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Evaluating the Bonn Agreement and some key issues

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Abstract

This report evaluates the environmental effectiveness and economic efficiency of the Kyoto Protocol as agreed at the resumed session of COP 6 in July 2001 in Bonn. We put our evaluation in dynamic perspective by breaking the COP 6 process down into three major steps: the pre-COP 6 version of the Kyoto Protocol, the US withdrawal and the Bonn Agreement. According to the evaluation, the Bonn Agreement leads to a reduction of 130 MtC, compared to the 755 MtC in the pre-COP 6 version of the Kyoto Protocol. Annex I emissions without the US will be reduced by 3 per cent below baseline, just below the 1990 level. Annex I emissions including the US will increase by 10 per cent. The US withdrawal has by far the greatest impact in reducing the environmental effectiveness of the Kyoto Protocol. Compared to the US non-participation, the decisions in the Bonn Agreement and, in particular, on sinks may be considered an acceptable price for realising a political agreement. Another consequence of the US withdrawal is that permit demand is substantially reduced and permit prices will drop dramatically. Hot air becomes increasingly dominant and may threaten the viability of the Kyoto Mechanisms, especially in lower baseline scenarios. As prices are pushed downwards and even approach zero, it would be in the seller's interest (FSU) to exercise market power. Curtailing FSU permit supply and banking 50 per cent of the hot air improves the environmental effectiveness and generates positive financial benefits for both the FSU and the non-Annex I countries. Alternatively, the FSU could consider imposing a minimum permit price. This would offer the FSU the most attractive financial incentives, but it does not improve the overall environmental performance. A voluntary EU target of 50 per cent domestic action would wipe out any emissions market potential and should not be considered without curtailing permit supply. A combination of a voluntary EU target along with FSU banking 90 per cent of hot air would increase total Annex I reductions to 425 MtC and domestic action to 50 per cent but raise Annex I costs fourfold. Ultimately, the most promising strategy for enhancing the Kyoto Protocol is to seek options for US re-entry. Our simulations show that this would improve the environmental effectiveness at moderately higher costs while creating a sufficient emissions market potential. The Bonn Agreement meets many of the previous US demands and may even be characterised as US-friendly; thus, the current agreement leaves the door open for US re-entry. Whether the current US administration will indeed rejoin the Kyoto Protocol, is largely determined by the domestic political environment.

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More detailed information concerning this evaluation can be found in the report, “Evaluating the Bonn Agreement and some key issues: an Analysis with the FAIR model: Background-document” (Den Elzen and de Moor, 2001).

Contents

Samenvatting

Deze rapportage evalueert het onlangs in Bonn bereikte akkoord over het Kyoto Protocol. Het analyseert de milieu-effectiviteit en de kosten van het akkoord redenerend vanuit de belangrijkste fasen van het onderhandelingsproces: de pre-COP 6 versie van het Protocol, de weigering van de VS het Protocol te tekenen en het Bonn Akkoord zelf. De evaluatie laat zien dat het Bonn Akkoord tot een emissiereductie van 130 MtC leidt, oftewel 3 procent onder het referentiepad. Dit is veel lager dan de 755 MtC in de pre-COP 6 versie van het Kyoto Protocol. De emissies van de Annex I landen zonder de VS komen daarmee net iets onder het niveau van 1990 uit maar met de VS ruim 10 procent erboven. Het terugtrekken van de VS heeft verreweg de grootste invloed op de verminderde milieu-effectiviteit van het Kyoto Protocol. Hiermee vergeleken kunnen de beslissingen in het Bonn Akkoord, met name over sinks, worden gezien als een acceptabele prijs om een politiek akkoord te krijgen. Zonder de VS echter zal de vraag naar emissierechten sterk dalen en daardoor de prijs op de internationale emissiemarkt. Hot air wordt een zeer dominant probleem, met name in lagere groeiscenario's, en kan zelfs de ontwikkeling van de emissiemarkt ondermijnen omdat de prijs naar nul dreigt te gaan. Het ligt in de verwachting dat de (enige) aanbieder (landen uit de voormalig Soviet-Unie, FSU) marktmacht zal uitoefenen door volume- of prijscontrole. Een halvering van het FSU aanbod van hot air door deze te banken zal er toe leiden dat de milieu-effectiviteit wordt versterkt terwijl tegelijk de financiële opbrengsten voor de FSU en niet-Annex I landen zullen stijgen. Het instellen van een minimum-prijs daarentegen zal de milieu-effectiviteit niet ten goede komen maar biedt de FSU wel de meest aantrekkelijke financiële perspectieven. Een vrijwillige EU doelstelling om de helft van haar emissiereducties binnenlands te realiseren ondermijnt de ontwikkeling van een internationale emissiemarkt en moet in combinatie met een beperking van het aanbod worden beschouwd. Samen met het banken van 90 procent van FSU hot air kan dit de milieu-effectiviteit van het Bonn Akkoord versterken doordat Annex I emissiereducties worden opgeschroefd tot 425 MtC en binnenlandse actie tot 50 procent. Daar staat tegenover dat de totale kosten een factor vier zullen toenemen. Uiteindelijk is de hertoetreding van de VS de meest veelbelovende strategie om het Kyoto Protocol te versterken. Dit zal de milieu-effectiviteit verbeteren en tegelijk voldoende marktpotentieel bieden voor internationale emissiehandel. Het Bonn Akkoord biedt voldoende ruimte voor her-toetreding van de VS, mede omdat veel belangrijke onderdelen overeenkomen met eerdere VS-eisen. Desondanks zal feitelijke her-toetreding vooral worden bepaald door de binnenlandse politieke omgeving.

1 Introduction

On December 11, 1997, the Parties at the third session of the Conference of the Parties (COP 3) to the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto agreed to the Kyoto Protocol (UNFCCC, 1998). Four years later, the 23rd of July 2001 reflects another landmark in international climate change policy. Delegates of the resumed session of COP 6 in Bonn approved a political agreement on a number of key implementation issues of the Kyoto Protocol, which may pave the way towards ratification in 2002 at the Johannesburg Summit on Sustainable Development.

The Bonn Agreement has seen a difficult birth.[1] Parties had failed to close a deal earlier at the first session of COP 6 in The Hague. During the preparations for the follow-up, the new US administration declared the Kyoto Protocol to be fatally flawed and announced that the US would not agree to any outcome of the resumed session of COP 6. Yet, after fierce negotiations, all Parties in Bonn, except the US, agreed to the compromise drafted by the president of COP 6 Pronk. Some praised the fact that several key Parties had shown surprising flexibility in their positions to close the deal. Others, however, were critical of the generous offers that had stripped the Kyoto Protocol of its environmental meaning.

This report deals with the following questions. What has been accomplished at Bonn? What is the environmental and economic significance of the agreement? Are there important issues that need to be further addressed? Section 2 briefly summarises the main elements of the Bonn Agreement. Next, Section 3 examines its environmental and economic implications. We will analyse the Agreement from a dynamic perspective by breaking down the international process into the main steps: the pre-COP 6 version of the Kyoto Protocol, the withdrawal of the US and the final decisions as agreed in Bonn. Section 4 explores some key issues such as the dominance of hot air, FSU market power and the subject of supplementarity. We will also simulate the meaning of the current Bonn Agreement *with* the participation of the US and briefly discuss the potential and impacts of re-entry of the US. Finally, Section 5 will present the main conclusions.

[1] We refer to UNFCCC (2001a).

2 Key elements in the Bonn Agreement

The political agreement in Bonn (UNFCCC, 2001a) shows compromises on the following major areas:

- Kyoto Mechanisms;
- Land use, land use change and forestry (sinks);
- Compliance;
- Financing for developing countries.

The following section briefly describes the main elements of the Bonn Agreement in these four areas.

2.1 Kyoto Mechanisms

An important element in the Bonn Agreement involves the absence of a quantitative cap on emissions trading, the so-called supplementarity issue. Up to the Bonn meeting, the international negotiations had concentrated on setting a quantitative cap on the use of the Kyoto Mechanisms by Annex I countries. The EU, in particular, was strongly in favour of such caps, proposing that at least half of the reduction effort would have to be done domestically. The Bonn Agreement now includes only a qualitative approach by stating that "domestic action shall thus constitute a significant element of the effort" by each Annex I Party.

Another decision relevant to international emissions trading relates to the commitment period reserve. This reserve intends to prevent a country overselling, which may result into non-compliance. Countries are obliged to maintain a commitment period reserve, which should not drop below 90 per cent of that country's emission budget (assigned amounts) or 100 per cent of five times the most recently reviewed inventory, whichever is lowest. The former condition of 90 per cent of the emission budget is probably effective for net buyers (most industrialised countries). For net sellers and countries with large amounts of hot air, like Russia, the latter condition with its most recently reviewed inventory applies and suggests that the country cannot trade more than the fall in emissions below its emission budget around the time of the first commitment period.[2]

As regards Joint Implementation, countries have agreed to "refrain from using emission reduction units generated from nuclear facilities". A similar condition also applies to the Clean Development Mechanism (CDM). Furthermore, small-scale activities focused on renewable energy and efficiency are given a preferential treatment under the CDM through the development of simplified conditions and procedures. Afforestation and reforestation are eligible for CDM in the first commitment period, capped to 1 per cent of Annex I base-year emissions (see Section 2.2).[3] Finally, a 2 per cent share of proceeds will be levied upon CDM projects and serve as a funding mechanism to the Adaptation Fund (see Section 2.4)

[2] The ERUs from Joint Implementation are excluded from this commitment period reserve. ERUs constitute certified emission reductions already realised and are deducted from a seller country's assigned amounts.

[3] Afforestation is defined as direct human-induced conversion of land that has not been forested for at least 50 years. Reforestation is defined as direct human-induced conversion of previously forested land but that has been converted to non-forest land and re-converted to forest land (did not contain forest on 31/12/1989). See UNFCCC (2001b) for the exact LULUCF definitions.

2.2 Land use, land use change and forestry

The issue of sinks was at the very heart of the international negotiations. Earlier negotiations in the Hague failed to yield a compromise, but in Bonn the Parties were successful in closing an agreement on the rules and modalities on activities related to land use, land use change and forestry (LULUCF). The main decisions include:

- The accounting excludes carbon removal resulting from (a) elevated CO_2 concentrations above the pre-industrial level; (b) indirect nitrogen deposition and (c) ongoing carbon stock increase due to the ageing effect of many forests.
- Afforestation, reforestation and deforestation shall be defined on the basis of a change in land use. This implies that certain reforestation activities are excluded from the accounting framework. There are no caps on carbon credits from afforestation and reforestation activities for Annex I countries (Article 3.3).
- Deforestation under Article 3.3 may not be greater than afforestation and reforestation on the same unit of land. This may imply a more land-based accounting system, reducing the total sink potential.
- Countries may choose to apply any or all of the activities under Article 3.4 (forest management, cropland management, grazing land management and revegetation); however, they must fix their choice prior to the start of the first commitment period. A Party shall demonstrate that such activities have occurred since 1990 and are human induced.
- Any ARD-debit may be compensated by forest management (up to 8.2 MtC).
- Countries may claim credits from forest management to meet their reduction commitments, but this is capped to country specific limits as given in Appendix Z, which total 83 MtC per year.[4]
- Countries may also claim credits for agricultural land management and revegetation activities on a net-net accounting basis without an explicit cap.[5]
- Afforestation and reforestation projects in developing countries are eligible for CDM up to a cap of 1 per cent of a country's base-year emissions, which suggest a total of 49 MtC per year.[6]

These decisions on the use of sink credits have a direct impact on the environmental effectiveness and economic efficiency of the Kyoto Protocol. Section 3.3 offers a more detailed examination of these LULUCF decisions.

2.3 Compliance

Negotiations turned out to be difficult on the subject of compliance. Apart from deciding upon procedures and governing bodies the discussion focused on whether or not and how to include penalties for non-compliance. Countries agreed in Bonn to choose a more "rewarding" approach and to set for the first commitment period at a so-called restoration rate of 1.3, meaning that 130 per cent of the excess would be subtracted from the assigned amounts in the second commitment period. Parties in non-compliance were also to develop a compliance plan and are suspended from using the Kyoto Mechanisms until compliance is restored.

[4] This includes 28 MtC for the US; hence the total would be 55 MtC without the US (see section 3.3). JI can also be used to achieve the commitment but subject to the caps as given in Appendix Z.
[5] The net-net accounting approach is based on comparing the net emissions in the first commitment period with the net emissions in 1990.
[6] Without the US, this cap runs up to 33 MtC per year (see section 3.3).

2.4 Financing for developing countries

The Bonn Agreement includes three new funds:

- Special Climate Change Fund: complementary to GEF resources and bilateral and multilateral funding, and targeted at adaptation, technology transfer, mitigation and developing country's activities to diversify the economy.
- Least Developed Countries Fund: to support a work programme for the least developing countries including National Adaptation Programmes of Action.
- Adaptation Fund: to finance concrete adaptation projects and programmes in developing countries that have become Parties to the Protocol.

The Adaptation Fund is financed by among others a 2 per cent share of proceeds on CDM projects. The Bonn Agreement explicitly stipulates that the public resources for CDM would not result in a diversion to be counted as official development assistance. Other contributions for this Fund are the pledge of several Annex I countries (EU, Canada, Iceland, New Zealand, Norway and Switzerland) to contribute $410 million annually by 2005.

3 Evaluating the Bonn Agreement

The Bonn Agreement is the result of an international process that has finally culminated in a political deal at the resumed session of COP 6 in Bonn. We will break this international process down into three major steps. The starting point for our evaluation is the pre-COP 6 version of the Kyoto Protocol that includes no explicit quantitative caps on emissions trading as well as US participation.[7] After the first session of COP 6 in The Hague, where no consensus was reached, the newly elected US government declared the Kyoto Protocol "fatally flawed" and stepped out of the negotiations on the Kyoto Protocol. This US withdrawal is a major factor in examining the environmental value of the Bonn Agreement. Finally, the Bonn Agreement itself, in particular the decisions on sinks, marks the last step in our evaluation.

3.1 Framework and assumptions

We evaluate the environmental effectiveness and economic efficiency of the Kyoto Protocol with the help of the FAIR model. This model has been designed to quantitatively explore a range of alternative policy options for international climate change regimes.[8] FAIR also includes a cost module with marginal abatement curves, which can be used to determine marginal and total abatement costs and examine the gains of emissions trading. A marginal abatement curve (MAC) reflects the additional costs of reducing the last unit of carbon and differs per country.[9]

The FAIR cost module uses the MACs from the WorldScan model, a dynamic multi-sector, multi-region computable general equilibrium model (CPB, 1999). FAIR calculates the market-clearing equilibrium permit price under different regulation schemes by using the properties of the aggregated permit supply and demand curves.[10]

Figure 1 shows the demand and supply curves of permit trading for the pre-COP 6 version of the Kyoto Protocol and includes US participation. The supply curve starts from a point just below 300 MtC. This quantity can be supplied at no cost and reflects the so-called hot air.[11] The maximum demand is equal to the sum of total Annex I commitments and intersects the horizontal axis at 1050 MtC. This estimate is based on the A1B scenario (see Figure 1). The market for emissions trading, JI and CDM is determined by the point where demand meets supply. In Figure 1, this is at a price of 36 US$/tC, with about 570 MtC traded on the international market.[12]

[7] Results without emissions trading will also be given to demonstrate the significance of the Kyoto Mechanisms.
[8] We use the new 1.1 version of FAIR (Framework to Assess International Regimes for differentiation of future commitments), which can be downloaded from early 2002 at: http://www.rivm.nl/FAIR/. See also Den Elzen et al. (2001) and Den Elzen and Both (2001).
[9] A great advantage of using MACs is that it clearly shows the effects of permit trading. However, there are some limitations as well. Carbon leakage cannot be taken into account. Furthermore, MACs only reflect total abatement costs but not the welfare losses. See Den Elzen and de Moor (2001).
[10] The same methodology is used as in the ASPEN software (Criqui et al., 1999; Criqui, 2001).
[11] Hot air is defined as the positive difference between the assigned amounts and actual emissions under business as usual conditions. This estimate of hot air is based on current emissions projections, see section 4.1.
[12] The amount of hot air is 295 MtC while emissions trading and CDM run up to 280 MtC.

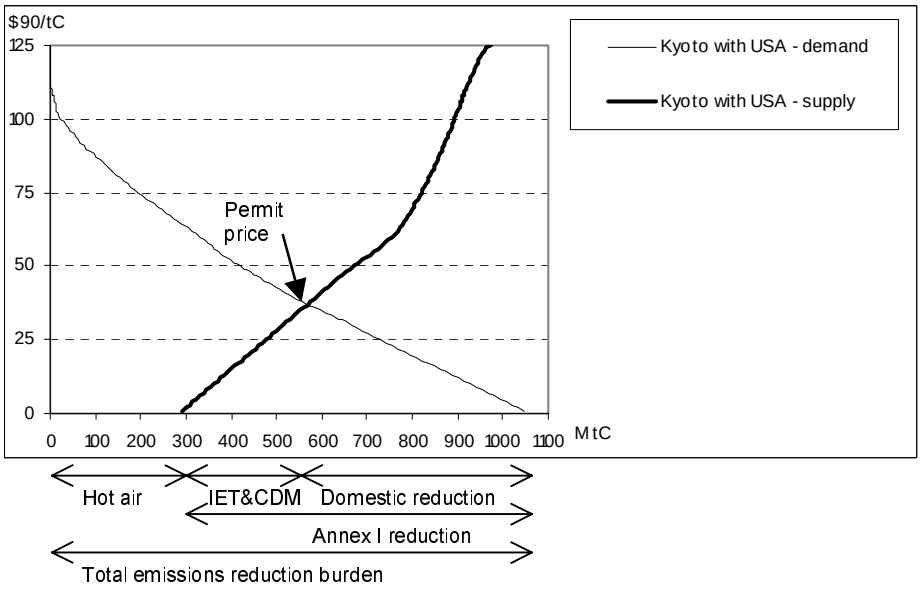


Figure 1: Permit demand and supply curves for the pre-COP 6 version of the Kyoto Protocol (including US participation)

The evaluation focuses on the environmental effectiveness and economic efficiency of the Bonn Agreement in the first commitment period, i.e. 2008-2012. We use the following indicators to reflect the environmental effectiveness:

- *Annex I abatement* refers to the total amount of CO_2 emission reductions per year within Annex I countries: i.e. reductions through domestic policies, international emissions trading, Joint Implementation (JI) and Clean Development Mechanism (CDM). The abatement efforts are given in absolute terms, relative to baseline emissions and compared to 1990 levels.[13]
- *Domestic abatement* indicates how much Annex I countries reduce CO_2 emissions domestically if they strictly follow a least-cost approach; it is expressed in percentage of total reductions. Obviously, the remainder will be realised through the Kyoto Mechanisms.

Economic efficiency is measured as follows:

- *Abatement costs* (in US$90) for Annex I countries to comply with their Kyoto commitments.
- *Net revenues from emissions trading* (in US$90) reflect the net financial gains associated with the Kyoto Mechanisms: i.e. gross revenues minus the costs.
- *International permit price* reflects the expected average clearing price in the international permit market over the commitment period.

[13] Results will be given both with and without the US where appropriate

Box 1: Evaluation and model assumptions[14]

- Just like most of the models, FAIR focuses on CO_2 only and, hence, abatement costs only reflect CO_2 reductions. The costs of reducing non-CO_2 emissions are *not* included and therefore total abatement costs for reducing CO_2 *equivalent* emissions will be higher. Although the non-CO_2 emissions account for about 18 per cent of the overall base-year emissions, we estimate total costs of abating all greenhouse gas emissions (including non-CO_2) will only be 5-10 per cent higher since the options to reduce non-CO_2 emissions are assumed to be more cost-effective than energy CO_2 abatement options. FAIR uses marginal abatement curves from the WorldScan model.
- The IMAGE 2.2 implementation of the A1B scenario is our reference scenario (IMAGE-team, 2001).[15] This scenario reflects high economic growth with rapid introduction of new and more efficient technologies (see Box 2).
- Transaction costs associated with the use of the Kyoto Mechanisms are set at 20 per cent.
- The CDM accessibility factor reflects the operational availability of viable CDM projects and is set at 10 per cent of the theoretical maximum.
- The Kyoto targets (CO_2-assigned amounts) are calculated by applying the Kyoto emissions reductions formulated on the 1990 CO_2 emissions estimates.
- The interpretation of the Bonn Agreement as described in Chapter 2.
- FAO estimates are used for carbon credits from Art 3.3 afforestation, reforestation and deforestation, Art 3.4 forest management and Art 3.4 agricultural management. Carbon credits from forest management have been, if necessary, capped, except for Japan, Canada, Greece, Italy, Portugal, Slovenia, Spain, Switzerland, United Kingdom and the US, where we used the reported values in Appendix Z (UNFCCC, 2001a). For more details, we refer to Appendix II.
- Carbon credits from sinks are incorporated by adding these credits to the CO_2-assigned amounts.
- Sink credits are assumed to be more cost-effective than credits from (energy-related) emission reductions; recent research suggests that common sinks projects in non-Annex I countries may cost around 1 US$/ tCO_2.
- The costs related to the implementation of ARD projects and forest management in Annex I as well as under CDM are assumed to be negligible.

3.2 Environmental effectiveness and economic efficiency

We evaluate the environmental effectiveness and economic efficiency in each of the steps leading to the Bonn Agreement. Table 1 presents the results. It re-illustrates the economic significance of the Kyoto Mechanisms to substantially cut down the costs of the Kyoto Protocol from US$ 47 billion to US$ 19 billion, less than 0.1 per cent of GDP. When including US-participation, the international emissions trading market clears at a price of 36 US$/tC (see also Figure 1). The industrialised Annex I countries realise slightly more than half of their commitments abroad and 46 per cent at home. The Former Soviet Union (FSU) dominates permit supply and trades 473 MtC in emission and project credits.

[14] For more details of the analysis and the methodology we refer to Den Elzen and de Moor (2001).
[15] The historical regional CO_2 emissions from fossil fuel combustion and cement production (excluding emissions from bunkers) are based on the CDIAC dataset. For the period 1995-2010 we use the growth trajectories as given by the IMAGE 2.2 A1B scenario.

Table 1: Environmental effectiveness and economic efficiency of the Bonn Agreement

	Environmental effectiveness					**Economic efficiency**		
	Annex I abatement (index = 100: 755 MtC)		Annex I emissions compared to 1990-levels		Domestic reduction Annex I	Internat. Permit price (US$/tC)	Annex I costs (index = 100: 19 bUS$)	
	Index	MtC	Excl US	Incl. US			Index	bUS$
0. KP with US (w/o IET)	140	1050	-14%	-12%	100%	--	220	47
1. KP with US (with IET)	100	755	-4%	-5.1%	46%	36	100	19
2. KP w/o US (with IET)	31	235	-4%	+8%	22%	16	18	3.5
3. Bonn Agreement*	17	130	-0.1%[16]	+10.6%	14%	9	9	1.8

* The Kyoto Protocol (KP) without US and including sinks from LULUCF (and with International Emissions Trading).

As the US accounts for roughly half of total Annex I reduction commitments, the US withdrawal has a dramatic impact on the environmental effectiveness of the Kyoto Protocol. Total abatement is reduced substantially to a level of only 5 per cent below baseline levels instead of 17 per cent with US participation. Another consequence of the US withdrawal is that the demand for permits collapses and the permit price drops to 16 US$/tC. Under the assumption of a least-cost approach, the industrialised countries will cut down on their domestic abatement efforts to less than a quarter of total commitments and increase their use of the Kyoto Mechanisms. The fall in permit prices reduces total costs for Annex I countries by over 80 per cent to US$ 3.5 billion, an insignificant portion of GDP (0.01 per cent).

Compared to the US withdrawal the decisions in the Bonn Agreement and, in particular, on sinks have a relatively minor impact on the environmental effectiveness of the Kyoto Protocol[17]. The "price" for this agreement is another lower Annex I abatement effort of 105 MtC. It does, however, further reduce demand for emissions permits and the permit price drops to 9 US$/tC.[18] Domestic abatement accounts for one-seventh of total reductions. Thus, compared to the US withdrawal, the decisions on sinks may be considered an acceptable compromise for reaching a political agreement (see also Section 3.3).

Summing up, the Bonn Agreement reduces total Annex I abatement excluding the US emissions by 130 MtC, which implies a reduction of 3 per cent below baseline and a 0.1 per cent reduction under the level of 1990. Including the US, however, total Annex I emissions end up over 10 per cent above 1990 levels.[19] The pre-COP 6 version of the Protocol is expected to reduce emissions by 755 MtC. The difference is almost entirely explained by the US withdrawal from the Kyoto Protocol and only a little by the decisions related to sinks. Total costs of the current Bonn Agreement for Annex I countries amount to US$ 2 billion, which is less than 0.01 per cent of GDP.

[16] In our calculations we add the carbon credits from sinks to the CO_2-assigned amounts and compare the Annex I CO_2 (!) emission reduction with our 1990 CO_2-base year emissions. This leads to the reduction of –0.1 per cent compared to 1990. However, this is different than the –1.1 per cent reduction as reported in Table 2 since there, we calculate with CO_2-*equivalent* base year emissions and add the carbon credits from sinks to the CO_2-*equivalent* assigned amounts.

[17] The requirements on the commitment period reserve do not effectively restrict FSU permit sales.

[18] Our outcomes fall into the middle range of permit price and trading volume prognoses as reported in Grütter (2001).

[19] The results also imply that the contribution of the Bonn Agreement to decrease the gap between Annex I and non-Annex I per capita CO_2 emissions is rather limited. In 2010, the ratio Annex I versus non-Annex I per capita CO_2 emissions comes out 4.65:1 compared to 4.13:1 for the pre-COP 6 version of the Kyoto Protocol. Again, the US withdrawal is of major influence.

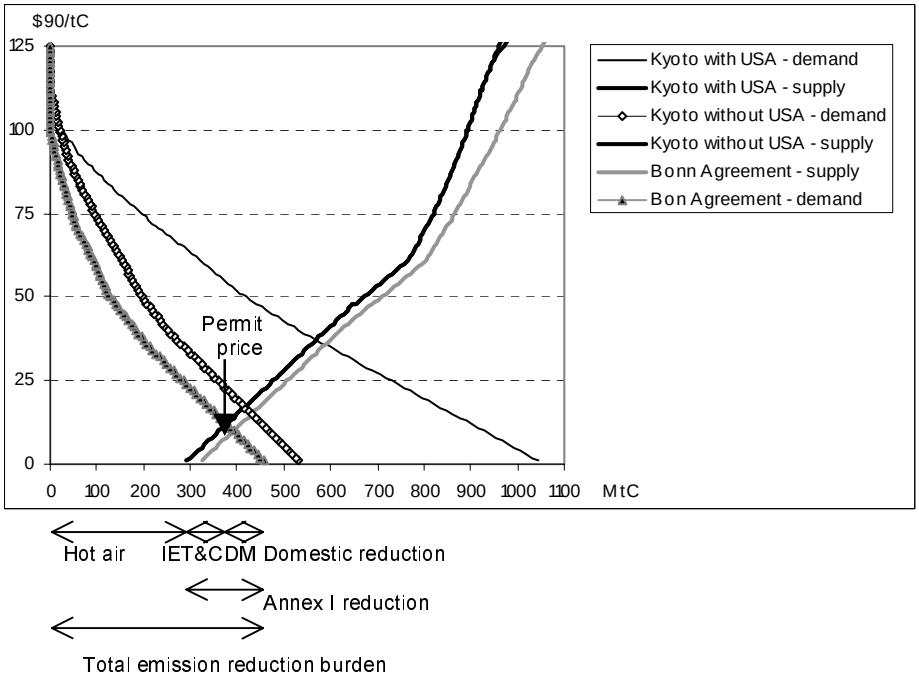


Figure 2: Permit demand and supply curves for the major steps towards the Bonn Agreement[20]

Figure 2 visualises the different steps leading to the Bonn Agreement. It shows the shift in permit demand and supply curves. As the demand curve is continuously pushed down by the US withdrawal and decisions on sinks, the permit price drops to 9 US$/tC. The quantity traded on the market amounts to some 395 MtC. Decomposition of the permit market shows that 75 per cent concerns hot air (295 MtC), about 18 per cent or 70 MtC Joint Implementation, while almost 7 per cent, or 30 MtC, are sink credits through the CDM.

3.3 Assessing the decisions on sinks

At the first session of COP 6 in The Hague, the negotiations on sinks proved to be an insuperable barrier to reach international consensus. Therefore, many regard the decision on sinks in Bonn as a major achievement. What has been decided and what are the implications?

The Kyoto Protocol allows the following activities related to land use, land use change and forestry (LULUCF) to be counted as (domestic) sinks:
1. Article 3.3 afforestation, reforestation and deforestation (ARD);
2. Article 3.4 forest management;
3. Article 3.4 agricultural management (cropland management, grazing land management), revegetation and conservation activities.

The Bonn Agreement further allows:
4. afforestation and reforestation projects to be eligible under CDM in non-Annex I countries, capped at a level 1 per cent of base-year emissions.

The Bonn Agreement limits the sink potential in the respect that only direct human induced activities can be selected. Countries have to demonstrate that these activities have occurred since

[20] The supply curves for the Kyoto Protocol with the US and without the US are the same.

1990 and are human induced.[21] Table 2 shows regional estimates on the above-mentioned sinks-related activities in the Bonn Agreement based on FAO data (see also Box 1).

Table 2: Estimated achievable carbon credits from LULUCF-activities under Article 3.3, 3.4 and CDM

	Domestic sinks credits					CDM-sinks			
Annex I countries	Base-year*	1. carbon credits from ARD Art 3.3	2. carbon credits from forest management (App. Z) Art 3.4	3. carbon credits from agricultural management (no cap) Art 3.4	To-tal	4. sinks CDM projects for non-Annex I Art 12	Total carbon credits	%-base year	Corrected assigned amounts
	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	%	Base-year = 100
Canada	166	0.00	12.00	5.00	17.00	1.66	18.7	11.2%	105.2
US	1655	0.00	28.00	10.20	38.20	16.55	54.8	3.3%	96.3
Western Europe	1184	2.07	6.06	0.32	8.45	11.85	20.3	1.7%	93.7
Eastern Europe	375	0.00	3.75	0.00	3.75	3.74	7.5	2.0%	95.0
FSU	1112	0.00	19.46	0.00	19.46	11.12	30.6	2.7%	102.7
Oceania	154.	7.64	0.20	2.18	10.02	1.54	11.6	7.5%	114.5
Japan	335	0.00	13.00	0.00	13.00	3.35	16.4	4.9%	98.9
Total with US	4982	9.7	82.5	17.7	109.9	49.8	159.7	3.21%	98.1
Total w/o US	3326	9.7	54.5	7.5	71.7	33.3	105.0	3.15%	98.9[22]

* Base-year emissions are based on the Pronk proposal at COP 6 in The Hague (Pronk, 2001)
Source: FAO data (TBFRA, 2000)

Without the US, the carbon credits from sinks-related activities total about 105 MtC per year, three-quarters are domestic sinks (mainly from forest management) while the remaining quarter stems from CDM projects. This is just over 3 per cent of base-year emissions and slightly above the minimum potential, as reported in Van Minnen et al. (2001). Translating the sinks decisions into "corrected" assigned amounts shows that Annex I emissions without the US will come out just below the 1990 level.

When confronting the regional numbers with FAO data, Table 2 shows that Canada, Australia, New Zealand and Japan have been generously treated in their domestic sinks potential (see also Table II.1 in Appendix II for more details). The total credits for these countries amount to 5 per cent or more of base-year emissions. Japan and Canada in particular have been granted many more credits for forest management than on the basis of FAO data, i.e. almost 11 and 5 MtC more credits. Interestingly, a similar observation can be made for the US, which has been given an amount of 28 MtC worth of credits from forest management, twice as much compared with FAO data. On the other hand, the cap on carbon credits from forest management for Russia (in Appendix Z) is well under the potential (about 46 MtC) based on FAO data.[23] For Western Europe, credits from sinks are in line with FAO data and account for less than 2 per cent of base-year emissions. In conclusion, the total amount of sink credits allowed are just above the minimum potential and slightly less than what could have been expected from FAO data.

[21] Indirect human induced carbon removals through CO_2 and N fertilization are excluded from the accounting framework.
[22] Expressed in CO_2 (!) emissions, this would be –0.1 per cent compared to 1990. See footnote 16 for more details.
[23] When using the data submitted by Parties on 1 August 2000 (Table 1, Pronk Proposal) for forest management after discount, the observation of generous treatment also holds for Canada and Japan but not for the US which reports 42 MtC. The 28 MtC in Appendix Z reflect the average of FAO data and data provided by Parties. For the Russian Federation, the value in Appendix Z corresponds with the data provided by Parties (Table 1, Pronk Proposal) after discount. See Appendix II for more details.

3.4 Net financial revenues from the Kyoto Mechanisms

It is interesting to note the financial implications of the different steps towards the Bonn Agreement are for countries such as the Former Soviet Union (FSU). In addition, for non-Annex I countries, several funds have been created to finance certain goals including the Adaptation Fund (see Section 2.4). This Fund is among others financed through a 2 per cent share of proceeds on CDM projects. Table 3 shows the net financial revenues associated with the Kyoto Mechanisms.

Table 3: Net revenues from the Kyoto Mechanisms for FSU and non-Annex I countries

	permit price	**FSU**		**Non-Annex I countries**	
		volume	**revenues**	**volume****	**revenues*****
	US$/tC	MtC	bUS$	MtC	bUS$
1. KP with US (with IET)	36	473	14.0	96	3.4
2. KP w/o US (with IET)	16	373	5.5	43	0.7
3. The Bonn Agreement*	9	369	3.1	57	0.5

* Kyoto Protocol without US including sinks from LULUCF (and with International Emissions Trading)
** Including 33 MtC sinks from CDM
*** Including 2% of proceeds on CDM

Table 3 clearly shows how the net financial revenues for the FSU and non-Annex I countries are reduced dramatically as a result of the US withdrawal. In the pre-COP 6 version of the Kyoto Protocol, the FSU dominates permit supply and would trade 473 MtC in emission and project credits. The financial revenues for the FSU would be substantial, running up to nearly US$ 14 billion or close to 2 per cent of GDP. As the US decision to withdraw from the Kyoto Protocol implies a major reduction in permit demand, the consequence for the FSU is that it would trade much less at a far lower permit price. Net financial revenues are slashed to US$ 6 billion or 0.7 per cent GDP. Finally, the Bonn Agreement implies a further reduction in permit demand and revenues drop to US$ 3 billion, or 0.4 per cent of GDP. This is not even the worst case for the FSU. Baseline scenarios with lower emissions, such as in B1 (see Box 2), may produce no financial gains at all. The only way to get “revenue” then is to curtail supply and bank the hot air as credits for better times (see Section 4.1).

The US withdrawal also has dramatic implications for the financial revenues for non-Annex I countries. The volume traded through the CDM is more than halved to 43 MtC (including sinks) and this reduces the originally projected US$ 3.4 billion in revenues to US$ 0.7 billion. Although the decision to include sinks in the CDM produces some financial benefits for non-Annex I countries, the lower price for CDM credits outweighs this effect and brings total financial revenues for non-Annex I countries to US$ 0.5 billion.

3.5 Robustness of results

This section investigates to what extent the results depend on key assumptions and model parameters. We examine the impact of different baseline scenarios and marginal abatement curves and different assumptions concerning the CDM accessibility factor and transaction costs. Table 4 presents the results for the Bonn Agreement and shows that the results of our evaluation are fairly robust. Only the baseline scenarios may affect the results; the other factors have only a marginal impact.

Table 4: Environmental effectiveness and economic efficiency of the Bonn Agreement in different scenarios and under different assumptions

Robustness of results	**Environmental effectiveness**				**Economic efficiency**	
	Annex I Abatement	Domestic reduction Annex I	Annex I emissions compared to 1990-levels		International permit price	Annex I costs
	GtC	%	Excl. US	Incl US	US$/tC	bUS$
Bonn Agreement	130	14%	-0.1%	+10.6%	9	1.8
Baseline scenarios[1]						
- A1B =>B1 scenario	0	0%	-5.2%[24]	+4.2%	0	0
- A1B =>A2 scenario	0	0%	-1.2%	+11.1%	0	0
Marginal Abatement Curves						
- WorldScan => Poles	same	16%	same	same	18	3.5
CDM						
- 10% =>30%	same	10%	same	same	7	1.4
Transaction costs						
- 20% => 30%	same	15%	same	same	9.5	2.2
- 20% => 0%	same	13%	same	same	8.7	1.3
Overall						
- A1B => LOW[2]	0	0%	-5.2%	+5%	0	0
- A1B => HIGH[3]	130	16%	-0.1%	+10.6%	19	4.4

[1] reference case: Baseline A1B, MAC: WorldScan; CDM-10%; TAC-20%

[2] LOW: Baseline B1, MAC: WorldScan; CDM-30%; TAC-0%

[3] HIGH: Baseline A1B, MAC: Poles; CDM-10%; TAC-30%

Baseline emissions

Our evaluation used the IPCC SRES A1B scenario as the reference. This scenario can be characterised by increasingly globalisation in which technological developments and economic growth are quite rapid (see Box 2). Emissions are relatively high. Other scenarios differ mainly in their orientation on international developments and sustainability. The A2 scenario, for example, differs from an A1B world in that regions are much more self-oriented and international developments are fragmented. Economic growth is lower and global emissions are also somewhat lower. The B1 scenario, on the other hand, reflects a global orientation similar toA1 but has a much stronger emphasis on environmental and social development. As a consequence, emissions are much lower. Figure 3 illustrates graphically the dynamic process towards the Bonn Agreement for three different scenarios.

Figure 3 shows clearly that the costs of the pre-COP 6 version of the Kyoto Protocol are very different in the three scenarios. It also illustrates the strong impact of the US withdrawal on Annex I emission reductions and compliance costs. In all scenarios the Bonn Agreement will lead to a sharp increase in Annex I emissions, including the US, relative to 1990. Without the US, however, emissions will slightly decrease relative to 1990.

[24] Now there is a surplus of hot air on the permit market (see also Table 5) and only a part (66 per cent) of the hot air is being traded. This implies that the total Annex I emission reductions without the US as a percentage of 1990 emissions changes from –4 per cent (all hot air being traded in the pre-COP 6 version of the Kyoto Protocol, see Table 1) to –5 per cent. A similar argument can be made for A2, but now 90 per cent of the hot air is being traded. See also Section 4.1.

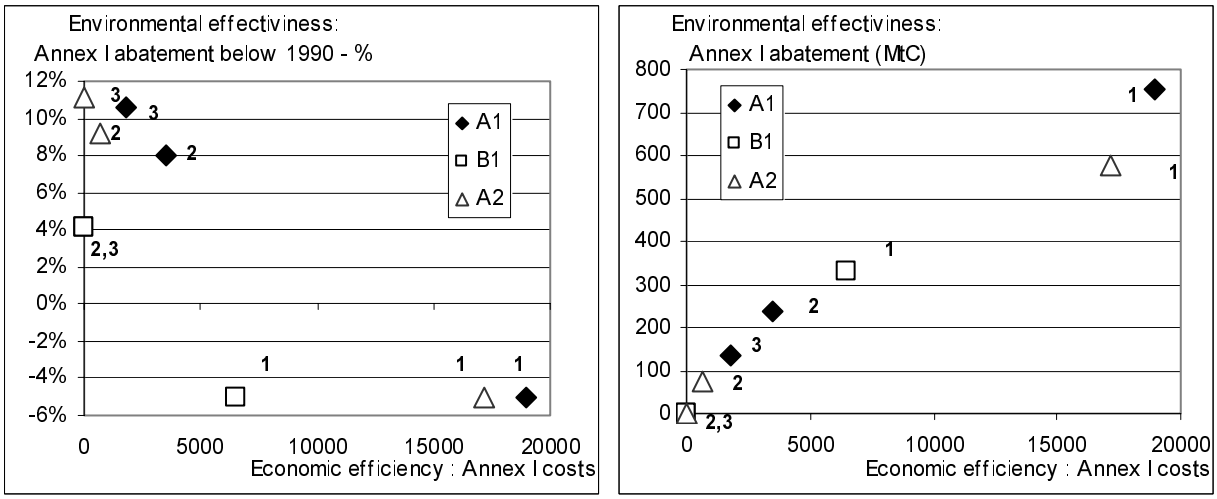


Figure 3 Environmental effectiveness and economic efficiency of the Bonn Agreement in three different scenarios for the three cases

* cases 1, 2 and 3 correspond with Table 1 (KP with IET, KP w/o US, KP w/o US and incl. sinks).

The right hand side of Figure 3 shows, in absolute terms, that the emission reduction burden of the Bonn Agreement is reduced to 130 MtC. In the A2 and B1 scenarios, however, baseline emissions come out even below the Kyoto targets and Annex I abatement is reduced to (near) zero.

A consequence of lower baseline emissions is that hot air becomes so dominant that it may drastically reduce permit demand and drive prices down to zero. In fact, such a situation may effectively wipe out the permit market. A rational reaction for the FSU would then be to curtail supply of emission permits to raise prices and increase revenues. This issue will be discussed extensively in Section 4.1.

Box 2: The IPCC SRES scenarios

The IPCC SRES scenario can be characterised as follows (Nakicenovic et al., 2000):

- *A1* describes a future world of substantial reduction in regional differences in per capita income.
- *A2* reflects a heterogeneous world with self-reliance and preservation of local identities as the underlying theme. Fertility patterns across regions converge slowly, which results in high population growth. Economic development is regionally oriented and per capita economic growth and technological change are more fragmented and slower than in the other scenarios
- *B1* assumes continuing globalisation and economic growth but with a strong focus on the environmental and social aspects. It represents a balanced, transformed 'modernisation' process. Governance at all levels and regulated forms of market capitalism are seen as the way forward and includes the strengthening of NGOs.
- *B2* describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with moderate population growth, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 story-lines.

Marginal abatement curves

The marginal abatement curves (MACs) determine total compliance costs for Annex I countries. Although we have used the MACs from WorldScan, we have also examined the impact of using cost curves from the POLES model (see Table 4). However, this has only little impact on

environmental effectiveness. Total abatement is similar but the permit price is about twice as high at a level of 18 US$/tC.[25] As a result total abatement costs are higher.

CDM accessibility
Different assumptions concerning the viability of CDM projects show the impact is also small, although larger than assumptions concerning MACs. A higher accessibility factor suggests more CDM projects and this would reduce the permit price to 7 US$/tC. Total costs for Annex I countries fall to US$ 1.4 billion. Domestic abatement will be reduced to 10 per cent of total commitments. Likewise, a lower CDM accessibility factor will increase the price and may lead to higher Annex I costs.[26]

Transaction costs
The results show that different assumptions on transaction costs have an insignificant impact on the results.

[25] Apparently the MACs from the POLES model appear to be somewhat higher than the MACs from WorldScan but the shapes are roughly similar. An explanation is that WorldScan does not take the inertia of the energy system into account, which underestimates total abatement costs. The energy model Poles does account for this inertia, which, besides model differences, explains the doubling of abatement costs compared to World Scan.
[26] In our FAIR model, the permit price varies from 3 US$/tC for 100% accessibility to 11 US$/tC for 0% accessibility.

4 Examining some key issues

The evaluation of the Bonn Agreement in the previous section has revealed three major issues for further analysis. Hot air may become extremely dominant and even threaten the viability of the Kyoto Mechanisms. In this section, we will further examine the importance and impact of hot air. The analysis will show that it would be in the interest of major sellers of emission permits, that is the FSU, to exercise market power. In this context, we will explore what happens if the FSU is capable of exercising market power both through volume and price controls.

Another outcome of the evaluation is that domestic efforts account for only one-seventh of total commitments, well under the 50 per cent supplementarity target in previous climate change discussions. The EU in particular was strongly in favour of realising at least 50 percent of reduction commitments at home. Although the current Bonn Agreement does not comprise a quantitative cap (see Section 2.1), we will examine what would happen if the EU were to voluntarily stick to the 50 per cent target for domestic emission reduction.

Finally, we will assess the significance of US non-participation by simulating what the outcome of the Bonn Agreement would be if the US were to rejoin the Protocol. We will argue that the current agreement meets many of the previous US demands and opens the door for US re-entry.

4.1 The importance and impact of hot air

As common underlying factor of all analyses is the projection of hot air for the FSU. Economies in transition, in particular, countries belonging to the FSU, have been faced with an economic downturn in the early 1990s, which has caused a sharp decline in emissions. Although it was expected that emissions would start to rise as soon as economic growth picked up, the recovery has not, as yet, happened. Given the Kyoto targets, this has created a substantial amount of so-called hot air.

Our model estimates hot air in a range of 275 to 375 MtC, depending on the scenario (see also Table 5). This range is 25 to 33 per cent below 1990 levels. Our estimates compare very well with recent energy demand forecasts, among others by the Russian National Energy Strategy. The former predicts CO_2 emissions in 2010 at 30 per cent (see Korppoo and Vrolijk, 2001) under the 1990 level, while the IEA presents a range almost identical to FAIR.

Table 5: Net Annex I permit demand (MtC) in three scenarios

Bonn Agreement	**A1B**	**A2**	**B1**
Annex I (minus FSU) demand	530	423	342
Hot Air*	295	347	372
Sinks**	105	105	105
Net Annex I demand	130	-29	-135
Hot air* in %			
1. KP with US (with IET)	28%	35%	50%
2. KP w/o US (with IET)	56%	82%	>100%
3. Bonn Agreement	70%	>100%	>100%

* Excluding sinks of FSU; ** Including sinks of FSU (see Section 3.3)

After the US withdrawal from the Kyoto Protocol the permit demand by Annex I countries has been substantially reduced and hot air becomes extremely dominant. This happens in all scenarios; in fact, hot air may even exceed 100 per cent of the Annex I demand in case of low emissions baselines. This excess supply over Annex I demand drives prices down to zero and such a situation would seriously undermine the development of an international permit market.

It is difficult to imagine what this would mean in practice. In theory, a situation of zero price and a dysfunctional market is unlikely to occur, since this is also clearly not in the interest of the sellers themselves, the FSU and non-Annex I countries. A rational reaction for the dominant seller on the market, i.e. FSU, would be to exercise market power by limiting the supply of hot air and bank it for better times. Box 3 explains that the FSU would maximise net financial revenues from permit trading by limiting hot air supply by about 50 per cent (depending on the baseline).

Box 3: Former Soviet Union will benefit from limiting and banking hot air supply

As a dominant seller on the permit market, the FSU is in theory capable of exercising market power, for example by limiting the supply of hot air to the international emissions market. A lower permit supply will increase the permit price and as a result, OECD countries will choose to reduce more at home and decrease permit imports. The impact on financial revenues for the FSU depends on whether the higher permit price will outweigh the lower volume of permit sales.

Figure 4 shows the impact of different levels of hot air supply on the permit price and the revenues for the FSU. The financial gains for the FSU are maximised when 40 per cent of hot air supply is banked in the A1B scenario up to 55-70 per cent in the A2 and B1 scenarios. Hence, it is in the own interest of the FSU to limit hot air supply. The non-Annex I countries benefit indirectly by the higher permit price. Other CDM accessibility factors do not change the optimum values for FSU.

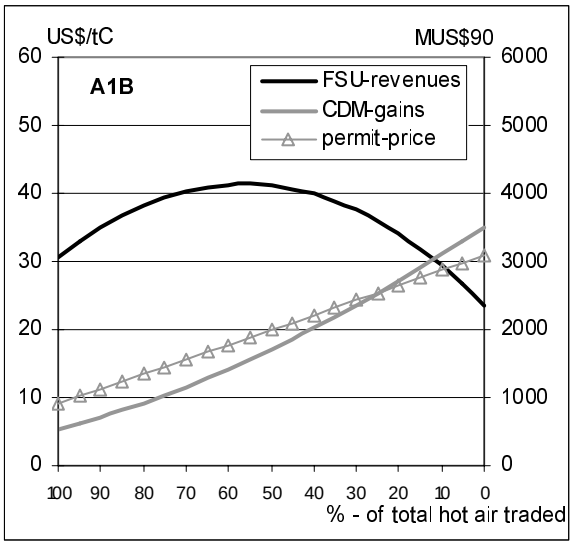


Figure 4: The revenues of the FSU and non-Annex I countries and the international permit price in the A1B scenario for different percentages of hot air traded.

4.2 Exercising market power

In the previous section it was concluded that a dysfunctional international emissions market with zero prices is not in the interest of the sellers on the permit market, i.e. the FSU and non-Annex I countries. It would be rational for the dominant seller FSU to exercise market power and engage upon strategies towards maximising the revenues from permit sales. The rationale for such behaviour is quite simple. A low price in the first commitment period will induce sellers to defer part of their emission budgets for use in subsequent periods. This banking is certainly attractive if one expects a (much) higher permit price in the future due to, for example, (re-)entry by other

countries to the Kyoto Protocol or more stringent emission targets in the second commitment period.[27]

We will examine what happens if the FSU is capable of exercising market power through volume and price controls. In the first option, volume control, we assume the FSU banks 50 per cent of the hot air supply to the second commitment period. This would maximise FSU revenues (see Box 3). In the second option, price control, we assume the FSU is capable of imposing a minimum permit price of 25 US$/tC. Table 6 presents the results of these what-if situations and compares them with the Bonn Agreement.

Table 6: The environmental effectiveness and economic efficiency of the Bonn Agreement compared to several what-if situations

	Environmental effectiveness					**Economic efficiency**		
	Annex I Abatement (index = 100: 130 MtC)		Domestic reduction Annex I	Annex I emissions compared to 1990-levels		Interna-tional permit price	Annex I costs(index =100:2 bUS$)	
	Index	MtC		excl US	incl US	US$/tC	Index	bUS$
1. KP with US (with IET)	580	755	46%	-4%	-5.1%	36	1000	19
3. Bonn Agreement (BA)	100	130	14%	-0.1%	+10.6%	9	100	2
4. BA & volume control (banking 50% hot air supply)	190	300	31%	-6.2%	+6.5%	20	300	5.3
5. BA & price control (minimum permit price of 25 US$/tC)	100	130	44%	-0.1%	+10.6%	25	250	4.6
6. BA & 50% EU-target and banking 90% hot air supply	260	425	51%	-11%	+3.3%	25	500	9.1
7. BA & US re-entry	400	595	41%	-0.1%	-1.0%	29	800	14

As supply is limited, the international permit price increases from 9 to 20 US$/tC. Permits become more expensive and Annex I countries turn more to domestic efforts for abatement. Total abatement costs almost triple in comparison with the current Bonn Agreement. Still, the costs are 70 per cent below the cost level of the pre-COP 6 version of the Kyoto Protocol. The winners are the FSU and the environment. The FSU benefits financially and sees its revenues increase from US$ 3 to 4 billion, nearly 0.5 per cent of GDP. The environment also profits as total abatement increases to 320 MtC compared to the 130 MtC of the current Bonn Agreement; the share of domestic abatement doubles to 31 per cent of total commitments. Annex I emissions without the US now come out 6 per cent under the 1990 level. Total Annex I emissions with the US reach a level of about 7 per cent above 1990 levels.

Market power could also be imposed through a minimum permit price. This would have the effect of ensuring the FSU as well as non-Annex I countries receive acceptable prices for their permit sales, while also stimulating domestic action by Annex I countries. We have simulated what will happen if the FSU is capable of fixing the price level at 25 US$/tC (see Table 6). Total Annex I emission reductions remain the same as under the Bonn Agreement as part of the hot air is still being traded. However, the higher (minimum) price encourages countries to abate more at home, which raises the share of domestic action as a percentage of total reductions. As a result, total costs increase, although less when compared to limiting hot air supply and well under the pre-COP 6 version of the Kyoto Protocol.

With regard to the financial revenues, banking 50 per cent of hot air supply implies a reduction in the volume of FSU permit sales by about 30 per cent (see Table 7). However, this is more than

[27] Mann and Richels (2001) point at the importance of these factors for the level of banking and the carbon permit price. However, these factors are presently unknown and speculative and, therefore, not taken into account.

offset by the higher permit price and more revenues from JI projects. Ultimately, revenues for the FSU amount to over US$ 4 billion, an almost one-third increase compared to the Bonn Agreement. A minimum price of 25 US$/tC is even more beneficial to the FSU as the profit margin on permit sales is much higher. Total FSU revenues stagger up to US$ 7 billion. The financial revenues for non-Annex I countries are somewhat different. The sales of sink credits under CDM remain the same, since we assume that these projects are economically beneficial above energy-related CDM projects. However, the volume of sales of CDM energy projects more than doubles and further benefits from the higher price on the international market, boosting sales up to nearly US$ 2 billion. With a minimum permit price, the vast amount of FSU permit sales pushes the exports of energy-related CDM projects off the market. The revenues for non-Annex I countries come only from the sales of sinks credits under the CDM.[28]

Table 7: Net financial revenues and volumes of permit trading for the Bonn Agreement compared to several what-if situations

	FSU				**Non-Annex I***			
	A1B		B1		A1B		B1	
	volume	reven.	volume	reven.	volume	revenue	volume	reven.
	MtC	bUS$	MtC	bUS$	MtC	bUS$	MtC	bUS$
3. Bonn Agreement (BA)	370	2.8	268	0	57	0.6	33	0
4. BA & volume control (banking 50% hot air supply)	260	4.1	224	1.1	86	1.8	45	0.3
5. BA & price control (minimum permit price 25US$/tC)	280	6.6	141	3.2	33	0.9	33	0.9
6. BA & 50% EU-target and banking 90% hot air supply	160	2.3	100	0.8	100	2.6	65	1.0
7. BA & US re-entry	470	11.2	451	4.6	109	3.6	59	0.9

* The volume of CDM sales includes 33 MtC from sinks under CDM

In conclusion, both types of exercising market power have various impacts on the Bonn Agreement. Limiting and banking hot air supply improves the environmental effectiveness of the Kyoto Protocol but also leads to a threefold increase in Annex I abatement costs. At the same time, banking also generates positive financial benefits for both the FSU and the non-Annex I countries. Imposing a minimum price does not improve the overall environmental Annex I performance although domestic abatement as a percentage of total reductions increases. It increases Annex I costs substantially, although slightly less than banking, but offers the FSU the best financial incentives. A common conclusion is that total abatement costs will not be reduced by the US withdrawal as much as currently expected assuming the FSU will indeed exercise some type of market power.

4.3 Voluntary EU target for domestic reduction

The Bonn Agreement comprises no quantitative caps on emissions trading. However, this so-called supplementarity issue has been of major importance in the subsequent international negotiations. The Kyoto Protocol stipulates that Parties may participate in emissions trading, but that such trading should supplement domestic abatement measures. The EU, in particular, has been a strong advocate of imposing concrete ceilings on permit trading in order to encourage domestic actions. Although the Bonn Agreement includes no quantitative cap on permit imports, we have simulated what the impact would be if the EU voluntarily decides to realise 50 per cent of their own commitments domestically.

[28]The results are different in the B1 scenario. Both the FSU and non-Annex I countries gain from a minimum permit price of 25 US$/tC compared to limiting hot air supply by 50 per cent. The explanation is that the minimum permit price more than compensates the losses in the export volumes for non-Annex I.

The outcome (not shown in Table 6) demonstrates that this would wipe out almost all Annex I permit demand and bring down the permit price to zero. Pursuing a voluntary 50 per cent target for domestic reduction will therefore undermine any emissions market potential and should not be considered without curtailing permit supply. We have, therefore, examined the impacts of a voluntary EU target of 50 per cent domestic action together with a situation in which the FSU would limit and bank 90 per cent of hot air supply.[29] This what-if situation would drive the permit price up from about 10 to 25 US$/tC. The environmental effectiveness is improved as total reductions increase to 425 MtC and domestic action of Annex I countries exceeds the 50 per cent. Emissions will be 9 per cent below baseline without US emissions, which is similar to 11 per cent under 1990 levels. Total abatement costs for Annex I countries increase substantially to over US$ 9 billion, compared to just over US$ 2 billion for the Bonn Agreement without caps on permit trading.

The financial implications of this what-if situation are different for the FSU and non-Annex I countries (see Table 7). The financial gains for the FSU are about 25 per cent lower compared to the Bonn Agreement. Apparently, the sharp decrease in the volume of permit sales from a much lower EU demand outweighs the effect of a higher permit price (as a result of limiting hot air supply). The non-Annex I countries, on the other hand, profit as CDM sales are boosted to nearly US$ 2.6 billion, a four-fold of the gains under the unrestricted Bonn Agreement.[30]

4.4 What about re-entry of the US?

The previous analyses have demonstrated the key importance of (non-)US participation in the Kyoto Protocol. It is interesting to see what the outcome of the Bonn Agreement would be if the US rejoins the Protocol. The results in Table 6 show that the US re-entry would significantly improve the environmental effectiveness of the Kyoto Protocol. Emission reductions would run up to nearly 600 MtC, fourfold the current Bonn Agreement although still less than the pre-COP 6 version of the Kyoto Protocol. This is the result of the decisions on sinks that allows the US to count almost 55 MtC as emissions. Total Annex I emissions end up 13 per cent below baseline levels and about 1 per cent under the level of 1990.

Another important effect of US re-entry is that it strengthens the international emissions market by strongly raising permit demand. The permit price triples up to 29 US$/tC. This price increase results in more domestic abatement at 41 per cent of total commitments. Higher prices on the international market and more expensive domestic action substantially increase Annex I abatement costs from US$ 2 to 14 billion, still less than 0.1 per cent of GDP. This cost level is also about 20 per cent below the pre-COP 6 version of the Kyoto Protocol. Net financial revenues to the FSU run up to US$ 11 billion or 1.4 per cent of GDP. Non-Annex I countries would significantly benefit from US re-entry as the sales of CDM credits will almost double to nearly US$ 4 billion.

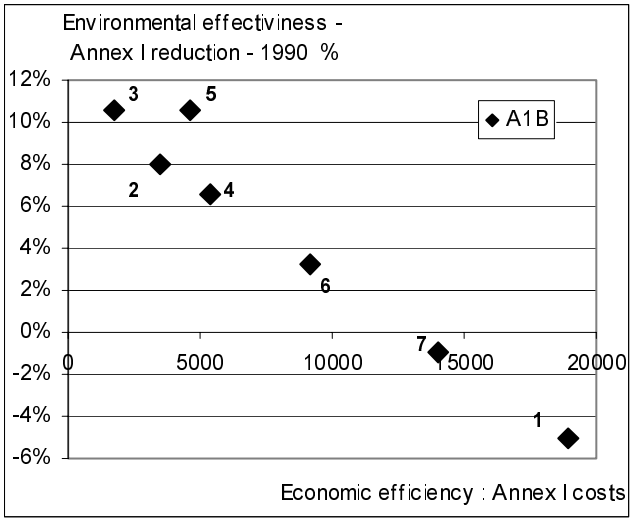
The conclusion is that US re-entry will be of key environmental importance and would imply a firmer step forward in limiting global emissions. Although the current US administration seems determined in its preference for alternatives to the Kyoto Protocol, the Bonn Agreement offers

[29] This 90 per cent limitation of hot air supply is close to the optimum value of 75 per cent that maximises net FSU revenues given the 50 per cent EU-target. Under this optimum value the net revenues for the FSU given this 50 per cent EU target will be the same as net revenues under the Bonn Agreement (see Den Elzen and de Moor, 2001).
[30] In the B1 scenario, this pattern is different as then both FSU and non-Annex I would gain in the restricted market, which is evident since there is no equilibrium price in the unrestricted market.

ample scope for US re-entry. The decisions underlying the Bonn Agreement largely meet previous US demands on key issues and may even be characterised as US-friendly. For example, the sinks provision for the US is more than what could have been expected from official FAO data (see Section 3.3). Also the absence of a quantitative and mandatory cap on permit trading (supplementarity) corresponds with US interests. Ultimately, US abatement costs would be much lower than envisioned in the pre-COP 6 of the Kyoto Protocol, about 25 per cent, at a level of nearly US$ 13 billion. Considering these advantages, the Bonn Agreement leaves the door open for US re-entry. Whether the US will indeed re-join the Kyoto Protocol will be largely determined by the domestic political environment.

4.5 Overview of cases

Figure 5 summarises the various cases in a graphic overview. It shows again how far the Bonn Agreement is from the pre-COP 6 version of the Kyoto Protocol and that US withdrawal has been by far the largest influence in this process. Figure 5 also clearly demonstrates the significance and impact of the various what-if situations. A minimum price will hardly affect the environmental performance of the Kyoto Protocol, although it may strengthen the emissions market and offers the most attractive financial incentives for the FSU. Limiting and banking hot air supply does improve the environmental effectiveness and even substantially more in conjunction with an EU voluntary target for 50 per cent domestic action. A US re-entry further enhances the environmental performance of the Kyoto Protocol and brings it much closer to the original situation. US re-entry will also strengthen the emissions market.



Cases:
1. Pre-COP 6 version of the Kyoto Protocol with the US
2. Pre-COP 6 version of the Kyoto Protocol without the US
3. Bonn Agreement (BA)
4. BA & volume control (banking 50% hot air)
5. BA & price control (minimum permit price of 25 US$/tC)
6. BA & EU-50% target & banking 90% hot air supply
7. BA & US re-entry

Figure 5: Environmental effectiveness and economic efficiency of the major steps leading to the Bonn Agreement and the various 'what-if' cases for the A1B scenario

5 Conclusions

This report evaluates the environmental effectiveness and economic efficiency of the Kyoto Protocol as agreed at the resumed session of COP 6 in Bonn. The Bonn Agreement is the culmination of a turbulent international negotiating process with some major steps: the pre-COP 6 version of the Kyoto Protocol, the withdrawal of the US and the final decisions as agreed in Bonn. Our evaluation focuses on these three steps. We have further explored several what-if situations to identify important issues that may need further attention.

- The Bonn Agreement points to a reduction of 130 MtC, compared to the 755 MtC in the pre-COP 6 version of the Kyoto Protocol. The Bonn Agreement implies an emission level of 3 per cent below baseline and just under the level of 1990 without US emissions.
- The US withdrawal has been by far the greatest impact in reducing the environmental effectiveness of the Kyoto Protocol. Total Annex I emissions including the US come out 10 per cent above the 1990 level.
- The decisions on sinks further reduce the environmental effectiveness, although the impact is comparatively small. In fact, compared to the US withdrawal, the decisions on sinks in the Bonn Agreement may be considered an acceptable price for a political agreement.
- However, without a major buyer like the US, permit demand is significantly reduced and as a consequence, permit prices may drop to around 9 US$/tC. Hot air becomes increasingly dominant and may threaten the viability of the Kyoto Mechanisms.
- The results are fairly robust and depend mainly on baseline scenarios. Lower economic growth and lower emissions further reduce permit demand and bring prices down to zero.
- As hot air pushes prices downwards, it would be in the dominant seller's interest (the FSU) to curtail supply and bank the hot air. Limiting and banking hot air supply improves the environmental effectiveness and generates positive financial benefits for both the FSU and the non-Annex I countries. Alternatively, the FSU could exercise market power by imposing a minimum permit price. This would offer the FSU the best financial incentives but does not improve the overall environmental performance.
- A voluntary EU target of 50 per cent domestic action would wipe out any emissions market potential and should not be considered without curtailing permit supply. A 50 per cent EU target combined with curtailing and banking 90 per cent of hot air supply improves the environmental effectiveness by increasing total Annex I reductions to 425 MtC and domestic action to 50 per cent. However, this would also increase abatement costs substantially, not only for the EU but also for other Annex I countries by a four-fold to over US$ 9 billion.
- The Bonn Agreement leaves the door open for US re-entry. The decisions on key issues meet many of the previous US demands and may even be characterised as US-friendly. Abatement costs for the US are also less than US$ 13 billion, slightly over 0.1 per cent of GDP. Considering these advantages, the Bonn Agreement offers ample scope for US re-entry. Whether the current US administration will indeed rejoin the Kyoto Protocol seems largely a matter of the domestic political environment.

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Appendix I: Detailed model results

Table I.1: Emissions trading, abatement and costs for the pre-COP 6 version of the Kyoto protocol including US participation (reference case)

REGIONS	NO TRADE						TRADE									GAINS TRADE		PER CAPITA	
	Reference	Target	Reduc-tion	Burden	MAC	Costs	Emissions	Dom./ Total	MAC	Dom Act	Trade	Dom costs	Trade costs*	Total costs*	%-GDP	Gains trade	%	Target	Emission
	MtC	MtC	%	MtC	US$/tC	MUS$	MtC	%	US$/tC	MtC	MtC	MUS$	MUS$	MUS$	%	MUS$	%	tC/cap	tC/cap
Canada	153	105	-31	48	101	2092	132	44	36.1	21	27	384	1155	1539	-0.18	553	26	3.15	3.95
USA	1739	1224	-30	514	100	23246	1522	42	36.1	216	298	3915	12914	16830	-0.14	6416	28	4.04	5.03
OECD Europe	1088	804	-26	285	111	13776	973	41	36.1	116	169	2096	7323	9418	-0.08	4357	32	1.98	2.40
Eastern Europe	318	252	-21	66	38	1271	256	95	36.1	62	3	1151	141	1292	-0.19	-21	-2	2.03	2.06
Former USSR	719	1011	41	-293	0	0	538	0	36.1	0	-473	2711	-17082	-14371	1.78	14371	100	3.34	1.78
Oceania	124	87	-29	36	91	1477	106	47	36.1	17	19	311	837	1147	-0.18	330	22	2.79	3.40
Japan	372	275	-26	97	92	4003	327	46	36.1	45	52	805	2273	3079	-0.05	924	23	2.06	2.46
Annex I	4512	3759	-17	753	70	45866	3854	46	36.1	477	96	11374	7561	18935	-0.06	26931	59	2.82	2.89
Non-Annex I	3971	3971	0	0	0	0	3876	0	36.1	0	-96	144	-3454	-3310	0.03	3310	100	0.71	0.70
World	8483	7730	-9	753	1	45866	7730	46	36.1	477	0	11518	4107	15625	-0.03	30241	66	1.12	1.12

Table I.2: Emissions trading, abatement and costs for the pre-COP 6 version of the Kyoto protocol without US participation (reference case)

REGIONS	NO TRADE						TRADE									GAINS TRADE		PER CAPITA	
	Reference	Target	Reduc-tion	Burden	MAC	Costs	Emissions	Dom./ Total	MAC	Dom Act	Trade	Dom costs	Trade costs*	Total costs*	%-GDP	Gains trade	%	Target	Emission
	MtC	MtC	%	MtC	US$/tC	MUS$	MtC	%	US$/tC	MtC	MtC	MUS$	MUS$	MUS$	%	MUS$	%	tC/cap	tC/cap
Canada	153	105	-31	48	101	2092	144	20	16.1	9	38	77	744	821	-0.10	1272	61	3.15	4.30
USA	1739	1739	0	0	0	0	1739	0	16.1	0	0	0	0	0	0.00	0	0	5.74	5.74
OECD Europe	1088	804	-26	285	111	13776	1037	18	16.1	52	233	419	4513	4932	-0.04	8844	64	1.98	2.55
Eastern Europe	318	252	-21	66	38	1271	291	41	16.1	27	39	217	746	963	-0.14	309	24	2.03	2.34
Former USSR	719	1011	41	-293	0	0	638	0	16.1	0	-373	542	-6022	-5480	0.68	5480	100	3.34	2.11
Oceania	124	87	-29	36	91	1477	116	21	16.1	8	29	62	558	620	-0.10	857	58	2.79	3.71
Japan	372	275	-26	97	92	4003	352	21	16.1	20	77	163	1493	1655	-0.03	2348	59	2.06	2.64
Annex I	4512	4273	-5	239	33	22620	4316	22	16.1	116	43	1479	2031	3511	-0.01	19109	84	3.20	3.24
Non-Annex I	3971	3971	0	0	0	0	3929	0	16.1	0	-43	29	-689	-660	0.00	660	100	0.71	0.71
World	8483	8245	-3	239	1	22620	8245	22	16.1	116	0	1508	1342	2850	-0.01	19770	87	1.20	1.20

Table I.3: Emissions trading, abatement and costs for the Bonn Agreement (reference case)

REGIONS	NO TRADE						TRADE									GAINS TRADE		PER CAPITA	
	Reference	Target	Reduc-tion	Burden	MAC	Costs	Emissions	Dom./ Total	MAC	Dom Act	Trade	Dom costs	Trade costs*	Total costs*	%-GDP	Gains trade	%	Target	Emission
	MtC	MtC	%	MtC	US$/tC	MUS$	MtC	%	US$/tC	MtC	MtC	MUS$	MUS$	MUS$	%	MUS$	%	tC/cap	tC/cap
Canada	153	124	-19	29	50	727	148	18	9.1	5	24	24	279	303	-0.04	424	58	3.71	4.43
USA	1739	1739	0	0	0	0	1739	0	9.1	0	0	0	0	0	0.00	0	0	5.74	5.74
OECD Europe	1088	824	-24	264	99	11647	1060	11	9.1	29	236	130	2699	2830	-0.02	8817	76	2.03	2.61
Eastern Europe	318	260	-18	58	34	1003	303	26	9.1	15	43	70	507	576	-0.08	427	43	2.09	2.44
Former USSR	719	1042	45	-323	0	0	673	0	9.1	0	-369	171	-3228	-3057	0.38	3057	100	3.44	2.22
Oceania	124	99	-20	25	54	654	119	17	9.1	4	21	19	242	261	-0.04	393	60	3.15	3.81
Japan	372	291	-22	81	70	2683	361	14	9.1	11	70	51	796	847	-0.01	1836	68	2.19	2.71
Annex I	4512	4378	-3	134	28	16714	4402	14	9.1	65	24	465	1295	1760	-0.01	14955	89	3.28	3.30
Non-Annex I	3971	3971	0	0	0	0	3947	0	9.1	0	-24	9	-521	-512	0.00	210	100	0.71	0.71
World	8483	8350	-2	134	1	16714	8350	14	9.1	65	0	474	774	1248	0.00	15164	91	1.21	1.21

Table I.4: Emissions trading, abatement and costs for the 50% banking of hot air for the A1B scenario (case 4)

REGIONS	NO TRADE						TRADE									GAINS TRADE		PER CAPITA	
	Reference	Target	Reduc-tion	Burden	MAC	Costs	Emissions	Dom./ Total	MAC	Dom Act	Trade	Dom costs	Trade costs*	Total costs*	%-GDP	Gains trade	%	Target	Emission
	MtC	MtC	%	MtC	US$/tC	MUS$	MtC	%	US$/tC	MtC	MtC	MUS$	MUS$	MUS$	%	MUS$	%	tC/cap	tC/cap
Canada	153	124	-19	29	50	727	141	40	19.9	12	17	118	458	576	-0.07	152	21	3.71	4.24
USA	1739	1739	0	0	0	0	1739	0	19.9	0	0	0	0	0	0.00	0	0	5.74	5.74
OECD Europe	1088	824	-24	264	99	11647	1024	24	19.9	64	200	643	5077	5720	-0.05	5927	51	2.03	2.52
Eastern Europe	318	260	-18	58	34	1003	285	57	19.9	33	25	330	682	1012	-0.15	-9	-1	2.09	2.29
Former USSR	719	880	23	-162	0	0	619	0	19.9	0	-261	829	-4942	-4113	0.51	4113	100	2.91	2.04
Oceania	124	99	-20	25	54	654	114	38	19.9	9	15	95	406	501	-0.08	153	23	3.15	3.65
Japan	372	291	-22	81	70	2683	347	31	19.9	25	56	249	1419	1668	-0.03	1015	38	2.19	2.61
Annex I	4512	4216	-7	296	29	16714	4269	31	19.9	143	53	2264	3100	5364	-0.02	11350	68	3.16	3.20
Non-Annex I	3971	3971	0	0	0	0	3919	0	19.9	0	-53	44	-1715	-1671	0.01	1009	100	0.71	0.71
World	8483	8188	-3	296	1	16714	8188	31	19.9	143	0	2308	1385	3693	-0.01	12359	74	1.19	1.19

Table I.5: Emissions trading, abatement and costs for the 25US$/tC minimum permit price for the A1B scenario (case 5)

REGIONS	NO TRADE						TRADE									GAINS TRADE		PER CAPITA	
	Reference	Target	Reduc-tion	Burden	MAC	Costs	Emissions	Dom./ Total	MAC	Dom Act	Trade	Dom costs	Trade costs*	Total costs*	%-GDP	Gains trade	%	Target	Emission
	MtC	MtC	%	MtC	US$/tC	MUS$	MtC	%	US$/tC	MtC	MtC	MUS$	MUS$	MUS$	%	MUS$	%	tC/cap	tC/cap
Canada	153	124	-19	29	50	727	138	50	25.0	15	15	184	486	670	-0.08	57	8	3.71	4.15
USA	1739	1739	0	0	0	0	1739	0	25.0	0	0	0	0	0	0.00	0	0	5.74	5.74
OECD Europe	1088	824	-24	264	99	11647	1008	30	25.0	80	184	1003	5888	6891	-0.06	4756	41	2.03	2.48
Eastern Europe	318	260	-18	58	34	1003	276	72	25.0	42	16	522	599	1121	-0.17	-118	-12	2.09	2.22
Former USSR	719	1042	45	-323	0	0	719	0	25.0	0	-278	0	-6616	-6616	0.82	6616	100	3.44	2.37
Oceania	124	99	-20	25	54	654	112	48	25.0	12	13	149	438	586	-0.09	68	10	3.15	3.57
Japan	372	291	-22	81	70	2683	341	38	25.0	31	50	389	1593	1982	-0.03	701	26	2.19	2.56
Annex I	4512	4378	-3	134	28	16714	4333	44	25.0	179	0	2246	2388	4634	-0.01	12081	72	3.28	3.25
Non-Annex I	3971	3971	0	0	0	0	3971	0	25.0	0	0	0	-832	-832	0.01	0	0	0.71	0.71
World	8483	8350	-2	134	1	16714	8304	44	25.0	179	0	2246	1556	3802	-0.01	12081	72	1.21	1.21

Table I.6: Emissions trading, abatement and costs for 50% EU target & 90% banking of hot air for the A1B scenario (case 6b)

REGIONS	NO TRADE						TRADE									GAINS TRADE		PER CAPITA	
	Reference	Target	Reduc-tion	Burden	MAC	Costs	Emissions	Dom./ Total	MAC	Dom Act	Trade	Dom costs	Trade costs*	Total costs*	%-GDP	Gains trade	%	Target	Emission
	MtC	MtC	%	MtC	US$/tC	MUS$	MtC	%	US$/tC	MtC	MtC	MUS$	MUS$	MUS$	%	MUS$	%	tC/cap	tC/cap
Canada	153	124	-19	29	50	727	138	51	25,2	15	14	187	487	673	-0,08	54	7	3,71	4,14
USA	1739	1739	0	0	0	0	1739	0	25,2	0	0	0	0	0	0,00	0	0	5,74	5,74
OECD Europe	1088	824	-24	264	99	11647	956	50	25,2	132	132	2733	4355	7088	-0,06	4559	39	2,03	2,36
Eastern Europe	318	260	-18	58	34	1003	276	73	25,2	42	16	530	594	1124	-0,17	-121	-12	2,09	2,22
Former USSR	719	751	5	-32	0	0	593	0	25,2	0	-158	1325	-3651	-2326	0,29	2326	100	2,48	1,96
Oceania	331	331	0	0	0	0	329	0	25,2	0	-2	2	-52	-49	0,00	49	100	0,59	0,58
Japan	124	99	-20	25	54	654	112	48	25,2	12	13	151	438	589	-0,09	65	10	3,15	3,57
Annex I	4512	4087	-9	425	30	16714	4154	51	25,2	232	67	5320	3820	9141	-0,03	7574	45	3,06	3,11
Non-Annex I	3971	3971	0	0	0	0	3905	0	25,2	0	-67	70	-2519	-2449	0,02	1611	100	0,71	0,70
World	8483	8058	-5	425	1	16714	8058	51	25,2	232	0	5390	1301	6692	-0,01	9185	55	1,17	1,17

Table I.7: Emissions trading, abatement and costs for the Bonn Agreement with the participation of US for the A1B scenario (case 7)

REGIONS	NO TRADE						TRADE									GAINS TRADE		PER CAPITA	
	Reference	Target	Reduc-tion	Burden	MAC	Costs	Emissions	Dom./ Total	MAC	Dom Act	Trade	Dom costs	Trade costs*	Total costs*	%-GDP	Gains trade	%	Target	Emission
	MtC	MtC	%	MtC	US$/tC	MUS$	MtC	%	US$/tC	MtC	MtC	MUS$	MUS$	MUS$	%	MUS$	%	tC/cap	tC/cap
Canada	153	124	-19	29	50	727	136	57	28,6	17	12	239	485	724	-0,08	4	0	3,71	4,09
USA	1739	1279	-26	460	85	18202	1568	37	28,6	171	289	2436	10470	12906	-0,11	5297	29	4,22	5,18
OECD Europe	1088	824	-24	264	99	11647	997	34	28,6	91	173	1303	6340	7643	-0,06	4004	34	2,03	2,46
Eastern Europe	318	260	-18	58	34	1003	270	82	28,6	48	10	682	479	1161	-0,17	-158	-16	2,09	2,17
Former USSR	719	1042	45	-323	0	0	576	0	28,6	0	-466	1699	-12927	-11228	1,39	11228	100	3,44	1,90
Oceania	124	99	-20	25	54	654	110	54	28,6	14	11	193	442	636	-0,10	18	3	3,15	3,52
Japan	372	291	-22	81	70	2683	336	44	28,6	35	45	506	1670	2176	-0,03	507	19	2,19	2,53
Annex I	4512	3918	-13	593	59	34916	3994	41	28,6	375	76	7058	6960	14017	-0,04	20899	60	2,94	3,00
Non-Annex I	3971	3971	0	0	0	0	3896	0	28,6	0	-76	90	-3582	-3492	0,03	2070	100	0,71	0,70
World	8483	7890	-7	593	1	34916	7890	41	28,6	375	0	7148	3378	10526	-0,02	22969	66	1,15	1,15

* Excluding 2% of proceeds on CDM for non-Annex I

Appendix II: Detailed sinks estimates

Table II.1 Estimates of emissions by sources and removals by sinks under Article 3.3 and 3.4 based on FAO data, accounting for the LULUCF caps as agreed in Bonn

	Base-year	Art 3.3 credit (+) or debit (-)	Art 3.4[31] Forest mana ge-ment	Art 3.3 debit com-pen-sated	Forest mana-gement after discount	Appendi x Z	Art 3.4 Forest mana-gement[32]	Art 3.4 Agricult ural manage ment (net-net)	Art 3.3 credits	Total Art 3.3 + 3.4	CDM 1% Base-year	Total credits	%-base-year
	1	2	3	4	5=0.15* ((3)-(4))	6	7=min (6,5)	8	9	10=7 +8+9	11	12=11 +10	15
	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr	MtC/yr		%
Australia	134.54	0.00	40.49	0.00	6.07	0.00	0.00	2.18		2.18	1.35	3.53	2.4%
Austria	21.04	-0.20	5.14	0.20	0.74	0.63	0.63			0.63	0.21	0.84	4.3%
Belgium	37.24		0.22		0.03	0.03	0.03			0.03	0.37	0.40	1.2%
Bulgaria	42.84		2.44		0.37	0.37	0.37			0.37	0.43	0.79	2.0%
Canada	166.17	-4.30	49	4.30	6.71	12.00	12.00	5.00		17.00	1.66	18.66	11.9%
Czech Republ.	51.74		2.13		0.32	0.32	0.32			0.32	0.52	0.84	1.8%
Denmark	19.08	0.09	0.31	0.00	0.05	0.05	0.05		0.09	0.14	0.19	0.33	1.9%
Estonia	11.10		0.64		0.10	0.10	0.10			0.10	0.11	0.21	2.0%
Finland	20.51	-0.36	5.65	0.36	0.79	0.16	0.16			0.16	0.21	0.37	1.9%
France	148.96	-0.62	8.95	0.62	1.25	0.88	0.88			0.88	1.49	2.37	1.7%
Germany	330.28	-0.21	14.07	0.21	2.08	1.24	1.24			1.24	3.30	4.54	1.5%
Greece	29.28		0.23		0.03	0.09	0.09			0.09	0.29	0.38	1.4%
Hungary	27.72		1.92		0.29	0.29	0.29			0.29	0.28	0.57	2.2%
Iceland	0.70	0.02	0	0.00	0.00	0.00	0.00	0.04	0.02	0.06	0.01	0.07	8.7%
Ireland	14.59	0.91	0.32	0.00	0.05	0.05	0.05		0.91	0.96	0.15	1.10	8.2%
Italy	141.64	0.47	0.71	0.00	0.11	0.18	0.18		0.47	0.65	1.42	2.07	1.6%
Japan	334.78	-1.02	13.58	1.02	1.88	13.00	13.00			13.00	3.35	16.35	5.2%
Latvia	9.73		2.52		0.38	0.34	0.34			0.34	0.10	0.44	4.9%
Liechtenstein	0.07				0.00	0.01	0.00			0.00	0.00	0.00	1.1%
Lithuania	14.06		1.88		0.28	0.28	0.28			0.28	0.14	0.42	3.3%
Luxembourg	3.67		0.01		0.00	0.01	0.01			0.01	0.04	0.05	1.4%
Monaco	0.03				0.00	0.00	0.00			0.00	0.00	0.00	1.1%
Netherlands	59.77	0.00	0.4	0.00	0.06	0.01	0.01	0.02	0.00	0.03	0.60	0.63	1.1%
New Zealand	19.90	7.64	3.67	0.00	0.55	0.20	0.20		7.64	7.84	0.20	8.04	40.4%
Norway	14.22	0.02	3.53	0.00	0.53	0.40	0.40		0.02	0.42	0.14	0.56	3.9%
Poland	153.89		5.45		0.82	0.82	0.82			0.82	1.54	2.36	1.6%
Portugal	17.12		0.51		0.08	0.22	0.22			0.22	0.17	0.39	2.5%
Romania	72.24		7.35		1.10	1.10	1.10			1.10	0.72	1.82	2.7%
Russian Federation	826.56		425.5		63.83	17.63	17.63			17.63	8.27	25.90	3.1%
Slovakia	20.79		3.36		0.50	0.50	0.50			0.50	0.21	0.71	3.7%
Slovenia	5.24		1.78		0.27	0.36	0.36			0.36	0.05	0.41	8.6%
Spain	84.13		3		0.45	0.67	0.67			0.67	0.84	1.51	2.0%
Sweden	19.25	-0.09	10.89	0.09	1.62	0.58	0.58			0.58	0.19	0.77	4.4%
Switzerland	14.46	-0.02	0.66	0.02	0.10	0.50	0.50	0.01		0.51	0.14	0.65	4.9%
Ukraine	250.70		7.41	0.00	1.11	1.11	1.11			1.11	2.51	3.62	1.4%
UK	208.84	0.56	1.67	0.00	0.25	0.37	0.37	0.25	0.56	1.18	2.09	3.27	1.7%
USA	1655.38	-7.20	101.2	7.20	14.10	28.00	28.00	10.20		38.20	16.55	54.75	3.6%
TOTAL with USA	4982.25	-4.31	726.6	14.02	106.89	82.50	82.47	17.70	9.71	109.9	49.82	159.7	3.4%
Non-EU	3826.9	-4.86	674.5	12.5	99.3	77.3	77.3	17.4	7.7	102.4	38.3	140.7	3.8%
EU	1155.39	0.55	52.08	1.48	7.59	5.17	5.16	0.27	2.03	7.46	11.55	19.02	1.8%
TOTAL wo USA	3326.9	2.89	625.4	6.8	92.8		54.5	7.50	9.71	71.68	33.27	105.0	3.3%
FAIR Annex I regions													
Canada	166.17	-4.30	49.00	4.30	6.71	12.00	12.00	5.00	0.00	17.00	1.66	18.66	11.9%
USA	1655.38	-7.20	101.2	7.20	14.10	28.00	28.00	10.20	0.00	38.20	16.55	54.75	3.6%
West.Europe	1184.88	0.57	56.27	1.50	8.22	6.08	6.06	0.32	2.07	8.45	11.85	20.30	1.9%
East. Europe	374.46	0.00	24.43	0.00	3.66	3.76	3.75	0.00	0.00	3.75	3.74	7.50	2.2%
FSU	1112.14	0.00	438.9	0.00	65.70	19.46	19.46	0.00	0.00	19.46	11.12	30.58	2.8%
Oceania	154.44	7.64	44.16	0.00	6.62	0.20	0.20	2.18	7.64	10.02	1.54	11.56	7.0%
Japan	334.78	-1.02	13.58	1.02	1.88	13.00	13.00	0.00	0.00	13.00	3.35	16.35	5.2%
Annex I	4982.25	-4.31	726.6	14.02	106.89	82.50	82.47	17.70	9.71	109.9	49.8	159.7	3.4%

[31] Here we use the FAO data (TBFRA, 2000), as reported in Table 2 of Pronk (2001). Although Pronk is referring to Annex 3.B3 page 169, the numbers in Table 2 do not correspond with the reported FAO-data in Annex 3.B3. In particular, for Canada, Italy, Russia and US, these are higher. Since we already use the Appendix Z values for these regions, the final carbon credits from forest management do not change by using the updated FAO data.

[32] For Japan, Canada, Greece, Italy, Portugal, Slovenia, Spain, Switzerland, United Kingdom and the US, the values as given in Appendix Z are used.

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