PBL Netherlands Environmental Assessment Agency

# PBL Note

# Non-ETS emission targets for 2030

Indication of emission targets for the Netherlands and other EU Member States under the European Effort Sharing Decision

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# Summary and findings

As European Member States are making progress towards their 2020 targets in the Effort Sharing Decision, the attention of policymakers is shifting to a framework beyond 2020. The European Commission launched a discussion with its Green Paper on a possible policy framework for 2030. This PBL Note aims to contribute to that discussion by analysing the effects of various assumptions on Member States' non-ETS emission targets for 2030. The effort sharing of the current European target for 2020 has resulted in an emission target of +20% relative to 2005 levels for the least wealthy Member State and -20% for the three wealthiest Member States. The targets for all other Member States were determined based on per-capita income levels of 2005.

For possible non-ETS targets for 2030, we assumed a Europe-wide emission reduction target of 40% for 2030, compared to 1990 levels. This target is considered by the European Commission as the most cost-efficient to achieve a low-carbon economy by 2050. The 2030 target was split into a target for emissions covered by the EU Emissions Trading System (ETS) and one for emissions that are not covered by the ETS (non-ETS). According to our estimations, European non-ETS emissions need to be reduced by around 30% by 2030, compared to 2005 levels. We distributed the non-ETS reduction target of 30% over the Member States by using similar effort sharing principles that are applied in the EU Effort Sharing Decision for 2020, but with different targets assumed for the least wealthy Member State. We also took recent per-capita income levels into account. However, we did not take into account the costs and effects of emission reductions on GDP.

This PBL Note analyses two possible scenarios that differ in the target assumed for the least wealthy Member State, in order to assess the effects of differing assumptions on the 2030 non-ETS targets. These scenarios should be considered as 'what if' scenarios and not as political positions. Our main findings are presented in the table below.

### Scenario assumptions and main findings

| | Scenario A | Scenario B |
|---|---|---|
| *Assumptions* | The 2030 non-ETS emission target for the least wealthy Member State has been set at 0% relative to its 2005 emission level, while targets for all other Member States have been determined based on per-capita income levels, in such a way that the total EU target will be achieved. | The 2030 non-ETS emission target for the least wealthy Member State has been set at 0% relative to its targeted emission level for 2020, while targets for all other Member States have been determined based on per-capita income levels, in such a way that the total EU target will be achieved. |
| *Findings* | Bulgaria receives the lowest reduction target (0% compared to 2005)<br><br>This implies a significant reduction target for Bulgaria that was allowed to increase its emissions between 2005 and 2020<br><br>Luxembourg, Denmark and Sweden receive the highest reduction target (47% compared to 2005) | Bulgaria receives the lowest reduction target (20% increase compared to 2005)<br><br>This implies that Bulgaria must keep its emission level constant between 2020 and 2030<br><br>Luxembourg, Denmark and Sweden receive the highest reduction target (52% compared to 2005) |

Our sensitivity analysis suggests that reduction targets for the wealthier Member States are not very sensitive to the assumptions made about the minimum reduction target for the least wealthy Member State. The effect of an increase in the overall EU reduction target is larger. We found that an increase in the reduction target from 40% to 45%, while keeping the minimum reduction target constant, would lead to an increase of about 11% in the reduction target for the wealthiest Member States (for the Netherlands this would be about 9%).

For the Netherlands, we found non-ETS emission reduction targets for 2030 of 40% (scenario A) and 43% (scenario B), compared to 2005 emission levels. This corresponds to a respective non-ETS emission budget of 76 and 72 Mt $CO_2$ equivalents by 2030. These emission budgets should however be considered as mere indications. When taking into account the enlarged scope of the ETS from 2013 onwards, the 2030 emission budgets are expected to be somewhat lower. For the Netherlands, the effect could be about 1 Mt $CO_2$ equivalent.

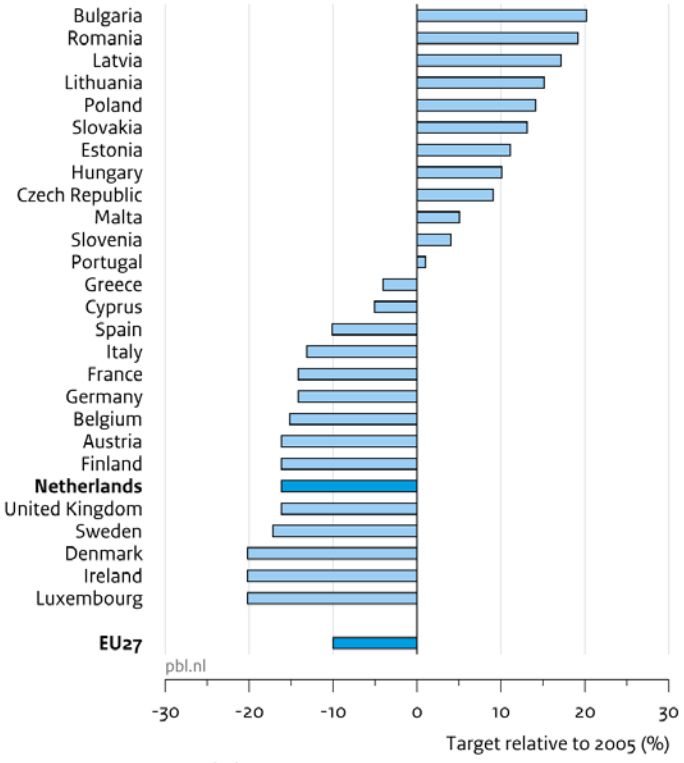
# 1 Introduction

*Current framework of European climate and energy policies up to 2020*

In 2008, the current European climate and energy policy framework was adopted. This framework, which consists of various directives, a guideline and a decision, sets three main targets for 2020, on European level: 20% reduction in greenhouse gas emissions compared to 1990, 20% use of renewable energy, and 20% energy savings compared to a baseline scenario. The 20% emission reduction in greenhouse gases is further divided into emissions covered by the European Emissions Trading System (ETS) Directive, and the Effort Sharing Decision (ESD) for emissions not covered by ETS. The target for emissions under the ETS is a 21% reduction from 2005 levels, by 2020; for emissions under the ESD the reduction target is 10%. These targets have been based on a cost-efficient allocation between ETS and ESD emission reductions. The ETS only has a European emission budget, whereas the ESD target is distributed among Member States to reflect differences in GDP. Wealthy Member States have higher ESD reduction targets than the less wealthy Member States. The ESD reduction targets are within the range of +20% to -20%, relative to 2005 levels (see Figure 1).

Figure 1

**Non-ETS emission targets for 2020**




Source: European Commission

### *Attention of policymakers shifts to 2030*

As European Member States are making progress towards their 2020 targets in the 2020 framework, the attention of policymakers shifts towards a framework beyond 2020. This is deemed relevant as investment decisions, in the short term, have an impact on the period after 2020. Moreover, investors seek clarity on the policy focus for that period. Therefore, in March 2013, the European Commission launched a Green Paper on a policy framework for 2030 (EC, 2013a), which also includes questions regarding climate targets for that time frame. These questions must be seen in the context of the wider ambition of the European Commission and Member States to move towards a low-carbon economy by 2050 (EC, 2013a). This ambition would result in greenhouse gas emission reductions in the range of 80% to 95% by 2050, compared to 1990 levels (EC, 2011a). According to the EC, this would imply that, by 2030, European greenhouse gas emissions must be reduced by around 40% to 44%, compared to 1990 levels (EC, 2011b).

### *Current effort sharing exacerbates reduction targets for 2030*

Under the assumption that the framework of the ETS and ESD will remain in place up to at least 2030, the European-wide ESD emission reduction for 2030 needs to be distributed over the Member States. However, applying the current effort sharing agreement to the more ambitious overall EU 2030 target would result in an exacerbation of current reduction targets. This would lead to an increase of up to 63% in emissions for the least wealthy Member State and a 63% reduction for the wealthiest Member States, increasing differences in effects on GDP. As such, a renewed agreement on effort sharing with respect to reducing non-ETS emissions in all Member States can be expected.

### *Aim of this PBL Note*

This PBL Note is intended to contribute to the discussion on 2030 climate targets, in the context of the Effort Sharing Decision. The Dutch Ministry of Infrastructure and the Environment (IenM) has requested PBL Netherlands Environmental Assessment Agency to indicate possible non-ETS emission targets for Member States for 2030, while taking into account long-term EU climate ambitions. This would help the Dutch Government and other Member States to determine their position in the European debate on 2030 climate and energy targets. It would also help the Dutch Government to formulate national climate policies for 2030.

The results presented here should be considered as 'what if' scenarios in which basic assumptions on effort sharing vary, in order to analyse the effects on non-ETS emission reduction targets. The scenarios were not evaluated for their political feasibility, nor do they represent the position or preference of PBL.

### *Method*

We calculated new non-ETS targets for Member States by using the principles currently applied in the Effort Sharing Decision, but taking into account recent developments in Gross Domestic Product (GDP) and 2030 emission reduction targets in line with the ambition for a low-carbon economy by 2050. The resulting targets for Member States were then used to determine emission budgets for 2030, for each Member State. Emission budgets here are defined as the maximum emission level that Member States would be allowed to emit during a certain year (i.e. 2030). Effects of reduction targets on GDP were not taken into account.

### *Reading guidance*

The main results from our analysis are presented in Section 2. Section 3 describes the methodology and Section 4 presents detailed results, including a sensitivity analysis and a discussion on the results.

# 2 Main Results

## 2.1 Effort sharing of non-ETS emission reductions by 2030

*EU effort sharing of 30% non-ETS reduction: two default scenarios*

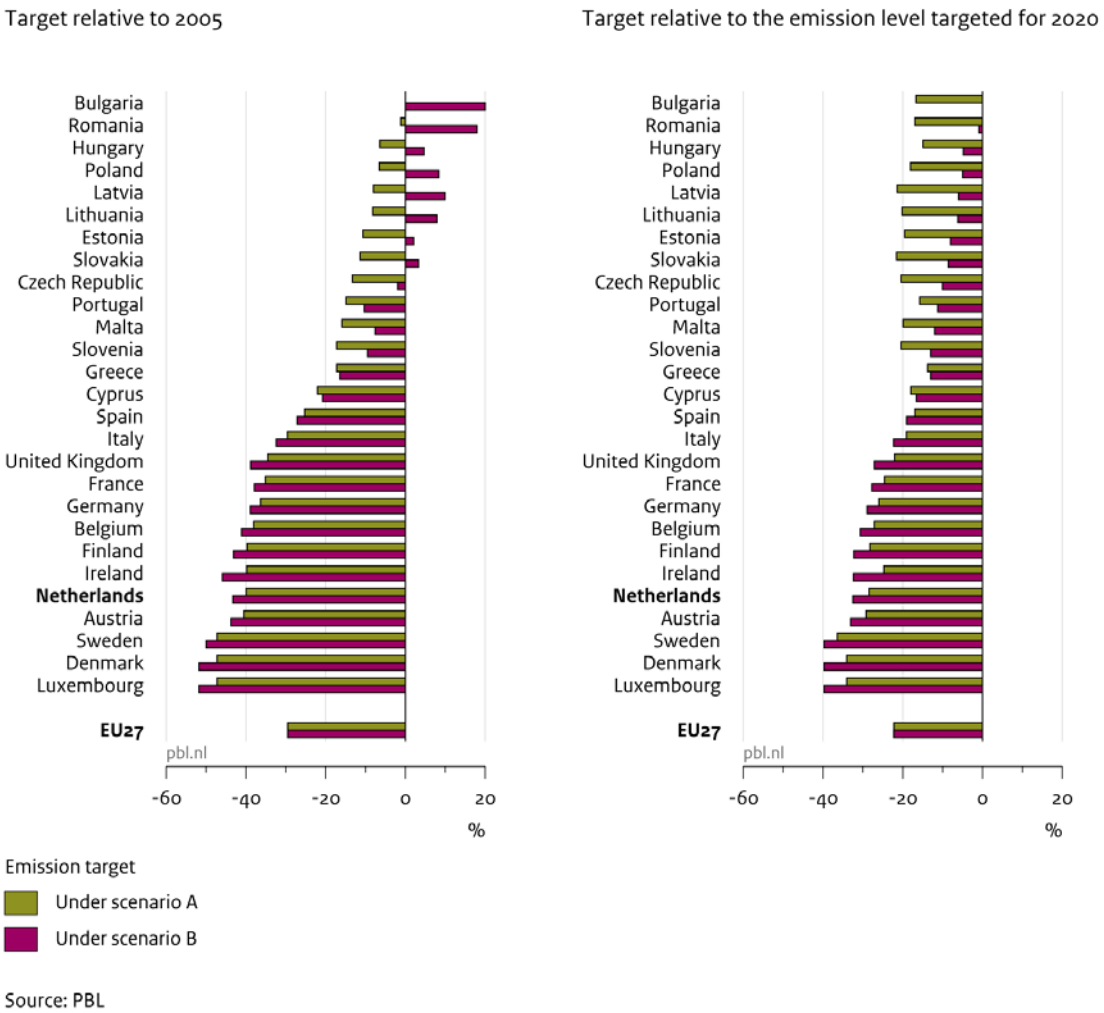
According to our estimations, European non-ETS emissions need to be reduced by around 30% by 2030, compared to 2005 levels. This is in line with a European-wide emission reduction of 40%, compared to 1990 levels; a target considered as cost-efficient to achieve a low-carbon economy by 2050. We calculated new reduction targets for 2030 based on the overall 30% non-ETS EU reduction and two default effort sharing scenarios, which differ in the reduction percentage assumed for the least wealthy Member State:

- Scenario A: The 2030 emission target for the least wealthy Member State has been set at 0% relative to its 2005 emission level, while targets for all other Member States have been determined based on their per-capita income levels;
- Scenario B: The 2030 emission target for the least wealthy Member State has been set at 0% relative to its targeted emission level for 2020, while targets for all other Member States have been determined based on their per-capita income levels.

The reduction targets were used for determining non-ETS emission budgets for 2030 – the maximum amount of emissions that Member States are allowed to emit within the context of the European Effort Sharing Decision. Section 3 provides a detailed description of the methodology and motivation for these scenarios.

Figure 2

**Non-ETS emission targets for 2030**




Source: PBL

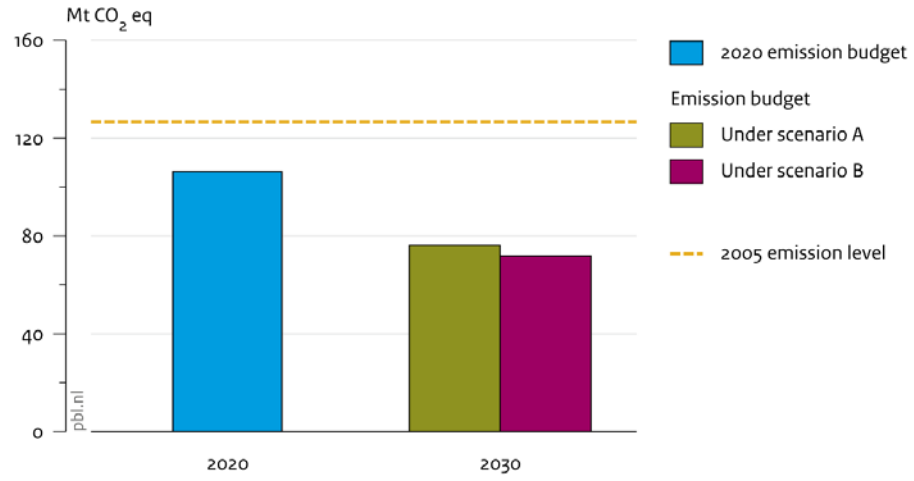
### *Reduction targets for 2030 for Member States*

Figure 2 presents the resulting reduction targets for scenarios A and B, relative to 2005 emission levels and the targeted emission levels for 2020. Based on recent statistics on GDP per capita, Bulgaria received the 0% reduction target in both scenarios (compared to 2005 and 2020 for scenarios A and B, respectively), while Luxembourg, Denmark and Sweden received the maximum reduction target. As the assumed minimum reduction target differs between the two scenarios, the resulting maximum reduction target in both scenarios varies, as well. Scenario A uses a maximum emission reduction of 47%, compared to 2005 levels, and this is 52% in scenario B. This corresponds with maximum reduction targets relative to the targeted emission levels for 2020 of 36% and 40%, respectively. This means that under scenario B, where the 2030 target for the least wealthy Member State is set at 0% relative to its targeted emission level for 2020, the relatively wealthy Member States receive higher emission reduction targets than under scenario A. However, under scenario A, the target for the least wealthy Member State implies reductions compared to targeted emission levels for 2020. That suggests a significant reduction target for this Member State, considering that this Member State is allowed to increase its emission level between 2005 and 2020. Figure 2 also shows that scenario A would result in a convergence of reduction targets when compared to the targeted emission levels for 2020. Under scenario A, the reduction targets for Member States range from 14% to 36%, compared to 0% to 40% under scenario B (both relative to the targeted emission levels for 2020).

### *Non-ETS emission reduction target for 2030 for the Netherlands*

For the Netherlands, non-ETS emission reduction targets of 40% were estimated for 2030 under scenario A and 43% under scenario B, compared to 2005 levels. This corresponds with respective non-ETS emissions budgets of 76 and 72 Mt $CO_2$ equivalents by 2030 (see Figure 3).

Figure 3
**Non-ETS emission budget for the Netherlands**




Source: PBL

### *Sensitivity of targets to basic assumptions*

We found reduction targets for the wealthier Member States to not be very sensitive to the assumptions made on the minimum reduction target for the least wealthy Member State. This is explained by the fact that these Member States are responsible for only a small share of total EU emissions. The targets for Member States with GDP levels close to the EU average, such as Spain and Italy, were also found to be very insensitive to the chosen minimum reduction target for the least wealthy Member State, as the targets for these Member States with average GDP levels, in all cases, are close to the average EU target. When the reduction target for the least wealthy Member State would be lowered in scenario A from 0% to 5%, compared to 2005 levels, the emission target for the wealthiest Member States would increase by 3% (and for the Netherlands by just under 2%). The effect of an increase in the overall EU reduction target is greater: an increase in the European-wide reduction target from 40% to 45% would for the wealthiest Member States lead to an increase of about 11% (and for the Netherlands this would be about 9%). Section 4 provides more details on the sensitivity results.

# 3 Methodology

## 3.1 Determining the European effort for reducing non-ETS emissions by 2030

*European climate ambitions for 2030 and 2050*

In 2011, the European Commission published its long-term ambition for a competitive, low-carbon economy by 2050 (EC, 2011a). That ambition would imply European emission reductions in the range of 80% to 95%, compared to 1990 levels. This ambition is considered to be relevant for the current debate on a possible policy framework for climate and energy policies up to 2030 (EC, 2013a). According to the EC, the ambition for 2050 would imply emission reductions of around 40% to 44% by 2030, compared to 1990 levels, under a cost-optimal scenario (EC, 2011b).

*Dividing the European ambition of 40% into ETS and non-ETS*

Our default scenarios assume that the EU will reduce its emissions by 40%, compared to 1990 levels, by 2030, and that the framework of ETS and ESD will remain in place. This corresponds to the ambition of the Dutch Government for agreeing on a new EU-wide target of at least 40% reduction in European greenhouse gas emissions by 2030, compared to 1990 levels (I&M, 2013). In our sensitivity analysis, we analysed the effect of a 45% reduction target (see Section 4). We divided the 40% ambition into an ETS and a non-ETS emission reduction effort (see Table 1), using the following assumptions:

- Non-ETS emissions are calculated by subtracting the ETS emission budget from the total European emission budget. Emission budgets for 2030 are linear interpolations between those for 2020 and 2050. The ETS and non-ETS emission budgets for 2020 were obtained from the EC (2012a).
- The total European emission budget for 2050 is based on a 80% emission reduction, compared to 1990 levels. This reduction will be achieved within the EU, without the use of international credits. The 1990 emission level was determined according to the definitions agreed by the Intergovernmental Panel on Climate Change (IPCC), but excludes emissions from land use, land-use change, forestry and the use of bunker fuel. Emissions from international aviation (except those from incoming international flights) were included.
- The ETS emission budget for 2050 is based on a 90% emission reduction, compared to 2005 levels. This is in the middle of the range of 88% to 92% indicated by the EC in the Roadmap scenario for 2050 (Table 9 in EC, 2011b). The ETS scope is that of the revised ETS directive (2009/29/EC), but excludes emissions from incoming international flights, which is similar to the assumptions in the Roadmap scenario (EC, 2011b). For emissions from aviation that are included in the ETS, we assumed an emission budget of 100 Mt $CO_2$ for 2050 (excluding incoming international flights), which roughly corresponds with the emission level projected for 2050 in the Roadmap scenario (EC, 2011b).

These assumptions result in a non-ETS emission reduction target of 30% for 2030, compared to 2005 levels (see Table 1). This target is in the middle of the range of 24% to 36% indicated by the EC in the Roadmap scenario for 2050 (Table 9 in EC, 2011b).

**Table 1. EU27 emission targets and budgets for the ETS and non-ETS sectors**

| % reduction compared to base-year emission level | | | | | |
|---|---|---|---|---|---|
| | | base year | 2020 | 2030 | 2050 |
| EU total | | 1990 | -20% | -40% | -80% |
| ETS total | | 2005 | -20% | -43% | -90% |
| - stationary installations | | 2005 | -21% | -45% | -94% |
| - aviation | | 2005 | -5% | -15% | -34% |
| non-ETS | | 2005 | -10% | -30% | -69% |
| | | | | | |
| emission budget in Mt $CO_2$ equivalents | | | | | |
| | 1990 | 2005 | 2020 | 2030 | 2050 |
| EU total | 5,644 | 5,262 | 4,515 | 3,367 | 1,129 |
| ETS total | | 2,447 | 1,958 | 1,387 | 245 |
| - stationary | | 2,296 | 1,814 | 1,258 | 145 |
| - aviation | | 151 | 144 | 129 | 100 |
| non-ETS | | 2,809 | 2,528 | 1,980 | 884 |

Sources: EC (2011b), EC (2012a), EEA (2013) and PBL calculations
Table does not include data from Croatia, and excludes emissions from incoming international flights.

## 3.2 Effort sharing by EU Member States to achieve the European non-ETS target

*Effort sharing for non-ETS emission reductions up to 2020*

The current European Effort Sharing Decision (406/2009/EC) sets a 10% reduction target for 2020, compared to 2005 levels, for European greenhouse gas emissions that are not covered by the ETS. The European effort to meet this target is shared among Member States in such a way that GDP effects are distributed in a fair and equitable manner (EC, 2008). This is considered to be the case under the following effort sharing principles:

- The Member State that had the lowest level of GDP per capita in 2005 is allowed to increase its emissions by 20% by 2020, compared to its 2005 level;
- The reduction targets for the three Member States that had the highest levels of GDP per capita in 2005 are set at 20% below those 2005 levels;
- The reduction targets for Member States that, in 2005, had a GDP level, per capita, that was equal to the EU average are set at the average EU reduction target;
- The targets for all other Member States are set according to a linear function of the GDP per capita of 2005. For the countries with below-average GDP per capita, this function is based on the minimum and average targets; for those with above-average level of GDP per capita, the function is based on the maximum and average targets.

The above principles results in an overall reduction target of about 10%, compared to 2005 emission levels. Bulgaria, being the least wealthy Member State, is allowed to increase its non-ETS emissions by 20% by 2020, compared to its 2005 level, while Luxembourg, Denmark and Ireland (the three Member States that had the highest level of GDP per capita in 2005) need to reduce their non-ETS emissions by 20%, compared to those 2005 levels. The Netherlands, one of the richest Member States, has a reduction target of 16% (Figure 1).

The relative efforts were agreed in 2008/2009 and were recently translated in absolute annual non-ETS emission budgets for the period up to 2020, for each Member State (EC, 2013b).

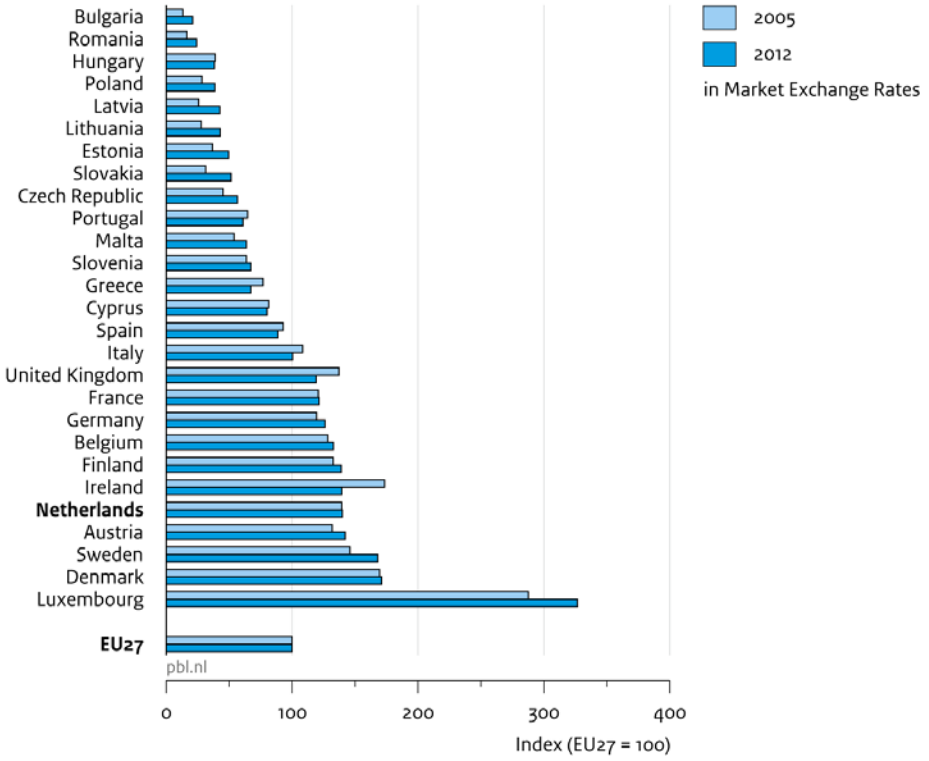
### *Assumptions on non-ETS effort sharing up to 2030*

For this paper, we applied similar principles as those used by the European Commission for the effort sharing up to 2020. The only two differences are that i) we used the GDP per capita figures of 2012 from Eurostat (2013), and ii) we changed the emission range of -20% to +20% in order to arrive at a total average non-ETS EU reduction of 30%, compared to 2005 levels. As we used GDP data on 2012, we did not take into account any feedbacks of emission reductions on GDP. The emission budgets for 2030 were calculated using the target (percentage) and the 2005 emission levels.

Figure 4 and Table 4 (in the Annex) provide insights into the differences in GDP per capita between Member States in 2005 and 2012. The EU average GDP per capita increased by 13% between 2005 and 2012. At the same time, the absolute differences between Member States increased, too. In 2005, the standard deviation of the level of GDP per capita was about 14,000 euros, compared to more than 16,000 in 2012 (Table 4 in the Annex). In most Member States, GDP per capita increased by more than the EU average, between 2005 and 2012. However, in some relatively large countries, such as the United Kingdom, Spain and Italy, GDP per capita increased by substantially less than the EU average; the United Kingdom even showed an absolute decrease in the level of GDP per capita between 2005 and 2012. Other (relatively small) Member States with increases in the level of GDP per capita that were lower than the EU average are Cyprus, Ireland, Greece, Hungary and Portugal. The level of GDP per capita of the Netherlands increased by 14% between 2005 and 2012. Bulgaria remains the Member State with the lowest GDP per capita. In 2005, Luxemburg, Ireland, and Denmark formed the top three of wealthiest Member States. By 2012, Sweden replaced Ireland in this top three.

As for the range of emission reduction targets across Member States, we included two default scenarios that differ in the assumed emission target for the least wealthy Member State. The emission targets for all other Member States result from the effort sharing principles as described above.

Figure 4
**GDP per capita**



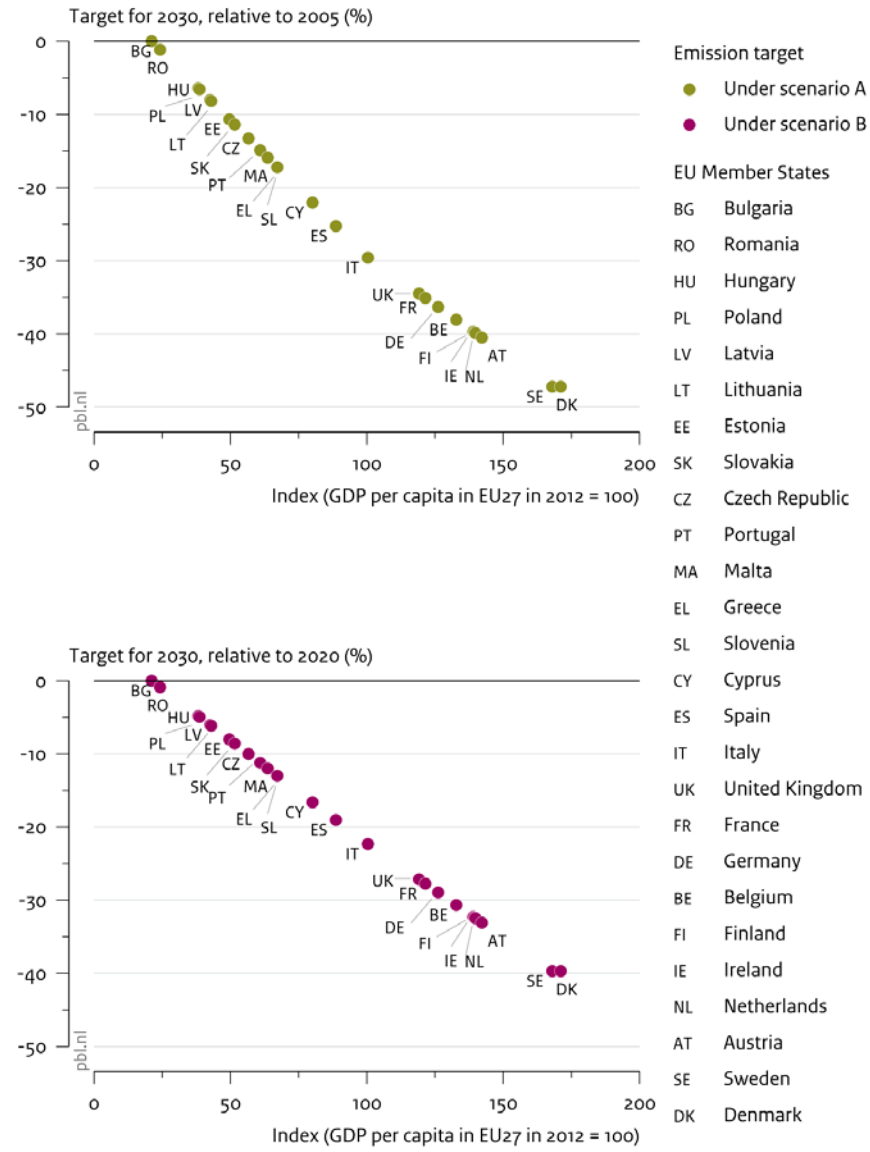

Source: Eurostat, 2013

*Scenario A: Least wealthy Member State will stabilise its emissions at the 2005 level by 2030*

In scenario A, the emission reduction target for 2030 for the least wealthy Member State (Bulgaria) is set at 0%, relative to its 2005 emission level. The rationale behind this scenario is that non-ETS emissions on a European level need to be reduced by 30% by 2030, from 2005 levels, compared to 10% under the current effort sharing up to 2020. This implies that an additional 20 percentage points must be reduced by 2030, compared to the reduction target for 2020. Therefore, we lowered the increase in emissions for the least wealthy Member State by 20 percentage points, relative to the effort sharing up to 2020. This resulted in a reduction target of 0% for 2030, compared to 2005 levels, for the least wealthy Member State. Under this scenario, in order to achieve the 30% overall EU non-ETS reduction target, the targets for the three wealthiest Member States were set at about 47% below 2005 levels (Figure 5).

Figure 5

**GDP per capita and non-ETS emission targets**




Source: PBL

# 4 Detailed results

This section presents the findings of our sensitivity analyses and discusses some caveats when interpreting the results. Numerical results can be found in the last part of this section.

## 4.1 Sensitivity analysis

### *Adjusting the minimum reduction target for the least wealthy Member State*

In our default scenarios, the minimum reduction target for the least wealthy Member State was kept constant at 0%, but the base year varied (2005 or 2020). In order to analyse the effect of a different minimum reduction target (compared to the same base year), we analysed two variants on our default scenario:

- The non-ETS emissions target for 2030, for the least wealthy Member State was set at 5% below its 2005 emission level. This variant increases the reduction target for the least wealthy Member State, compared to that under scenario A.
- The non-ETS emissions target for 2030, for the least wealthy Member State was set at 5% above the 2020 emission target. This variant decreases the reduction target for the least wealthy Member State, compared to that under scenario B.

Increasing the emission reduction target for the least wealthy Member State by 5% of 2005 levels would lower the non-ETS target for the wealthiest Member States by 3% (Table 2). This suggests that the reduction target for the wealthiest Member States is not very sensitive to the minimum reduction target for the least wealthy Member State. A similar conclusion can be drawn from the variant where a lower reduction target is assumed for the least wealthy Member State. In that case, the reduction target for the wealthiest Member States would increase by 3%. For the Netherlands, with an increase of 2% in both variants, the effect would be even smaller. This low sensitivity is due to the fact that the Member States less wealthy than the EU average, together, were responsible for only 28% of European non-ETS emissions in 2005. Adjusting the reduction target for this group of Member States, therefore, would have relatively little impact on the targets for Member States wealthier than the EU average. It should be noted that small differences in emissions targets may have large impacts on the costs of achieving these targets, as the marginal costs of additional emission reductions can be substantial. Such cost estimates, however, were beyond the scope of this analysis.

### *Raising the overall EU ambition level to an emission reduction of 45%*

We also analysed the effect that a higher EU ambition level to reduce emissions would have on effort sharing. For this purpose, we assumed an EU-wide emission reduction target of 45% for 2030, compared to 1990 levels. This would require the ETS and non-ETS targets for 2030 to be raised to 48% and 36%, respectively, compared to 2005 levels. Such a division of ETS and non-ETS would fall within the range as indicated by the EC under a cost-optimal scenario (EC, 2011b).

An increase in the non-ETS reduction target from 30% to 36%, under our scenarios A and B, would lead to an increase in the non-ETS emission reduction targets for all Member States, except for the least wealthy Member State (as this reduction target is assumed to remain constant). An EU reduction target of 45% would have the largest impact on the wealthiest Member States, including the Netherlands. Their reduction targets would increase by around 10%, relative to 2005 levels (Table 2). This implies that the reduction targets for the relatively wealthy Member States would be sensitive to the EU-wide ambition level.

Combining a higher European non-ETS reduction target with a higher reduction target for the least wealthy Member State, would lower the reduction target for the relatively wealthy Member States. Although this variant is not examined in this paper, the effect of a higher reduction target on the maximum reduction target, under such a scenario, would only be small. A sensitivity analysis of a 5% reduction increase for the least wealthy Member State showed a 3% lower reduction target for the most wealthy Member States (see previous section).

## 4.2 Discussion of the results

### *Scenario assumptions not based on costs considerations*

Although we applied principles similar to those in the effort sharing up to 2020, our scenarios did not take the costs and effects of emission reductions on GDP into account. Therefore, this study cannot be considered an integral assessment. The effort sharing principles up to 2020 are defined by the European Commission in such a way that any impacts on welfare are distributed in a fair and equitable manner (EC, 2008). Our results with respect to effort sharing could work out differently if effects on GDP also would be taken into account. However, this strongly depends on what politically would be considered as acceptable sharing of the costs among Member States. By analysing the effects of different assumptions, we could show the sensitivity of those assumptions on the effort sharing. Therefore, our sensitivity analysis included different minimum reduction targets for the least wealthy Member State.

### *Exploring other effort sharing principles by using 2 extreme scenarios*

Starting point for our analysis was an effort sharing principle for 2030 that is very similar to that used for 2020. However, a large variety of effort sharing principles are proposed in the literature, leading to a wide range of results (see Table 13.2 in Gupta et al., 2007 and Hof et al., 2009). As not all possible effort sharing principles could be studied, we chose the two – in our view – most extreme principles. The outcome of the other feasible effort sharing principles are likely to fit somewhere within the range between these two scenario variants:

- Continuation of the current effort sharing agreement, but also taking into account the EU target of reducing 30% of non-ETS emissions by 2030. Under this variant, the emission reduction effort for Member States, relative to the EU average of 10% (e.g. the 16% reduction target for the Netherlands for 2020 is 60% higher than the EU average) is multiplied by the EU reduction target for 2030 of 30%. This would result in a range of reduction targets for 2030 from a 63% increase to a 63% decrease, compared to 2005 emission levels. For the Netherlands, this would result in a reduction target of 50% below its 2005 emission level. Compared to other variants discussed in this paper, this would result in a further divergence of reduction targets across Member States;
- No effort sharing after 2020. Under this variant, the non-ETS emission reduction target for all Member States is lowered by 20 percentage points compared to their targets for 2020. This would result in a range of reduction targets from 0% (below 2005 levels) for the least wealthy Member State to 40% for the wealthiest Member States. Compared to other variants discussed in this paper, the discontinuation of effort sharing after 2020 would result in a convergence of the reduction targets for all Member States.

### *Effort sharing from a long-term perspective*

In order to realise a low-carbon economy, deep emission reductions are required. The European Commission has calculated that, in a cost-optimal scenario, non-ETS emissions would need to be reduced by around 69% by 2050, compared to 2005 levels (EC, 2011b). We analysed whether the effort sharing method that was agreed for the 2020 horizon would also be suitable for such deep emission reductions. If large differences in GDP between Member States would persist, as projected by the European Commission (EC, 2012b), this method may result in very deep reductions or even negative emissions by 2050 for wealthy Member States. This could be deemed

unacceptable from a political standpoint. However, by adjusting the minimum reduction target of the least wealthy Member State, this could be avoided. We found that, if the EU non-ETS emission reduction target were to be set at 69% for 2050 and the least wealthy Member State would be required to stabilise its emissions at the 2005 level, the wealthiest Member States would be required to reduce their non-ETS emissions by around 110%. This implies that those wealthier Member States need to sequester emissions. This can be avoided by setting the minimum reduction target to 18% or higher, compared to 2005 levels. This would lead to a reduction target of below 100% for the wealthiest Member States. Although this paper gives no indication of acceptable minimum (or maximum) reduction targets, we may conclude that the method itself could be used for achieving deep emission reductions beyond 2020.

It should also be noted that the current EU Effort Sharing Decision allows for trade in emission allowances between Member States. That means that Member States with large emission reduction targets may decide to reduce emissions not entirely domestically but also in other Member States. This may help to alleviate the effects of deep emission reductions on GDP.

### *Non-ETS emission budgets not corrected for ETS scope in the third trading period*

The non-ETS emission budgets for 2030 were calculated using emission levels from the same base year (2005) as was used by the European Commission for calculating the non-ETS emission budgets for 2020 (EC, 2013b). Although these data were corrected for changes in the scope of the ETS from the first trading period (2005–2007) to the second (2008–2012), the data were not corrected for changes in scope between the second and third trading periods (2013–2020). The scope in the third trading period is relevant for the emission budgets for 2020, but also for those for 2030. Considering that more sectors and greenhouse gases will be included within the scope of ETS in the third trading period (compared to the second period), the overall non-ETS emission level in the base year (2005) is expected to be slightly lower than presented in Tables 2 and 3[1].As the emission levels of these additional sectors and greenhouse gases are relatively small compared to EU-wide emission levels, the quantitative impact of this unaccounted change also is expected to be relatively small. For the Netherlands, for example, a non-ETS base year emission level of about 125 Mt $CO_2$ equivalents is estimated, which is 2 Mt lower than assumed in our analysis (Verdonk, 2011). This would result in an emission budget for 2030 that is about 1 Mt $CO_2$ equivalents lower than shown in Table 3.

[1] Non-ETS emissions in 2005 presented in Table 1 include an estimation of a corrected ETS scope for the third trading period. However, this estimation is not available on Member State level.

## 4.1 Detailed results

The full numerical results from our analyses are presented in Tables 2 and 3 below.

**Table 2. Non-ETS emission targets for 2030 (%)**

| | | % relative to 2005 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2005 | 2020 | 2030 | | | | | |
| | Mt $CO_2$ eq | | default scenarios | | sensivity analysis | | | |
| | | | scenario A | scenario B | scenario A but with minimum target of 5% below 2005 | scenario B but with minimum target of 5% above 2020 | scenario A but with 45% EU reduction | scenario B but with 45% EU reduction |
| Austria | 59 | -16% | -41% | -44% | -39% | -46% | -49% | -53% |
| Belgium | 83 | -15% | -38% | -41% | -37% | -43% | -46% | -49% |
| Bulgaria | 24 | 20% | 0% | 20% | -5% | 26% | 0% | 20% |
| Cyprus | 6 | -5% | -22% | -21% | -23% | -20% | -27% | -26% |
| Czech Republic | 63 | 9% | -13% | -2% | -16% | 1% | -16% | -5% |
| Denmark | 37 | -20% | -47% | -52% | -44% | -55% | -58% | -62% |
| Estonia | 6 | 11% | -11% | 2% | -14% | 6% | -13% | -1% |
| Finland | 35 | -16% | -40% | -43% | -38% | -45% | -48% | -52% |
| France | 422 | -14% | -35% | -38% | -34% | -39% | -43% | -46% |
| Germany | 509 | -14% | -36% | -39% | -35% | -40% | -44% | -47% |
| Greece | 63 | -4% | -17% | -16% | -19% | -14% | -21% | -20% |
| Hungary | 52 | 10% | -6% | 5% | -10% | 9% | -8% | 3% |
| Ireland | 47 | -20% | -40% | -46% | -38% | -48% | -49% | -54% |
| Italy | 341 | -13% | -30% | -32% | -30% | -32% | -36% | -39% |
| Latvia | 8 | 17% | -8% | 10% | -12% | 14% | -10% | 8% |
| Lithuania | 16 | 15% | -8% | 8% | -12% | 12% | -10% | 6% |
| Luxembourg | 10 | -20% | -47% | -52% | -44% | -55% | -58% | -62% |
| Malta | 1 | 5% | -16% | -8% | -18% | -5% | -19% | -12% |
| **Netherlands** | **127** | **-16%** | **-40%** | **-43%** | **-38%** | **-45%** | **-49%** | **-52%** |
| Poland | 180 | 14% | -7% | 8% | -10% | 13% | -8% | 7% |
| Portugal | 49 | 1% | -15% | -10% | -17% | -8% | -18% | -14% |
| Romania | 76 | 19% | -1% | 18% | -6% | 24% | -1% | 18% |
| Slovakia | 24 | 13% | -11% | 3% | -14% | 7% | -14% | 0% |
| Slovenia | 12 | 4% | -17% | -10% | -19% | -7% | -21% | -14% |
| Spain | 239 | -10% | -25% | -27% | -26% | -26% | -31% | -33% |
| Sweden | 46 | -17% | -47% | -50% | -44% | -53% | -58% | -61% |
| United Kingdom | 381 | -16% | -35% | -39% | -34% | -40% | -42% | -46% |
| ***EU27*** | ***2,913*** | ***-10%*** | -30% | -30% | -30% | -30% | -36% | -36% |

Source: PBL; 2005 emission data is from the European Commission

**Table 3. Non-ETS emission budgets for 2030 (Mt)**

| Mt $CO_2$ equivalents | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2005 | 2020 | 2030 | | | | | |
| | | | default scenarios | | sensivity analysis | | | |
| | | | Scenario A | Scenario B | Scenario A, but with minimum target of 5% below 2005 | Scenario B, but with minimum target of 5% above 2020 | Scenario A, but with 45% EU reduction | Scenario B, but with 45% EU reductio n |
| Austria | 59 | 50 | 35 | 33 | 36 | 32 | 30 | 28 |
| Belgium | 83 | 70 | 51 | 49 | 52 | 47 | 44 | 42 |
| Bulgaria | 24 | 29 | 24 | 29 | 23 | 30 | 24 | 29 |
| Cyprus | 6 | 6 | 5 | 5 | 4 | 5 | 4 | 4 |
| Czech Republic | 63 | 68 | 54 | 61 | 53 | 63 | 53 | 59 |
| Denmark | 37 | 30 | 20 | 18 | 21 | 17 | 16 | 14 |
| Estonia | 6 | 6 | 5 | 6 | 5 | 6 | 5 | 6 |
| Finland | 35 | 29 | 21 | 20 | 22 | 19 | 18 | 17 |
| France | 422 | 363 | 274 | 262 | 278 | 258 | 241 | 230 |
| Germany | 509 | 438 | 324 | 311 | 330 | 304 | 283 | 270 |
| Greece | 63 | 61 | 52 | 53 | 51 | 54 | 50 | 50 |
| Hungary | 52 | 57 | 48 | 54 | 46 | 56 | 48 | 53 |
| Ireland | 47 | 37 | 28 | 25 | 29 | 24 | 24 | 21 |
| Italy | 341 | 296 | 240 | 230 | 240 | 230 | 218 | 209 |
| Latvia | 8 | 10 | 8 | 9 | 7 | 9 | 7 | 9 |
| Lithuania | 16 | 19 | 15 | 17 | 14 | 18 | 15 | 17 |
| Luxembourg | 10 | 8 | 5 | 5 | 6 | 5 | 4 | 4 |
| Malta | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Netherlands** | **127** | **106** | 76 | 72 | 78 | 69 | 65 | 61 |
| Poland | 180 | 205 | 168 | 195 | 161 | 202 | 165 | 191 |
| Portugal | 49 | 50 | 42 | 44 | 41 | 45 | 40 | 42 |
| Romania | 76 | 90 | 75 | 89 | 71 | 94 | 75 | 89 |
| Slovakia | 24 | 27 | 21 | 25 | 21 | 26 | 21 | 24 |
| Slovenia | 12 | 12 | 10 | 11 | 9 | 11 | 9 | 10 |
| Spain | 239 | 216 | 179 | 175 | 177 | 176 | 166 | 161 |
| Sweden | 46 | 38 | 24 | 23 | 25 | 21 | 19 | 18 |
| United Kingdom | 381 | 320 | 249 | 233 | 253 | 229 | 220 | 205 |
| ***EU27*** | ***2,913*** | ***2,641*** | ***2,054*** | ***2,054*** | ***2,054*** | ***2,054*** | ***1,865*** | ***1,865*** |

Source: PBL; 2005 emission data is from the European Commission

## Annex

**Table 4. Changes in gross domestic product, per capita, between 2005 and 2012**

| | 2005 | 2012 | change |
|---|---|---|---|
| Austria | 29,800 | 36,400 | 22% |
| Belgium | 29,000 | 34,000 | 17% |
| Bulgaria | 3,000 | 5,400 | 80% |
| Cyprus | 18,400 | 20,500 | 11% |
| Czech Republic | 10,200 | 14,500 | 42% |
| Denmark | 38,300 | 43,800 | 14% |
| Estonia | 8,300 | 12,700 | 53% |
| Finland | 30,000 | 35,600 | 19% |
| France | 27,300 | 31,100 | 14% |
| Germany | 27,000 | 32,299 | 20% |
| Greece | 17,400 | 17,200 | -1% |
| Hungary | 8,800 | 9,800 | 11% |
| Ireland | 39,200 | 35,700 | -9% |
| Italy | 24,500 | 25,700 | 5% |
| Latvia | 5,800 | 10,900 | 88% |
| Lithuania | 6,300 | 11,000 | 75% |
| Luxembourg | 65,000 | 83,600 | 29% |
| Malta | 12,200 | 16,300 | 34% |
| **Netherlands** | 31,500 | 35,800 | 14% |
| Poland | 6,400 | 9,900 | 55% |
| Portugal | 14,600 | 15,600 | 7% |
| Romania | 3,700 | 6,200 | 68% |
| Slovakia | 7,100 | 13,200 | 86% |
| Slovenia | 14,400 | 17,200 | 19% |
| Spain | 21,000 | 22,700 | 8% |
| Sweden | 33,000 | 43,000 | 30% |
| United Kingdom | 31,000 | 30,500 | -2% |
| | | | |
| **Total EU** | 22,600 | 25,600 | 13% |
| *Standard deviation* | *14,032* | *16,205* | |

Source: Eurostat (2013) and PBL calculations

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