7% | -0,3% |

Note: The higher number for Estonia results from a wrong entry in the underlying data by gas.

Source: : (EEA 2019a, 2019b); Member State reporting of projections under the MMR 2017 and 2018, own calculation

Table 2-7 shows the same analysis but conducted for the ESR emission reductions for the period 2005 to 2030. The analysis shows that – similar to progress until 2017 illustrated in section 2.2 – the changes in emission reductions due to a switch of the GWP values are higher for the ESR sector than for national totals, due to the higher share of non-$CO_2$ gases in the ESR sector. With AR5 values, the EU-28 would report 0.3 percentage points higher projected emission reductions than with AR4 values. At member state level, the differences are somewhat higher, varying between -2.5 and +0.6 percentage points.

## Table 2-7: Projected ESR emission reductions from 2005 to 2030 in AR4 and AR5 (without LULUCF and without indirect $CO_2$)

| | **AR4 2005 ESR** emissions | **AR5 2005 ESR** emissions | **AR4** 2030 ESR emissions | **AR5** 2030 ESR emissions | **AR4** Change 2030/2005 | **AR5** Change 2030/2005 | **Difference in change between AR5 and AR4** |
|---|---|---|---|---|---|---|---|
| | kt CO2eq | | | | Reduction compared to 2005 | | Percentage points |
| EU28 | 2.871.168 | 2.910.427 | 2.333.347 | 2.356.422 | -18,7% | -19,0% | -0,3% |
| Austria | 56.421 | 56.986 | 44.860 | 45.207 | -20,5% | -20,7% | -0,2% |
| Belgium | 78.676 | 79.212 | 69.869 | 70.105 | -11,2% | -11,5% | -0,3% |
| Bulgaria | 25.969 | 26.613 | 23.452 | 23.828 | -9,7% | -10,5% | -0,8% |
| Croatia | 17.549 | 17.790 | 16.339 | 16.667 | -6,9% | -6,3% | 0,6% |
| Cyprus | 4.242 | 4.300 | 5.210 | 5.287 | 22,8% | 22,9% | 0,1% |
| Czech Republic | 62.413 | 63.607 | 57.253 | 57.994 | -8,3% | -8,8% | -0,6% |
| Denmark | 39.615 | 39.927 | 30.805 | 30.960 | -22,2% | -22,5% | -0,2% |
| Estonia | 6.329 | 6.401 | 6.393 | 6.414 | 1,0% | 0,2% | -0,8% |
| Finland | 33.971 | 34.153 | 26.799 | 26.758 | -21,1% | -21,7% | -0,5% |
| France | 395.790 | 398.796 | 289.711 | 291.944 | -26,8% | -26,8% | 0,0% |
| Germany | 476.127 | 480.420 | 378.904 | 380.556 | -20,4% | -20,8% | -0,4% |
| Greece | 62.075 | 62.824 | 48.730 | 49.427 | -21,5% | -21,3% | 0,2% |
| Hungary | 45.810 | 46.369 | 39.883 | 40.238 | -12,9% | -13,2% | -0,3% |
| Ireland | 46.604 | 47.479 | 47.810 | 48.654 | 2,6% | 2,5% | -0,1% |
| Italy | 330.203 | 333.733 | 253.868 | 256.219 | -23,1% | -23,2% | -0,1% |
| Latvia | 8.529 | 8.571 | 9.781 | 9.775 | 14,7% | 14,0% | -0,6% |
| Lithuania | 11.315 | 11.518 | 14.202 | 14.170 | 25,5% | 23,0% | -2,5% |
| Luxembourg | 10.105 | 10.144 | 8.158 | 8.200 | -19,3% | -19,2% | 0,1% |
| Malta | 938 | 958 | 1.429 | 1.446 | 52,3% | 50,9% | -1,3% |
| Netherlands | 123.180 | 124.709 | 90.013 | 91.313 | -26,9% | -26,8% | 0,1% |
| Poland | 182.024 | 185.944 | 195.800 | 198.591 | 7,6% | 6,8% | -0,8% |
| Portugal | 47.050 | 48.185 | 37.434 | 38.262 | -20,4% | -20,6% | -0,2% |
| Romania | 79.364 | 82.878 | 87.479 | 89.750 | 10,2% | 8,3% | -1,9% |
| Slovakia | 22.086 | 22.508 | 21.140 | 21.418 | -4,3% | -4,8% | -0,6% |
| Slovenia | 11.765 | 11.974 | 10.269 | 10.411 | -12,7% | -13,0% | -0,3% |
| Spain | 236.853 | 239.838 | 197.646 | 199.714 | -16,6% | -16,7% | -0,2% |
| Sweden | 42.485 | 42.744 | 26.421 | 26.425 | -37,8% | -38,2% | -0,4% |
| United Kingdom | 413.678 | 421.844 | 293.689 | 296.691 | -29,0% | -29,7% | -0,7% |

Note: AR4 2005 ESR emissions are calculated values, not the ESD base year numbers as used to track progress to target in (EEA 2018). ESR emissions 2030 shown in this table are calculated numbers as described above. These are on average higher than projected total ESR emissions in 2030; the differences vary between -0.2 (Spain) to 5.4 % (Bulgaria). Resulting projected emission reductions 2030/2005 can't be directly compared to ESR reduction targets.

Source: (EEA 2019a, 2019b); Member State reporting of projections under the MMR 2017 and 2018, own calculation

## 3. Conclusions of the quantitative analysis

The analysis indicates that a change of GWP values from AR4 to AR5 would have relatively small effects. Based on the emission reductions achieved so far as well as those projected by member states for 2030, the EU-28 would have to conduct slightly smaller emission reductions to achieve its NDC (about 0.1 percentage points, considering current progress). The same holds true for the progress to ESR targets. Even at member state level, the differences in emission reductions with AR4 and AR5 values are very small for national totals (between +/-0.5 percentage points) but slightly larger for the effort sharing sector. This is mainly because the increase in the GWP value of methane partially levels out with the decrease in the GWP value of nitrous oxide.

If the EU internally adopted an approach where ESR target levels are determined using AR4 values but emissions are reported using AR5 values, there is a larger, and opposite, effect: in this case, the EU-28 would need to implement more emission reductions to achieve the ESR targets (in aggregate about 1 percentage point). Under this approach the impact on member states also differs more strongly as compared to the situation that AR5 values were used for both ESR target levels and reporting of emissions.

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