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Consequences of ceilings on the use of Kyoto mechanisms

A tentative analysis of cost effects for EU Member States

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Preface

Several countries in the European Union have expressed in the fall of 1998 that the use of the so-called Kyoto Mechanisms (emission trading, joint implementation and clean development mechanism) should be limited. A way to limit this use is by imposing ceilings for buyers of emission reductions. The EU Ad Hoc Group on Climate Change has listed several alternative ceilings in December 1998 and January 1999.

To provide an input to the discussions within the EU Ad Hoc Group the Dutch Ministry of Economic Affairs has requested ECN to analyse the cost consequences for individual EU Member States of a selection of the suggested ceilings. A draft report was presented and distributed at the EU Ad Hoc Group on Climate Change on January 17 and 18, 1999. The project was conducted under ECN number 7.7185.

It is noted that after long discussions the EU Member States have agreed in May 1999 upon a common position in the climate negotiations with respect to ceilings on Kyoto Mechanism. The finally agreed proposal differs from the ceilings considered in this report, however, the insights gained with the present study are largely applicable to the final EU proposal.

Abstract

To safeguard that domestic actions will be taken to meet commitments, the Kyoto Protocol suggests that domestic action should be the main means for reaching the reduction commitments. Imposing ceilings on the *purchase* of emission reductions is one of the ways to limit the net use of Kyoto mechanisms. Several kinds of ceilings have been suggested.

This analysis gives some insight into the cost consequences for EU Member States that result from different types of ceilings for Kyoto mechanisms.

The impacts of ceilings can be very large but the precise impact is difficult to estimate due to uncertainties about the price of emission reductions and the price elasticity of the supply of emission reduction. Consequently, decisions on ceilings on the use of Kyoto mechanisms need to be taken with great care.

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SUMMARY

The Kyoto Protocol includes the so-called Kyoto mechanisms (Joint Implementation, Emission Trade and Clean Development Mechanism). To safeguard that domestic actions will be taken to meet the commitments, the Kyoto Protocol suggests that domestic action should be the main means for reaching the reduction commitments. Imposing ceilings on the *purchase* of emission reductions is one of the ways to limit the net use of Kyoto mechanisms. Several kinds of ceilings have been suggested.

This analysis gives some insight into the cost consequences for EU Member States that result from different types of ceilings for Kyoto mechanisms. Therefore, a number of proposals (see Table S.1) has been analysed with a model framework that includes emission projections and marginal cost curves for six greenhouse gases and for all EU Member States.

Table S.1 *Options for ceilings on the contribution of Kyoto mechanisms considered in the present analysis. (Base year is 1990/1995; average of budget period 2008-2012)*

Maximum net purchase of Kyoto mechanisms is linked to:	Variant 1	Variant 2
Percentage of base year emissions	2.5% (option 1.1)	10% (option 3.1)
Percentage of assigned amount for the first budget period	2.5% (option 1.2)	10% (option 3.2)
Percentage of the difference between the emissions of the base year and the assigned amount	50% (option 1.5)	--
Percentage of the difference between the business as usual (BAU) emissions in the budget period and the assigned amount	50% (option 3.5)	--

These ceiling options on the net use of Kyoto mechanisms can prove to be *binding* or *non-binding* for a country, depending on the amount of emission reductions a country would have bought without a ceiling.

Evaluation of ceilings on the contribution of Kyoto mechanisms shows analogues with the distribution of quantitative emission limits and reduction objectives. Most of the criteria that are relevant to evaluate reduction commitments, such as equity and cost-effectiveness, are also valid for the evaluation of ceilings on the use of Kyoto mechanisms. This paper will only deal with two criteria: one specific meaning of equity (change in cost compared to a situation without a ceiling on Kyoto mechanisms) and cost-effectiveness.

The international market price for emission reductions is not yet known. An earlier study indicated a market price in Western Europe amounting to \$16/tCO_2 and this price was taken as the default market price. To analyse the sensitivity, lower and higher market prices have also been considered (\$8 and \$30 per ton CO_2).

As a result of imposed ceilings the purchase of emission reductions will decrease and the market price of emission reductions may drop. This would result in significantly less cost for EU Member States that are net purchasers of emission reduction in case this ceiling is not binding for them. Also, this leads to more imports of permits, compared to a free use of Kyoto mechanisms. The lower market price will result in lower benefits for countries that are net sellers of emission reductions.

All proposals for ceilings considered here limit the contribution of Kyoto mechanisms to meeting the Kyoto reduction commitments. The largest effect on the purchase of emission reductions by individual EU Member States is a drop in purchases with almost 70% compared to a situation without a ceiling.

Three of the six options for ceilings considered lead to much less purchase of emission reductions. The cost consequences of ceilings for the EU as a whole are large for these ceilings. Then the cost will typically increase with 100-300% compared to a situation without ceilings. The cost impact of the other 3 ceilings considered is more modest resulting in a cost increase for the EU as a whole between 10% and 40%. The cost for the EU is least for the ceiling of 50% of the difference between baseline emissions and assigned amount. The cost consequences of ceilings will differ per country. All ceilings considered will result in higher cost to meet their Kyoto commitment for Austria and Denmark. Most ceiling options considered will give higher cost for Italy, Netherlands, Finland, Sweden, Belgium and the UK but other ceilings will lead to lower cost for these countries. Due to ceilings Germany, France, Spain and Portugal will have lower benefits from sales of emission reductions.

The impacts of ceilings can be very large but the precise impact is difficult to estimate due to uncertainties about the price of emission reductions and the price elasticity of the supply of emission reduction. Consequently, decisions on ceilings on the use of Kyoto mechanisms need to be taken with great care. At this moment in time additional analyses are required. Such analyses should preferably include other Annex I countries and cover the (world-wide) supply of emission reductions.

1. BACKGROUND

1.1 Kyoto Protocol, Kyoto mechanisms and ceilings

In December 1997 the Kyoto Protocol was adopted. The Kyoto Protocol includes legally binding commitments for Annex I countries (OECD, Russia and Eastern Europe) for the first budget period (2008-2012). The Kyoto Protocol presents the rough features of the so-called Kyoto mechanisms: Joint Implementation, Emission Trade and Clean Development Mechanism.

Several Articles in the Kyoto Protocol suggest that domestic action should be the main means for reaching the reduction commitments, rather than solely relying on the Kyoto mechanisms. Frequently mentioned motivations to primarily focus on domestic emission reduction are:

- To create an additional incentive for innovation.
- To more credibly show to developing countries that commitments are serious.

Ceilings can also be motivated as a step wise introduction of Kyoto Mechanisms that reduces the risks associated. Imposing ceilings on the purchase of emission reductions is one of the ways to limit the net use of Kyoto mechanisms. Ceilings on the net contribution of Kyoto mechanisms can be defined in different ways and several options to define ceilings have been suggested.

The European Union concluded at the Environmental Council meeting in October 1998 that a concrete ceiling on the contribution of the mechanisms should be implemented, defined in qualitative and quantitative terms, based on equitable criteria.

1.2 Problem definition and objective

When ceilings for Kyoto mechanisms are considered it is important to anticipate the consequences. Among other consequences, ceilings are likely to have effects for the cost burdens of countries and the cost-effectiveness to meet the Kyoto Protocol. As of yet, it is uncertain what these effects are and how they depend on the design of the ceilings. For the EU it is of particular interest what the effects would be for the individual Member States.

This analysis aims to provide insight into the rough cost consequences for the EU Member States of different types of ceilings for Kyoto mechanisms. Therefore, the cost effects of several concrete proposals have been analysed. The types of ceiling analysed here are also included in the draft ‘Proposals on a concrete ceiling’ of the EU Ad Hoc Group on Climate Change (EU Ad Hoc Group, 1998). It is noted that this tentative analysis is not intended to identify the most favourable kind of ceiling. In the current stage it is considered more appropriate to get a sense of the possible effects of some of the possible ceilings.

2. CEILINGS ON THE CONTRIBUTION OF KYOTO INSTRUMENTS

2.1 Types of proposals

The EU Ad Hoc Group on Climate Change has listed over 20 options to determine ceilings. These options can be classified as follows:

- *Options for quantitative ceilings that are linked to emission figures*. Such emission figures can be historic emissions, assigned amounts, baseline emission projections or differences between these figures. For most of these options the quantitative ceilings can directly be derived from known figures using relatively simple formulas.
- *Options for quantitative ceilings that are linked to efficiency indicators or to the efforts to limit domestic emissions.* In this case the use of Kyoto mechanisms is either conditional or the ceilings may be linked to e.g. the relative efficiency of energy use (which will be measured via e.g. benchmarking), the share of renewables in the energy mix, the removal of subsidies for fossil fuel use, etc.

This study needs to be regarded as a first analysis of a limited set of options. The quantitative ceilings that are linked to efficiency indicators or efforts to reduce domestic emissions will not yet be analysed.

Four main options to define ceilings with a link to emission figures have been proposed in (EU Ad Hoc Group, 1999). The maximum net purchase of emission reductions were linked to:

- A percentage of the emissions of the base year (options 1.1 and 3.1 in EU Ad Hoc Group, (1999)).
- A percentage of the assigned amount for the first budget period (options 1.2 and 3.2).
- A percentage of the difference between the emissions of the base year and the assigned amount (option 1.5).
- A percentage of the difference between the business as usual (BAU) emissions in the budget period and the assigned amount (option 3.5).

Apart from these proposals, Member States submitted many others, which differ due to correction factors and choice of numerical limit.

2.2 Evaluation of ceilings

The ceilings on the contribution of Kyoto mechanisms impose a maximum on the purchase of emission reductions. Here, the situation with ceilings will be compared with a situation without ceiling for Kyoto mechanisms as a reference situation suggested.

As a first remark it is noted that properly designed Kyoto mechanisms need to carefully consider both the demand and the supply of emission reductions. With respect to the supply of emission reductions many aspects, e.g. with respect to monitoring, verification and determination of baselines for CDM projects still have to be dealt with in the international climate negotiations. Such aspects relevant to the supply of emission reductions are not subject of this report.

Evaluation of ceilings on the contribution of Kyoto mechanisms shows analogues with the distribution of quantitative emission limits and reduction objectives.

Most of the criteria that are relevant to evaluate reduction commitments are also valid for the evaluation of ceilings on the use of Kyoto mechanisms, e.g.:

- equity,
- effectiveness (to reach targets, to stimulate domestic action, to enhance innovation,etc),
- cost-effectiveness,
- practicability/feasibility,
- verifiability.

In practice of international climate negotiations all such criteria are dealt with at the same time usually leading to some compromise in which none of these individual criteria may be fully met but the compromise gets sufficient support to become accepted.

This paper does not intend to systematically cover all criteria to evaluate different options for ceilings. Instead, this paper will only deal with one specific meaning of equity which is expected to support the negotiability of a ceiling in international climate negotiations (change in cost compared to a situation without a ceiling on Kyoto mechanisms) and with cost-effectiveness. Other criteria are also considered important but fall beyond the scope of this paper.

Equity is playing an important role in debates on burden sharing. It is noted that no single commonly accepted definition of equity exists. Different perspectives can be taken which build on different principles of equity, see e.g. (Ringius, 1998) for an overview. Some of the ways to quantify equity principles are:

- equal emissions per capita,
- equal welfare effects (or cost) per capita,
- share abatement costs across counties in proportion to emission levels,
- link emission levels to the country's efficiency (of energy use).

Most of the options for ceilings as listed by the EU Ad Hoc Group on Climate Change are not designed with an equity principle in mind. Only the second and fourth principle can be recognised in some of the options for ceilings. For the present analysis it was decided to start with the cost per capita when dealing with equity.

2.3 Proposals included in the quantitative analysis

The options for ceilings on Kyoto mechanisms that have been analysed in this study (see Table 2.1) are a limited set of possible ceilings. The ceilings analysed here are also included in the draft 'Proposals on climate change' of the EU Ad Hoc Group on Climate Change.

Table 2.1 *Options for ceilings on the contribution of Kyoto mechanisms considered in the present analysis*

Maximum net purchase of Kyoto mechanisms is linked to:	Variant 1	Variant 2
Percentage of base year emissions	2.5% (option 1.1)	10% (option 3.1)
Percentage of assigned amount for the first budget period	2.5% (option 1.2)	10% (option 3.2)
Percentage of the difference between the emissions of the base year and the assigned amount	50% (option 1.5)	--
Percentage of the difference between the business as usual (BAU) emissions in the commitment period and the assigned amount	50% (option 3.5)	--

3. MODEL BASED ANALYSIS OF THE EFFECTS OF CEILINGS ON THE COST OF MITIGATION

This chapter presents a model-based analysis of the cost consequences of ceilings on Kyoto mechanisms. Some remarks can be made with respect to the modelling analysis. The approach that has been followed assumes economic optimising behaviour. Further, a totally transparent market has been assumed which leads to one international market price for emission reductions. It is noted that only the EU Member States have been analysed as the applied analysis tool currently only includes marginal cost curves for these countries. The response to ceilings of the rest of the world had to be included by making some crude assumptions. The present analysis focuses on the year 2010. The year 2010 is assumed to be representative for the years in the first budget period (2008-2012). The use of Kyoto mechanisms has been assumed for all six (groups of) greenhouse gases.

Section 3.1 introduces the methodological approach. Section 3.2 presents the cost to meet the Kyoto Protocol commitments for a situation without limitations on the net contribution of Kyoto mechanisms. The cost consequences of different options for ceilings are presented in Section 3.3 and a comparison of the results is given in Section 3.4.

3.1 Brief introduction on methodological approach

Methodology

This analysis assumes sales and purchases of emission reductions to be limited to governments. In a situation without ceilings on the net use of Kyoto mechanisms, a country that minimises the cost to meet its emission target will take those domestic measures, which have marginal cost below the market price. If a country does not yet meet its commitment by carrying out domestic measures, the remainder of the commitment will be met by buying emission reductions at the market price. The cost of such a '*purchasing country*' to meet its commitment consists of the cost of the domestic measures and the product of amount of emission reductions that has to be purchased and the market price.

Countries that exceed their commitments when they take all domestic measures with marginal cost up to the international market price can sell emission reductions. The cost for these '*selling countries*' is the cost of the domestic measures minus the amount of emission reductions sold times the market price.

The options to define ceilings on the net use of Kyoto mechanisms can prove to be *binding* or *non-binding* for a country, depending on the amount of emission reductions the country would have bought without a ceiling. A binding ceiling actually limits the purchase of emission reductions by a country while a non-binding ceiling on the Kyoto mechanisms has no effect on the purchase of emission reductions.

If a binding ceiling is imposed on the net contribution of Kyoto mechanisms for only one small purchasing country, this will not significantly affect the market price of emission reductions. Then the estimation of the cost for this country to meet its commitment is straightforward. The cost consists of the amount of emission reductions that this country is allowed to purchase times the market price and the cost of the domestic reductions required to meet the national commitment.

However, if a binding ceiling is imposed for a large purchasing country or for all purchasing countries the drop in realised demand for emission reductions will lower the market price (*direct effect)*. It is important to note that the lower market price will have indirect effects. The lower market price for emission reductions will increase the demand for emission reduction, as countries for which the ceiling is non-binding will purchase more emission reductions (*indirect effect*). The net result of the direct and indirect effects will be a lower demand for emission reduction and a lower price for emission reduction. In this case the estimation of the cost for a country is somewhat more complicated as the new market prices need to be determined to calculate the cost effects both for selling and purchasing countries. Furthermore, the impact on emission imports of the countries that are not bound by the ceiling implies that implementing a ceiling may well lead to less domestic action instead of more.

In this analysis, the estimation of the new market prices includes the assumption that the relative drop for the EU in the demand to purchase emission reduction compared to a situation without ceilings is representative for the relative world wide drop in demand. Further, a price elasticity of supply of 1 has been assumed.

Model with marginal cost curves per country

This analysis builds on a model framework with a set of emission projections per greenhouse gas and a set of marginal cost curves for reduction of greenhouse gas emissions for the EU Member States. The greenhouse gas emission projections (Table 3.1) are largely consistent with the national communication of countries although some figures have been updated and/or adjusted. Between 1990 and 2010 the CO_2 emissions are projected to increase with 5.2%; the total greenhouse gas emissions expressed in CO_2 equivalent emissions will increase with 1.0% compared to the 1990/1995 base year (see also Figure 3.1).

Table 3.1 *Greenhouse gas emissions in the EU 1990/95 and in 2010 [Mton CO_2-equivalent]*

	CO_2		CH_4		N_2O		PFCs		HFCs		SF_6		LUCF
	1990	2010	1990	2010	1990	2010	1995	2010	1995	2010	1995	2010	2010
Austria	62	63	12.3	12.3	3.6	4.4	0.0	0.0	0.3	0.8	1.3	1.6	-0.1
Belgium	106	121	13.3	10.0	9.6	10.4	0.1	0.0	0.6	2.0	0.5	0.5	-0.1
Denmark	52	60	8.8	7.6	10.5	8.7	0.0	0.0	1.0	2.0	0.4	0.4	-0.2
Finland	53	72	5.2	4.0	5.6	7.3	0.0	0.0	0.1	0.2	0.1	0.1	0.0
France	378	415	63.4	53.0	56.3	36.0	0.7	0.9	1.9	9.5	0.5	0.5	-2.0
Germany	1003	845	119.3	57.9	70.1	66.9	1.7	0.8	3.2	18.3	6.0	5.4	-0.4
Greece	84	127	9.3	10.4	5.4	5.4	0.7	0.3	1.0	4.0	0.4	0.4	0.0
Ireland	31	41	17.0	17.6	5.1	8.1	0.0	0.0	0.1	0.4	0.1	0.2	-2.3
Italy	408	467	52.0	48.0	51.0	53.1	0.1	0.0	3.1	4.4	0.3	0.5	-0.6
Luxembourg	15	11	0.5	0.5	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	161	210	27.1	14.9	19.8	21.1	2.4	1.0	6.7	9.3	1.5	2.0	-0.1
Portugal	45	63	16.9	15.0	4.3	4.7	0.0	0.0	0.9	3.0	0.4	0.4	-0.9
Spain	208	265	45.8	50.4	29.2	29.1	4.5	2.4	6.5	10.3	0.2	0.3	-6.0
Sweden	56	64	6.8	5.5	2.9	3.9	0.4	0.6	0.2	0.9	1.2	1.2	-0.2
UK	580	589	92.6	58.9	63.0	52.3	0.6	0.7	15.4	6.1	0.7	1.0	-1.1
Total	3242	3412	490	366	337	311	11.0	6.7	40.9	71.0	13.6	14.4	-14.0

LUCF stands for Land Use Change and Forestry.
Source: (Gielen et al., 1998).

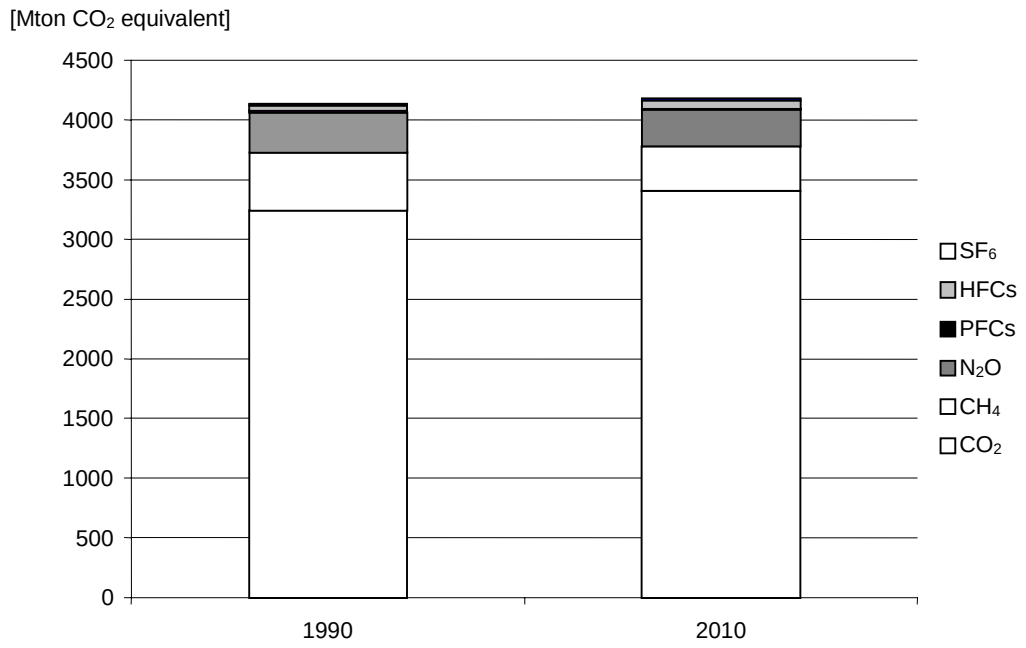

Figure 3.1 *Projected greenhouse gas emissions for 1990/1995 and 2010*

For CO_2 the marginal cost curves have been constructed with the help of national cost-optimising bottom-up energy models such as MARKAL, EFOM and MESSAGE. National teams to calculate strategies to meet increasing reduction targets and to give marginal and total energy system cost figures have used these models[1]. Country specific circumstances have been accounted for in these bottom-up energy models[2]. The marginal cost curves for the other greenhouse gases and for land use change per Member State have been constructed by ECN with a set of rather crude assumptions per emission source about the cost of emission abatement options[1]. The marginal cost curves for the 6 different gases add up to a CO_2 equivalent marginal cost curve.

Based on the marginal cost curves and an assumed international trade price for emission reductions the model calculates in a first step what part of the commitment of a country will be realised by domestic measures. The second step implies the calculation of the cost of countries to purchase emission reduction in case the national commitments are not yet met or the calculation of the emission reduction sales in case the country exceeds its Kyoto reduction commitment. Starting point for the analysis are the assigned amounts for EU Member States that have been agreed upon.

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1 Data on CO_2 emissions and reduction cost curves were taken from submissions to the IEA-ETSAP Programme (ETSAP, 1997), kindly provided by: *Koen Smekens*, VITO and *Denise van Regemorter*, CES-KULeuven (Belgium); *Paul-Erik Morthorst*, Risoe (Denmark); *Peter Schaumann*, IER Stuttgart (Germany); Magnus Wistbacka, VTT (Finland); *GianCarlo Tosato and Mario Contaldi*, ENEA (Italy); *Remko Ybema*, ECN (Netherlands); *Tomas Larsson*, Chalmers University (Sweden). For other member states own ECN estimates were used, for the most part adapted from early analyses with the EFOM model (Coherence, 1994) (CEC, 1991), (Balandynowicz, 1995).

2 It is noted that marginal cost curves are cost estimates for future emission reductions, based on most consistent, detailed and technical analyses available to ECN. In view of the existing uncertainties and the fact that the consistency of the national studies can be improved the results need to be considered carefully. Only limited value can be placed on the results in absolute sense. Comparison of the cost curves used in this study with other emission reduction studies shows a similar picture for the relative positions of countries concerning reductions costs (Gielen et al., 1998).

Market price for emission reduction

Rules, guidelines and conditions of the Kyoto mechanisms have not yet been agreed upon. Besides, substantial uncertainties are related to the projections of greenhouse gas emissions and the options to abate these emissions. As a result it is not possible to give a narrow range for the market price of emission reductions. Therefore this analysis takes different market prices as starting points. The assumed market prices are \$8/tCO_2, \$16/tCO_2 and \$30/tCO_2. The middle value (\$16) has been taken from the results of an earlier analysis (Balandynowicz, Reuter, Voss, 1995) [1]. In that study it appeared that \$16/tCO_2 would be the market price in the case that emission trading would only be allowed within the EU. The three market prices have been assumed for a situation without ceilings on the purchase of emission reductions (reference situation). As a result of the introduction of ceilings on Kyoto mechanisms the market price tends to drop in cases with ceilings.

3.2 Situation without ceilings for Kyoto mechanisms

To meet its Kyoto commitment the EU has to reduce its greenhouse gas emissions with 336 Mton CO_2 equivalents compared to the base case emission projection presented in Table 3.1. Table 3.2 shows which part of its commitment the EU will meet by domestic measures and how large the purchases and sales of much emission reductions will be for 3 possible market prices.

Table 3.2 *Optimal allocation of emission reduction of the EU for the year 2010 in a situation without ceilings on the contribution of Kyoto mechanisms and assuming different market prices for emission reductions*

Market price	Domestic measures	Reductions purchased by individual Member States	Reductions sold by individual Member States	Net trade with non-EU	Reduction from baseline
	[Mton]	[Mton]	[Mton]	[Mton]	[Mton]
\$8/tCO_2	212.0	196.1	71.9	124.2	336.2
\$16/tCO_2	335.5	137.3	136.6	0.7	336.2
\$30/tCO_2	470.1	81.9	215.8	-133.9	336.2

In case of a low market price for emission reductions (e.g. \$8/tCO_2) a larger share of the commitment will be met by buying emission reduction than with a higher price. Most EU Member States will purchase emission reductions at this price but some other Member States (Germany, France, Spain and Portugal) will sell emission reductions.

Table 3.2 shows that higher price for emission reduction (\$16 and \$30/tCO_2) will lead to more domestic measures and to less purchase of emission reductions. At the same time Member States will sell more emission reductions. With a market price of \$30/tCO_2 the EU becomes a net seller of emission reductions.

For an market price of \$8/tCO_2 the division between domestic measures and emission reduction via Kyoto mechanisms is as given in Figure 3.2. Domestic measures and emissions purchased are expressed as positive bars while emissions sold are expressed as negative bars. Expressed in absolute amounts, Italy, and the Netherlands are the largest purchasers of emission reductions. Austria and Denmark reach their commitments with the highest shares of Kyoto mechanisms.

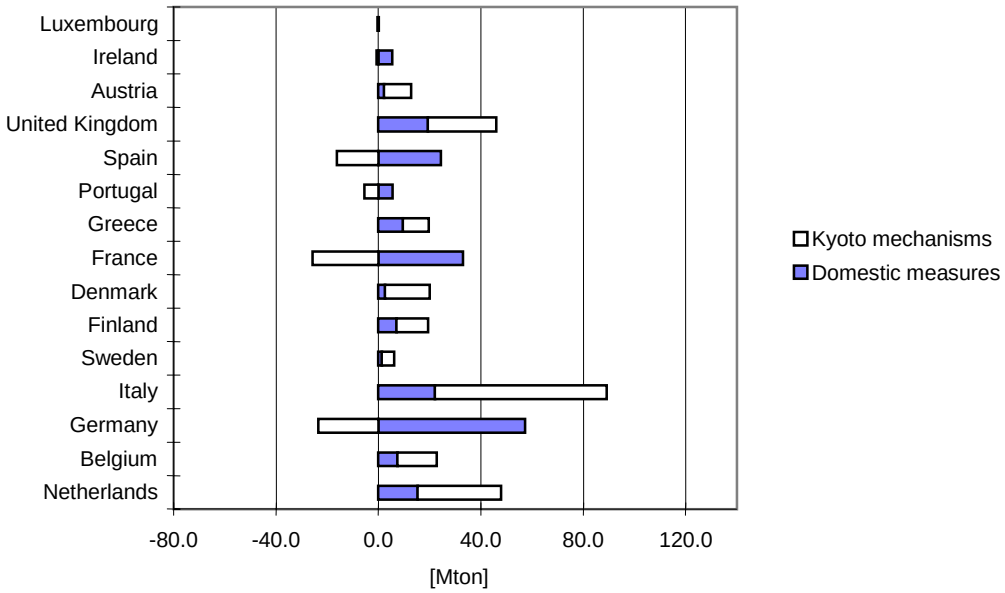

Figure 3.2 *Optimal allocation of emission via domestic measures and emission reduction via Kyoto mechanisms in 2010 to meet Kyoto commitments for the EU Member States assuming an market price of \$8/tCO$_2$. Emissions sold are expressed as negative bars*

If other market prices for emission reductions are assumed (\$16 and \$30 per ton CO_2), the part of the commitments that will be met by domestic measures will be larger and the part that will be met by purchasing emissions will decline.

Table 3.3 *Cost to meet Kyoto commitments [million \$1995]*

	Market price		
	[\$8/tCO$_2$]	[\$16/tCO$_2$]	[\$30/tCO$_2$]
Austria	93	172	301
Belgium	151	244	293
Denmark	148	277	473
Finland	126	203	261
France	-73	-356	-1019
Germany	41	-272	-1067
Greece	118	162	70
Ireland	15	-3	-64
Italy	624	1075	1604
Luxembourg	-2	-5	-9
Netherlands	321	528	677
Portugal	-22	-84	-270
Spain	-33	-247	-967
Sweden	43	76	105
United Kingdom	290	460	674
Net cost for EU-15	1842	2230	1062

Cost to meet Kyoto commitments (cost of domestic measures plus purchase of emission reductions minus sales of emission reductions) in the year 2010 for EU Member States in a situation without ceilings on the use of Kyoto mechanisms assuming several market prices for emission reductions (million \$1995).

The total cost to meet the commitments (cost of domestic measures plus purchase of emission reductions minus sales of emission reductions) differs per country and depends on the market price (see Table 3.3). Several countries, such as Germany, France, Portugal and Spain, will benefit from the Kyoto commitments, as they can profit from the fact that emission reductions can be sold. Their benefits increase with higher market prices. Most other countries will face net cost to meet their Kyoto commitment. Their cost will increase with higher market prices. The EU as a whole will suffer higher cost from an market price of $16 compared to a price of $8, but will gain when the price increases to $30. In the latter case, the net costs of the EU are even lower than with the market price of $8.

Table 3.4 shows that within the EU a large range in the cost per capita will occur. Denmark, Finland, Netherlands, Austria, Italy and Belgium have significant cost. Their cost increase with higher market prices.

Table 3.4 *Cost per capita in EU Member States [in $ per capita]*

	[$8/tCO$_2$]	[$16/tCO$_2$]	[$30/tCO$_2$]
Austria	12.0	22.3	39.0
Belgium	14.9	24.1	28.9
Denmark	27.9	52.3	89.3
Finland	24.1	38.8	49.8
France	-1.2	-5.7	-16.4
Germany	0.5	-3.4	-13.3
Greece	11.0	15.0	6.5
Ireland	4.4	-0.9	-18.3
Italy	10.4	17.9	26.7
Luxembourg	-5.6	-12.5	-24.6
Netherlands	19.2	31.6	40.6
Portugal	-2.3	-8.9	-28.5
Spain	-0.8	-6.1	-23.7
Sweden	4.7	8.2	11.5
United Kingdom	4.8	7.6	11.2
EU average	4.8	5.8	2.8

Cost per capita in EU Member States (in $ per capita) to meet the Kyoto commitments in a situation without ceilings for the net use of Kyoto mechanisms and for different market prices for emission reductions. Countries with a negative cost figure will have a net gain as a result of the sales of emission reductions.

Total cost for the EU in 2010 to meet the Kyoto commitments (accounting for benefits for some Member States) add up to 1.84, 2.23 and 1.06 billion $ with market prices of $8, $16 and $30/tCO$_2$ respectively. The lowest cost in case of the highest market price is a result of larger earning for the sellers of emission reduction than extra cost for purchasers.

It is noted that without the contribution of Kyoto mechanisms the cost for the EU would be much higher. The total cost would then be independent of the market price and amount to 8.5 billion $ in 2010 (Gielen et al., 1998).

3.3 Consequences of ceilings on Kyoto mechanisms

In this section the cost consequences are calculated for different options to quantify concrete ceilings for Kyoto mechanisms. The numerical examples were taken from the EU Ad Hoc Group paper on ceilings (EU Ad Hoc Group, 1998).

3.3.1 Percentage of base year emissions

Two percentages have been considered for ceilings based on base year emissions (10% and 2.5% of the base year emissions).

Table 3.5 *New market price and the net cost for the EU for ceilings of 10% and 2.5% of the base year emission and comparison of the cost to a situation without a ceiling*

Ceiling case market price without ceiling	New market price [$/tCO$_2$]	Net cost for the EU [billion $]	Increase compared to situation without ceiling [%]
10% of base year emission			
$8/tCO$_2$	6.29	2.07	12
$16/tCO$_2$	14.98	2.43	9
$30/tCO$_2$	28.50	1.35	27
2.5% of base year emission			
$8/tCO$_2$	2.69	5.22	183
$16/tCO$_2$	5.90	5.33	139
$30/tCO$_2$	17.15	4.72	344

Table 3.5 shows that the 2.5% ceiling has a dramatic effect on the market price and on the net cost of the EU. The market price drops 50-70% compared to a situation without ceilings and the net cost for the EU to meet its commitment increase to $4.7-5.3 billion. This is roughly equivalent to an increase with 140% to 340%. The effects of a 10% ceiling are much smaller. The new market price is 4-20% less than in a situation without ceilings while the increase of net cost for the EU is between 9-27%.

Table 3.5 shows the net cost per country to meet the Kyoto commitments with a ceiling of 2.5% of the base year emission. The changes in cost compared to a situation without ceilings shows a similar pattern for Netherlands, Belgium, Sweden and Finland. If the assumed initial market price (before ceilings are imposed) is $8/tCO$_2$ their cost will significantly increase (between 30% and 42%) due to the ceiling. On the other hand if the initial market price is $16/tCO$_2$ the increase in cost is either limited or the cost even show a small drop. With the $30/tCO$_2$ price the cost for these countries will be lower than in a situation without a ceiling. This can be explained as follows. At the $8/tCO$_2$ initial market price these countries want to buy larger amounts of emission reductions than at $16 or $30 per ton CO_2. Only in case of the initial price of $8/tCO$_2$ the ceiling is binding forcing these countries in order to meet their commitment to take more expensive domestic measures. In case of the $16 initial market price two effects compensate one another. On the one hand the ceiling slightly limits the wanted purchase of emission reductions. On the other hand the market price will drop due to the ceiling leading to lower purchase cost. With the $30 initial market price the ceiling is not binding for these countries and the national cost will decrease due to the somewhat lower market price for emission reductions.

Table 3.6 *Cost in 2010 to meet the Kyoto commitment for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 2.5% of the base year emissions assuming several market prices for emission reductions [in million $]*

Price [$/tCO$_2$]	8	16	30	8	16	30
		[Million $]			Change [%]	
Austria	802	809	831	765	370	176
Belgium	219	229	266	45	-6	-9
Denmark	698	704	724	372	154	53
Finland	217	222	240	72	10	-8
France	5	-29	-403			
Germany	65	75	-327	57		
Greece	129	137	162	9	-15	133
Ireland	12	16	-7	-25		
Italy	2262	2304	2448	262	114	53
Luxembourg	-1	-2	-5			
Netherlands	528	545	607	64	3	-10
Portugal	-2	-12	-96			
Spain	11	-5	-291			
Sweden	61	67	86	42	-12	-19
United Kingdom	210	270	481	-28	-41	-29

Note: Empty cells in the % increase of cost columns are due to net benefits for countries making the expression as % increase of cost inappropriate.

Countries like Italy, Denmark and Austria will be confronted with much higher cost than in a situation without a ceiling. These countries have relatively large demand for emission reductions also at the higher initial market prices. France, Portugal, Spain and Luxembourg will have lower benefits due to the lower revenues via the sales of emission reductions.

Table 3.6 illustrates that due to this ceiling the cost for the purchasing countries (e.g. Netherlands, Belgium, Italy) depend less on the market price than in a situation without ceilings.

By definition marginal cost are the same in a situation without limits on the use of Kyoto mechanisms. If ceilings are imposed differences will occur in the marginal cost per country, Countries with binding ceilings on the use of Kyoto mechanisms will have marginal cost higher than the market price. Countries with non-binding ceilings will have marginal cost equal to the market price. Table 3.7 shows the marginal cost for the different EU Member States in a situation with a ceiling on the Kyoto mechanisms amounting to 2,5% of the base year emissions.

Table 3.7 *Marginal cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 2.5% of the base year emissions*

Price [$/tCO$_2$]	2.7	6.0	17.2
Austria	176.7	176.7	176.7
Belgium	22.7	22.7	22.7
Denmark	79.2	79.2	79.2
Finland	30.3	30.3	30.3
France	2.7	6.0	17.2
Germany	2.7	6.0	17.2
Greece	14.6	14.6	17.2
Ireland	4.9	6.0	17.2
Italy	107.8	107.8	107.8
Luxembourg	2.7	6.0	17.2
Netherlands	29.5	29.5	29.5
Portugal	2.7	6.0	17.2
Spain	2.7	6.0	17.2
Sweden	25.4	25.4	25.4
United Kingdom	15.8	15.8	17.2

In this example Italy, Denmark and Austria will have the highest marginal cost, followed by Finland, Netherlands, Sweden and Belgium.

The cost effects of the ceiling which amounts to 10% of the base year emissions is much smaller than for the 2.5% case. This ceiling will only have substantial higher cost for Denmark, Austria and, in case of a low market price for emission reductions, for Finland. For some other countries (Netherlands, Belgium, Italy, Greece), this ceiling is sometimes binding (depending on the market price), but their national cost will not change much. The marginal cost (see Table 3.9) will only differ from the international market price if the ceiling is binding.

Table 3.8 *Cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 10% of the base year emissions assuming several initial market prices for emission reductions [million $]*

Price [$/tCO$_2$]	8	16	30	8	16	30
		[Million $]			Change [%]	
Austria	126	195	302	36	13	0
Belgium	131	235	293	-13	-4	0
Denmark	369	433	532	150	56	12
Finland	142	197	258	12	-3	-1
France	-36	-315	-941			
Germany	71	-226	-967	71		
Greece	101	160	88	-15	-1	27
Ireland	16	0	-56	2		
Italy	577	1024	1545	-8	-5	-4
Luxembourg	-2	-4	-9			
Netherlands	317	507	669	-1	-4	-1
Portugal	-13	-74	-247			
Spain	-9	-212	-876			
Sweden	35	72	104	-19	-5	-1
United Kingdom	241	441	655	-17	-4	-3

Note: Empty cells in the % increase of cost columns are due to net benefits for countries making the expression as % increase of cost inappropriate.

Table 3.9 *Marginal cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 10% of the base year emissions*

Assumed equilibrium price [$/tCO$_2$]	8	16	30
Austria	56.7	56.7	56.7
Belgium	10.3	15.0	28.5
Denmark	55.6	55.6	55.6
Finland	18.1	18.1	28.5
France	6.3	15.0	28.5
Germany	6.3	15.0	28.5
Greece	8.0	15.0	28.5
Ireland	6.3	15.0	28.5
Italy	17.5	17.5	28.5
Luxembourg	6,3	15.0	28.5
Netherlands	14.6	15.0	28.5
Portugal	6.3	15.0	28.5
Spain	6.3	15.0	28.5
Sweden	6.3	15.0	28.5
United Kingdom	6.3	15.0	28.5

3.3.2 Percentage of assigned amounts

For this type of ceiling also two different variants have been considered assuming ceilings of 2.5% and 10% of the assigned amounts.

The results (Tables 3.10 to 3.12) show similarities with the results for the ceiling based on base year emissions although the effects are somewhat larger than for the ceilings linked to the base year emissions. This latter effect could have been expected, as the base year emissions of the EU are higher than the assigned amounts. The cost effects of the 2.5% ceiling are much larger than the cost effects of the 10% ceiling.

Table 3.10 *New market price and the net cost for the EU for ceilings of 10% and 2.5% of the assigned amounts and comparison of the cost to a situation without a ceiling*

Ceiling case market price without ceiling	New market price [$/tCO$_2$]	Net cost for the EU [billion $]	Increase compared to situation without ceiling [%]
10%			
$8/tCO$_2$	6.08	2.25	22
$16/tCO$_2$	14.39	2.58	16
$30/tCO$_2$	27.94	1.51	43
2.5%			
$8/tCO$_2$	2.59	5.42	194
$16/tCO$_2$	5.50	5.52	148
$30/tCO$_2$	16.10	4.97	368

Only the country results are shown here for the case with a 10% ceiling of the assigned amount (Tables 3.11 and 3.12). This ceiling leads (also) to significant cost increases for Denmark and Austria.

Table 3.11 *Cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 10% of the assigned amounts assuming several market prices for emission reductions [in million $]*

Price [$/tCO$_2$]	8	16	30	8	16	30
		[Million $]			Change [%]	
Austria	191	249	342	106	44	14
Belgium	133	230	292	-12	-6	0
Denmark	449	497	575	204	79	22
Finland	140	193	257	11	-5	-2
France	-32	-292	-912			
Germany	73	-199	-931	77		
Greece	97	159	95	-18	-2	36
Ireland	16	2	-54	1		
Italy	608	1008	1522	-3	-6	-5
Luxembourg	-2	-4	-9			
Netherlands	325	495	666	1	-6	-2
Portugal	-13	-69	-238			
Spain	-7	-192	-842			
Sweden	34	70	103	-22	-7	-2
United Kingdom	235	429	648	-19	-7	-4

Note: Empty cells in the % increase of cost columns are due to net benefits for countries making the expression as % increase of cost inappropriate.

Table 3.12 *Marginal cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 10% of the assigned amounts*

Market price [$/tCO$_2$]	8	16	30
Austria	84.0	84.0	84.0
Belgium	11.6	14.4	27.9
Denmark	62.2	62.2	62.2
Finland	18.1	18.1	27.9
France	6.1	14.4	27.9
Germany	6.1	14.4	27.9
Greece	6.1	14.4	27.9
Ireland	6.1	14.4	27.9
Italy	20.0	20.0	27.9
Luxembourg	6.1	14.4	27.9
Netherlands	15.5	15.5	27.9
Portugal	6.1	14.4	27.9
Spain	6.1	14.4	27.9
Sweden	6.1	14.4	27.9
United Kingdom	6.1	14.4	27.9

3.3.3 Percentage of required reduction

This option refers to ceilings related to the required reduction that is equivalent to the difference between the base year emissions and the assigned amounts.

The results for the EU as a whole are shown in Table 3.13. The total cost of the EU will double or triple in comparison to a situation without a ceiling.

Table 3.13 *New market price and the net cost for the EU for ceilings amounting to 50% of the difference between the base year emissions and the assigned amounts and comparison of the cost to a situation without a ceilin.*

Ceiling case market price without ceiling	New market price [$/tCO$_2$]	Net cost for the EU [billion $]	Increase compared to situation without ceiling [%]
$8/tCO$_2$	3.54	4.43	140
$16/tCO$_2$	7.90	4.44	99
$30/tCO$_2$	20.88	3.39	219

For some countries this ceiling concept results in little or no room at all for purchase of emission reductions (e.g. in the case of France, Finland, Netherlands and Sweden). In the case of France the ceiling appear to have no effect as France is a net seller of emission reductions. However, the cost effects for Finland and Sweden are large. The costs also increase considerably for Italy, Denmark and Austria. This ceiling is beneficial for the United Kingdom. This kind of ceiling is not binding for the UK. As the net purchases of the UK will be significant the resulting cost reduction for the UK is also substantial.

Table 3.14 *Cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 50% of the difference between the base year emissions and the assigned amounts assuming several market prices for emission reductions [in million $]*

Market price [$/tCO$_2$]	8	16	30	8	16	30
	[Million $]			Change [%]		
Austria	347	370	437	274	115	45
Belgium	192	213	277	27	-13	-6
Denmark	331	364	464	123	31	-2
Finland	266	266	266	111	31	2
France	0	-71	-566			
Germany	75	44	-516	80		
Greece	403	348	185	240	115	165
Ireland	40	25	-21	158		
Italy	1875	1948	2165	200	81	35
Luxembourg	-1	-2	-6			
Netherlands	507	535	620	58	1	-8
Portugal	20	-16	-138			
Spain	71	-25	-453			
Sweden	156	150	132	260	98	26
United Kingdom	147	287	545	-49	-38	-19

Table 3.15 *Marginal cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 50% of the difference between the base year emissions and the assigned amounts*

Assumed equilibrium price [$/tCO$_2$]	8	16	30
Austria	119.0	119.0	119.0
Belgium	20.6	20.6	20.9
Denmark	54.0	54.0	54.0
Finland	36.9	36.9	36.9
France	3.5	7.9	20.9
Germany	3.5	7.9	20.9
Greece	29.6	29.6	29.6
Ireland	17.5	17.5	20.9
Italy	96.7	96.7	96.7
Luxembourg	3.5	7.9	20.9
Netherlands	25.1	25.1	25.1
Portugal	12.4	12.4	20.9
Spain	9.9	9.9	20.9
Sweden	43.3	43.3	43.3
United Kingdom	3.5	7.9	20.9

3.3.4 Percentage difference between baseline and assigned amount

One quantitative example has been analysed with a 50% ceiling on the difference between baseline and assigned amounts.

The net cost impact of this ceiling on the EU is relatively small (increase of 11-26%) as the ceiling is binding for only few of the countries (Denmark and Austria) and the sales price for selling countries will not change much. The purchasing countries other than Denmark and Austria will benefit from this ceiling, as the market price of emission reductions will drop.

Table 3.16 *New market price and the net cost for the EU for ceilings on the use of Kyoto mechanisms amounting to 50% of the difference between 2010 baseline emissions and assigned amounts*

Ceiling case market price without ceiling	New market price [$/tCO$_2$]	Net cost for the EU [billion $]	Increase compared to situation without ceiling [%]
$8/tCO$_2$	5.80	2.11	14
$16/tCO$_2$	14.61	2.48	11
$30/tCO$_2$	28.77	1.34	26

This ceiling appears to binding for 9 out of the 15 EU Member States. However, significant cost increases only occur to Denmark and Austria. Some other countries (Italy, Sweden, Greece) will be confronted with small cost increases with a part of the market prices. The other purchasing countries will have lower cost as the price of emission reductions will be lower and the ceiling is either slightly binding or non-binding (see also the marginal cost in Table 3.18). The net benefits for selling countries will decrease.

Table 3.17 *Cost to meet the Kyoto commitment for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 50% of the difference between 2010 baseline emissions and assigned amounts assuming several market prices for emission reductions [in million $]*

Market price [$/tCO$_2$]	8	16	30	8	16	30
		[Million $]			Change [%]	
Austria	239	294	384	157	71	27
Belgium	134	232	293	-11	-5	0
Denmark	252	339	479	70	22	1
Finland	109	192	258	-14	-5	-1
France	-27	-301	-955			
Germany	76	-209	-985	83		
Greece	97	159	85	-18	-1	22
Ireland	15	1	-58	0		
Italy	651	1043	1555	4	-3	-3
Luxembourg	-1	-4	-9			
Netherlands	290	499	671	-10	-5	-1
Portugal	-11	-71	-251			
Spain	-4	-199	-892			
Sweden	45	72	104	5	-5	-1
United Kingdom	242	434	659	-16	-6	-2

Note: Empty cells in the % increase of cost columns are due to net benefits for countries making the expression as % increase of cost inappropriate.

Table 3.18 *Marginal cost to meet the Kyoto commitment in 2010 for EU Member States for a situation with ceilings on the use of Kyoto mechanisms amounting to 50% of the difference between the baseline emissions and the assigned amounts*

Market price [$/tCO$_2$]	8	16	30
Austria	97.7	97.7	97.7
Belgium	12.5	14.6	28.8
Denmark	43.5	43.5	43.5
Finland	11.6	14.6	28.8
France	5.8	14.6	28.8
Germany	5.8	14.6	28.8
Greece	8.2	14.6	28.8
Ireland	5.8	14.6	28.8
Italy	22.7	22.7	28.8
Luxembourg	5.8	14.6	28.8
Netherlands	13.3	14.6	28.8
Portugal	5.8	14.6	28.8
Spain	5.8	14.6	28.8
Sweden	17.9	17.9	28.8
United Kingdom	9.5	14.6	28.8

3.4 Summary of the results of ceiling options

All proposals for ceilings considered here limit the contribution of Kyoto mechanisms to meeting the Kyoto reduction commitments. The largest effect on the purchase of emission reductions by individual EU Member States is a reduction with almost 70% compared to a situation without a ceiling. This is in case of the 2.5% ceiling of the assigned amount assuming a $8/tCO2 market price for emission reduction.

The smallest effect occur with a 10% ceiling on the base year emissions and a ceiling of 50% to the difference between baseline emissions and assigned amount in combination with high market prices.

Below the ceilings considered have been grouped in two groups with different impacts on the demand for emission reductions:

1. Large impact on the demand for emission reductions for the following ceilings:
   - 2.5% of assigned amount,
   - 2.5% of base year emissions,
   - 50% of required reduction.
2. Modest impact on the demand for emission reductions for the following ceilings:
   - 10% of assigned amount,
   - 10% of base year emissions,
   - 50% of difference between baseline and assigned amount.

The cost consequences of ceilings for the EU as a whole are much larger for the ceilings with large impact on the demand for emission reductions. Then the cost will typically increase with 100-300% compared to a situation without ceilings. The cost impact of ceilings that have modest effects on the demand for emission reduction for the EU as a whole implies an increase between 10% and 40%. The cost for the EU is least for the ceiling of 50% of the difference between baseline emissions and assigned amount.

The assumed market price for emission reduction has significant impacts on the cost effects of ceilings. Ceilings tend to increase the cost of meeting Kyoto commitment more with lower market prices assumed.

The cost consequences of ceilings differ per country. With respect to cost impacts four groups of countries can be discerned:

- Countries that will have less benefits from selling emission reduction. Such countries will face impacts through the lower sale prices of emission reductions. According to the present analysis this will be the case for Germany, France, Portugal, Spain, Ireland and Luxembourg.
- Countries that will have lower cost for all ceilings and market prices considered. Such countries are net purchasers of emission reduction, for which none of the ceilings is binding while it is binding for other countries. These countries can purchase emission reductions at lower prices than in a situation without ceilings existent. This is the case for the United Kingdom.
- Countries for which the impacts depend on the kind of ceilings and the market price assumed. With some of the ceilings considered the purchases of emissions reductions are constrained. Their net cost depend on the difference between the additional cost of domestic measures and possible less cost via the lower purchase price of emission reductions This is the case for the Netherlands, Belgium, Italy, Sweden, Finland and Greece.
- Some countries will have higher cost for all kinds of ceilings and market prices considered. All ceilings considered will be binding for these countries. This will be the case for Denmark and Austria.

4. INSIGHTS FROM THE ANALYSIS

To safeguard that domestic actions will be taken to meet the commitments, the Kyoto Protocol suggests that domestic action should be the main means for reaching the reduction commitments. Imposing ceilings on countries' purchase of emission reductions is one way to limit the use of Kyoto Mechanisms. This study has considered cost consequences of ceilings. The present analysis indicates that:

- Ceilings on the (national) contribution of Kyoto mechanisms can have large effects on the relative national cost to meet national Kyoto commitments. For all ceilings considered the net cost effect of imposing ceilings imply an increase in the net cost to the EU as a whole compared to a situation without ceilings on the use of Kyoto mechanisms.
- The magnitude of the impacts on the national cost depends on the stringency of the ceiling, the way the ceiling is designed and the assumed price of emission reductions. Some ceilings largely offset the benefits due to Kyoto mechanisms (compared to a situation without JI, emission trade and CDM).
- If applied, all ceilings considered in this analysis would have consequences for the effort required by Member States to meet their commitments.
- The cost effect of imposing ceilings is largest in a situation with lowest market prices for emission reductions.
- Imposing ceilings on the contribution of Kyoto mechanisms will lower the market price for emission reductions.
- The fact that the market price of emission reduction is not known makes it difficult to assess which kind of ceiling option is to be preferred.
- Under certain circumstances imposing ceilings will lead to net benefits for individual countries. There are countries that are net purchasers, which have a non-binding ceiling. The lower cost for these countries will result from the lower purchase price of emission reductions.
- All ceilings considered will result in higher cost to meet their Kyoto commitment for Austria and Denmark. A large part of the ceiling options will give higher cost for Italy, Netherlands, Finland, Sweden, Belgium and the UK but other ceilings will lead to lower cost for these countries. Due to ceilings Germany, France, Spain and Portugal will have lower benefits from sales of emission reductions.
- The ceilings that have been considered can be divided in ceilings that have large impacts and ceilings that have modest impacts. Large impact on the demand for emission reductions occur for the following ceilings:
  - 2.5% of assigned amount,
  - 2.5% of base year emissions,
  - 50% of required reduction.

  Modest impacts on the demand for emission reductions occur for the following ceilings:
  - 10% of assigned amount,
  - 10% of base year emissions,
  - 50% of difference between baseline and assigned amount.

The impacts of ceilings on the national cost can be large but the precise impact is difficult to estimate due to uncertainties about the price of emission reductions. Consequently, decisions on ceilings on the use of Kyoto mechanisms need to be taken with great care. At this moment in time additional analyses are required. Such analysis should preferably include other Annex I countries and cover the (world-wide) supply of emission reductions.

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