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Options for the Operationalisation of the Kyoto Mechanisms – Economic Analysis based on Partial Equilibrium Models

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Blueprints for the International Climate Negotiation at COP-6 - The Hague, and at COP-6 bis - Bonn

A series of Case-Studies with the ASPEN-sd software and the POLES model MAC curves

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SUMMARY FOR POLICY MAKERS AND METHODOLOGY

This report presents two series of studies performed before COP-6 and COP-6bis, in order to provide DG Environment with economic analyses of the issues at stake in international climate negotiations. These analyses used the background information provided by the large scale world energy partial equilibrium model POLES. They were also based on an extensive use of the Marginal Abatement Cost Curves produced by the POLES model through the ASPEN-sd software, specifically designed to produce assessment of the impact of different trading rules on a hypothetical tradable emission permit market.

Before COP-6 in The Hague

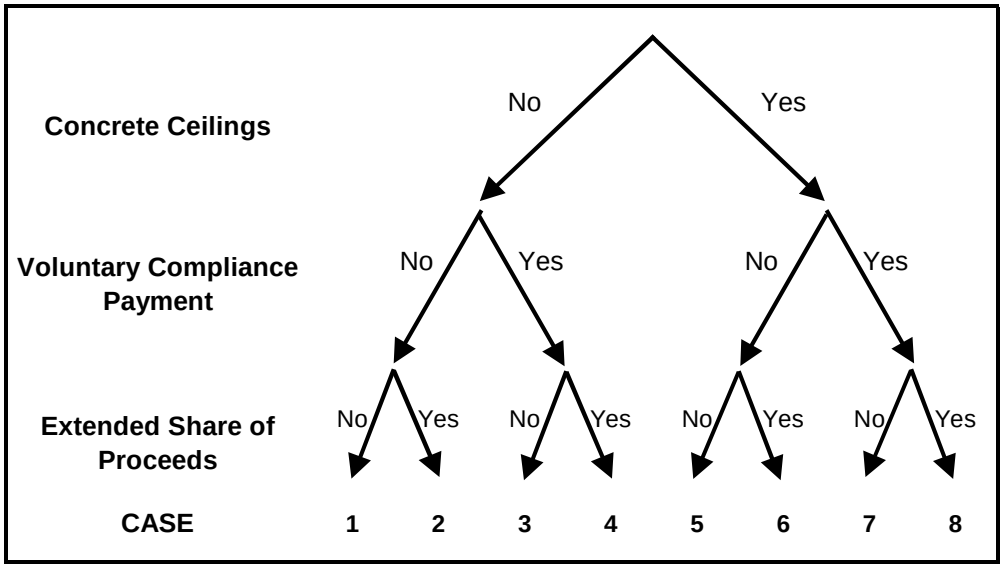
The ASPEN-sd software has been developed before COP-6 in order to facilitate the simultaneous testing of different trading rules associated to the Kyoto Protocol Flexibility Mechanisms. Associated to the POLES model Marginal Abatement Cost curves for 32 regions of the world, the software takes advantage of the properties of the aggregated permit supply and demand curves, in order to compute the market equilibrium price under different trade regulation schemes. The version used in the study of the negotiations before COP 6 indeed allows to test:

- the **Concrete Ceilings** on imports and exports (of different types, but in the following exercise expressed accordingly to the EU Environment Council proposals);
- the impact of the **Clean Development Mechanism;** although most modelling studies use, in order to simulate the CDM, transaction costs that are proportional to the direct abatement cost, earlier studies with ASPEN-sd showed that this solution produced unrealistic results, with very large CDM availability, even with high levels of transaction costs; this is why it has rather been decided to introduce a CDM "accessibility factor", which allows to take into account more realistic constraints on CDM projects identification and certification;
- the **Share of Proceeds** is considered in the Kyoto Protocol for CDM projects; it is introduced in absolute value ($ or E/tC) and is also considered as being possibly extended from CDM only to International Emission Trading in Annex B; earlier studies with ASPEN-sd indeed showed that the **Extended Share of Proceeds** (ESP) may have important positive impacts on North-South transfers associated to flexibility mechanisms;
- a **Hot Air Exclusion** option, which may reflect the possibility of reducing the quantities of hot air allowed to enter the permit trading system, or which may also account for the uncertainty on future energy developments and hot air availability in the Countries In Transition;
- finally, the **Safety Valve + Virtual Fund and Reverse Auction system,** initially introduced in the debate by Resources For the Future and which allows to reduce uncertainty by providing an insurance on the maximum level of the permit price that would have to be paid by the different parties; this option is now denominated as the **Voluntary Compliance Payment** system (VCP).

In order to provide a consistent set of hypotheses to be tested before the The Hague conference, it has been decided to build a decision-tree combining the three main options for trading rules. These are concrete ceilings, a voluntary compliance payment and an extended

Share of Proceeds. A ranking that corresponds to the chronology of their introduction in the negotiation process. This provides 2^3 cases to be studied, according to Diagram 1 below.

Diagram 1: Cases to be examined as blueprints for negotiation



The very purposes of the exercise have been twofold:

- to quantify the impacts of the different cases with simple indicators reflecting the different Parties preoccupations, i.e. global environmental effectiveness, global economic effectiveness, supplementarity, burden sharing implications, acceptability from a North-South perspective;
- to identify a new combined solution, which may present acceptable characteristics for the main parties and thus constitute a basis for a compromise concerning the first commitment period, as well as provide a sound ground for the negotiation on farther time horizons.

COP-6 : Synthesis and Conclusions

This first study illustrates how the main consequences of different trading rules and combinations can be studied in a consistent way and relatively great detail, while using marginal abatement cost curves from a detailed world energy sector model and a simple permit market analysis software. The key results are presented for all cases in the following synthesis table and graph.

They show that:

- the **No Trade case** is characterised by a high environmental effectiveness but at a very high cost, while **Cases 5 and 6** (with Concrete Ceilings of the “However Clause” type, i.e. “soft ceilings” except for hot air) achieve almost the same effective reductions at much lower total abatement cost (less than 30 b$99 instead of 67);
- the Full Trade **Case 1a**, minimise the cost (12.5 b$99) but with reduced environmental performances; the results of **Case 2b** are similar, with a slightly higher abatement cost but with important potential transfers to Non Annex B parties;

- **Cases 7 and 8** which combine the Concrete Ceilings and the Voluntary Compliance Payment provide an average level of environmental performance at a cost which remains low; these environmental results may however be highly dependent of the actual shape of the demand and supply curves; these may happen to be different in reality of what is hypothesised in this exercise and thus lead to quite divergent results; indeed the proper of the VCP systems is to reduce uncertainties on costs but leave the uncertainty open as concerns the quantities abated.

Taking into account these conclusions – and although the aim of this paper is to provide insights and not to identify one preferred solution to the international negotiation – it appears instructive to explore a new case, in order to combine a certain degree of simplicity in the trading rules and satisfactory performances in a triple perspective: environmental performance, cost limitation and North- South transfers.

Case 2c is indeed an additional case with all the characteristics of 2b but wit a 50 % hot air exclusion. It provides a simple framework of regulation for a high level of environmental performance, supplementarity and North-South transfers, but of course at a higher total abatement cost – although this cost is limited to 22 b$90. Its characteristics are compared to those of the other cases in the graph and table below, which show that such a configuration may provide an interesting intermediate solution with important North-South transfers potential (5 b$99).

Before and after COP-6bis in Bonn

The ASPEN-sd2 software used in that study is an extension of the ASPEN-sd software described above. Although it is based on exactly the same principles, it has some extra features.

First of all there are now 38 countries/regions studied, instead of 32 previously. The 6 new countries come from the (almost) complete desegregation of the EU (the only remaining aggregate is Belgium + Luxembourg).

In addition to the previous tests (concrete ceilings, CDM, Share of Proceeds, Safety Valve and Hot Air Exclusion), this version allows to test:

- the use by the different parties of any quantity of **Sinks,** through Article 3.3, 3.4 or through CDM projects. The quantity is added to the Party's Assigned Amount. Are tested combinations of the proposed quantities for sinks under Art. 3.4 forest management, Art. 3.4 agriculture management, Art. 3.3 credits and sinks through CDM projects for the different countries
- following the US withdrawal from the Kyoto Protocol, ASPEN-sd2 allows to simulate the impact of the **Participation or non-Participation** of any Party
- the set of **Objectives** for 2010 other than Kyoto's
- the implementation of a **domestic policy** in Parties that do not participate to a global agreement through the introduction of a price cap or the set of voluntary emission reductions objectives for 2010
- finally the application of the **Share of Proceeds** can now be differentiated following a Annex B / Non-Annex B / Least Developed Countries partition.

Two studies have been carried out with that tool: before and after the Bonn Conference in Bonn in July 2001.

In the first part of the chapter III we present a preparatory study for the "COP-6 II" Conference in Bonn with the assessment of five exploratory climate negotiation scenarios.

The second part is an analysis of the political agreement reached in Bonn. It draws some conclusions on outstanding issues that will have to be dealt with in the future COP meetings.

COP-6bis : Synthesis and Conclusions

We can easily understand the importance of sinks in the success of the Bonn conference, in particular in keeping the hesitating countries at the negotiation table to ensure that a political agreement will gather a sufficient number of Annex B countries to meet the minimum of 55% of 1990 CO_2 emissions condition for the Protocol to be enforceable.

Indeed, sinks are likely to have a major impact on the commitment efforts of Japan, Canada, and Australia - New Zealand. The willingness of the EU to keep the process on track despite the US withdrawal probably helped much in adopting soft positions on this issue.

However, the issue of sinks still faces many technical difficulties, which are to be seriously dealt with if these means of sequestration are to be considered as reliable ways of mitigating climate change in the mid to long-term. Although these questions go beyond the scope of this study, it is important to bear them in mind.

Along with large scientific and technical uncertainties with regards to the accounting of carbon stocks, there remains to define precise rules and to design tools to ensure that the proper monitoring of the projects is guaranteed and that the non-permanence of the sinks (concerning either the physical presence of the forest or its role as a sink rather than a source) is taken into account in the crediting accorded to Parties. The phenomenon of carbon leakage will also have to be prevented.

The second main conclusion of this study on the Bonn agreement is that 'a Kyoto Protocol without the US is like musical chairs with one too many chair' as R.J. Kopp puts it (Kopp R.J., "A climate accord without the US", Resources For the Future Weathervane, 2001, available on http://www.weathervane.rff.org/features/feature135.htm). If the agreement is to be environmentally meaningful, the amount of hot air in the system should be limited, at least partially, through the banking for subsequent commitment periods or by the use of schemes making the FSU and EEE maximise their benefits (and therefore limit the quantity of hot air put in the market). The present study shows that, assuming the US does not take part to the Protocol, the trading of emission reduction units from Joint Implementation projects only in Economies In Transitions (FSU and EEE), in addition to the Certified Emissions Reductions from CDM projects, does not affect much the different Parties: as an effect of the higher permit price and because there is a large potential for JI projects, the benefits for EITs are close to their maximum (see graph III.2.c) while the buyers' commitment effort is similar to a situation where the US participates and all available hot air is traded (see tables III.2.a and III.2.b). Moreover, the use of banking by FSU and EEE and the use of unsold hot air for a subsequent commitment period should help them to meet future objectives.

In the meantime, and providing hot air is traded only partially, the environmental result of such an agreement remains significant.

Methodology: The ASPEN-sd software and the POLES model

The ASPEN-sd software has been developed in the perspective of the on-going climate negotiation and in order to develop a flexible tool to assess different options for flexibility mechanisms and trading rules. Like the preceding versions of the ASPEN software it is based on the POLES model Marginal Abatement Cost Curves but may be used with other sets of MACCs, originating from other models.

Its main characteristics however is that it uses the properties of the aggregated permit supply and demand curves at World level in order to calculate the market equilibrium price (when it exists) under the different conditions for Concrete Ceilings, CDM, Transaction Levy, Hot Air Reductions and, finally, Price Ceilings + Abatement Fund (PC+AF). All of these parameters can be introduced by the user in the EXCEL ASPEN-sd sheet and the graph immediately illustrates the move of the permit demand and supply curves, from the initial full Annex B or World trade to the new situation created by trading rules.

The software then computes the different outputs in terms of:

- disaggregation of the emission reductions by nature (domestic, CDM, hot air, effective Annex B supply …);
- total amount of the funds originating from the levy or from the PC+AF mechanism.
- permit price or reverse auction price in the PC+AF option;

Last but not least, the table below the graph presents the results for the different regions considered in the POLES model (38 regions, considered here in full detail in order to minimise the transaction under-estimation bias, when aggregated regions are considered). For each region the situation in the no-trade case is presented as a benchmark and then the situation with regulated trade, while considering: the effective emission level, the domestic marginal abatement cost, trade in volume and in money terms. In the end, gains from trade are expressed relatively to the no-trade situation, in percentage and in absolute money terms.

This software may provide a useful tool for negotiation purposes as it allows both for analytical insight on the consequences of different trading rules and mechanisms and for rough but consistent quantitative estimates. These remain provisional for the moment (a full version is under development) but provide consistent orders of magnitude for the impacts of the different options.

The POLES model: Prospective Outlook on Long-term Energy Systems

The POLES model is a world simulation model for the energy sector. It works in a year-by-year recursive simulation and partial equilibrium framework, with endogenous international energy prices and lagged adjustments of supply and demand by world region. Developed under the JOULE II and JOULE III programmes, the model is fully operational since 1997 and enables to produce:

- detailed long term (2030) world energy outlooks with demand, supply and price projections by main region;

- CO2 emission Marginal Abatement Cost curves by region, and emission trading systems analyses;

- technology improvement scenarios exogenous or with endogenous features and analyses of the value of technological progress in the context of CO2 abatement policies.

Target users of the model are international organisations and policy makers and energy analysts in the field of global energy markets and environmental issues.

Model characteristics

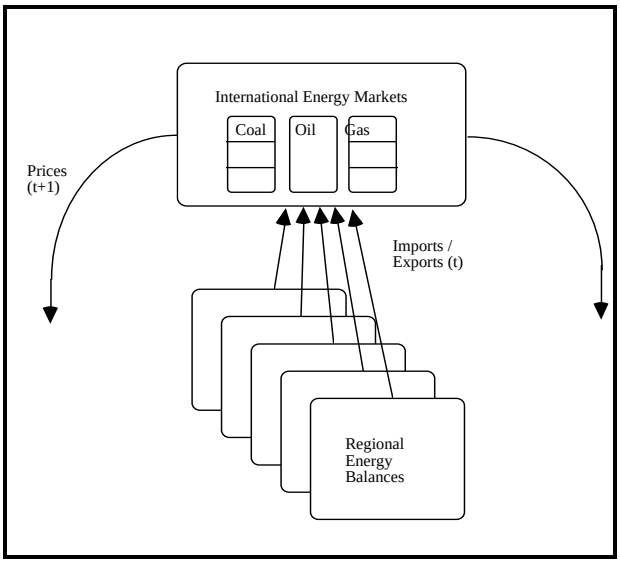
The POLES model is a global sectoral model of the world energy system. It has been developed in the framework of a hierarchical structure of interconnected sub-models at the international, regional, national level. The dynamics of the model is based on a recursive (year by year) simulation process of energy demand and supply with lagged adjustments to prices and a feedback loop through international energy prices.

Structure of the model

In the current geographic disaggregation of the model, the world is divided into thirty countries or regions, allowing to identify the key world regions of most energy studies: North America; South America; Western Europe; Central Europe; Former Soviet Union; North Africa and Middle-East; Africa South of Sahara; South Asia; South East Asia; Continental Asia; Pacific OECD.

In most of these regions the larger countries are identified and treated, as far as energy demand is concerned, by a detailed model. In the current version these countries are the G7 countries plus two groups for the rest of the European Union (North and South) and five key developing countries : Mexico, Brazil, India, South Korea and China. The other countries are dealt with in more compact but homogeneous models.

The POLES model



For each region, the model articulates four main modules dealing with :

- final energy demand by main sector

- new and renewable energy technologies

- the conventional energy and electricity transformation system

- fossil fuel supply

While the simulation of the different energy balances allows for the calculation of import demand / export capacities by region, the horizontal integration is ensured in the energy markets module, the main inputs of which are import demand and export capacities of the different regions. Only one world market is considered for the oil market (the "one great pool" concept), while three regional markets (America, Europe, Asia) are identified for coal, in order to take into account for different cost, market and technical structures. Natural gas production and trade flows are modelled on a bilateral trade

basis, thus allowing for the identification of a large number of geographical specificities and the nature of different export routes.

The comparison of import and export capacities and the changes in the Reserves/Production ratio for each market determines of the variation of the prices for the subsequent periods.

Final Energy Demand module

In the detailed demand model for the main countries or regions (14 in the current version, the consumption of energy is disaggregated into homogeneous sectors which allow to identify the key energy intensive industries, the main modes of transport and the residential and tertiary activities: Steel industry ; Chemical industry ; Non metallic mineral industries ; Other industries ; Road passenger transport ; Road freight transport ; Rail passenger transport ; Rail freight transport ; Air transport ; Residential sector ; Tertiary sector ; Agriculture.

In each sector energy consumption is calculated for substitutable fuels on one hand and for electricity on the other, wile taking into account specific energy consumption (electricity in electrical processes and coke for the other processes in steel-making, feedstock in the chemical sector, electricity for heat and for specific uses in the Residential and Tertiary sectors). Each demand equation combines a revenue or activity variable elasticity, price elasticity, technological trends and, when appropriate, saturation effects. Particular attention has been paid to the treatment of price effects.

New and Renewable Energy technologies diffusion module

Most studies on international energy perspectives either disregard new and renewable energy technologies as offering insufficient economic potential for development in the medium term or, conversely, try to assess their potential in a purely technical approach in order to show that their contribution to world energy supply can be important. The approach adopted in the New and Renewable Energy module of the POLES model tries to supersede these limits while recognising the difference between technical and economical potentials as well as the time-constant which characterise the diffusion process. Elements such as learning-curves and "niche-markets" have been introduced, which allow a truly dynamic approach of the development and diffusion of these technologies.

The module dedicated to the simulation of new and renewable technologies identifies ten generic technologies which are representative of the solutions to be implemented in different types of countries and might have a non negligible quantitative contribution in the long-term development of energy systems. The time horizon of the model (2030) in fact allows to consider that, given the development time-constants, the technologies that might have a significant role to this horizon should today be at least identified and have passed the first stages of development. Twelve technologies have been selected in the current version of the model from photovoltaics systems to biomass gasification or wind turbines.

Electricity and Transformation System module

While the transformation system for conventional fossil fuels is treated in a relatively aggregated way through the use of conversion, transport and distribution efficiency ratios, which is acceptable in a world model, the electricity system deserves a much more detailed treatment. In fact the electricity system is in any country not only one of the main energy consuming sectors but also probably the major sector for inter-fuel substitution. A last characteristic is that, because of the particularly long lifetime of equipment, this sector displays much higher price-elasticities in the long-term than in the short-term.

In order to take into account the capacity constraints in the electricity production system the module simulates the evolution of existing capacities at each period as a function of equipment development decisions taken in preceding periods and thus of the anticipated demand and costs at the corresponding time. In the current version of the model, twelve electricity generation technologies, conventional and new are identified, from conventional coal power plants and gas turbines in CC to new nuclear design or integrated coal gasification.

Oil and gas production module

Oil and gas production is simulated for each region using a full discovery-process model for the main producing countries and simplified relations for minor producing countries.

For each main producing country the available data cover the estimate of Ultimate Recoverable Resources for oil and for gas, the cumulative drilling and cumulative production since the beginning of fields development and the evolution of reserves. Cumulative discoveries are then calculated as the sum of cumulative production and remaining reserves. For base producers, oil or gas production then depends on a depletion ratio, applied to the remaining reserves (discoveries - cumulative production) in each period.

International Energy Prices module

In the current version of the model, the basis for international oil price modelling combines a Target Capacity Utilisation Rate model for the Gulf countries and the global oil R/P ratio as a long-term explanatory variable. This reflects the fact that most applied analyses of the oil market points to the fact that, as experienced in the seventies and eighties, the shorter term variations or shocks in the price of oil can be explained by the development of under- or over- capacity situations in the Gulf region.

Coal and natural gas prices are computed for each one of the three main regional markets with regional coal and gas trade matrixes and price variations linked respectively to coal production capacities and to the gas R/P ratio of the key residual producers for each region.

Outputs

*For a regularly updated **World Energy Outlook**, the model provides all information on energy flows for each country / region in a structure similar to that of a standard IEA-type energy balance. A summary balance provides a synthesis of information on energy consumption and transformation, new energy technologies and electricity production capacities.*

***Costing studies for CO2 abatement policies** are currently performed using the model by the systematic introduction of a "shadow-carbon tax" wherever it is relevant. Multiple simulations of the model then allow to analyse the impacts on emissions by sector and regions, to build the Marginal Abatement Cost curves and to analyse emission trading issues.*

*The **impact of technological change in the Baseline and in Emission Control Scenarios** can be addressed either with a set of exogenous "Technology Story" alternatives or with a module of R&D driven endogenous technology improvement.*

1 BLUEPRINTS FOR THE INTERNATIONAL CLIMATE NEGOTIATION - BEFORE COP6 IN THE HAGUE

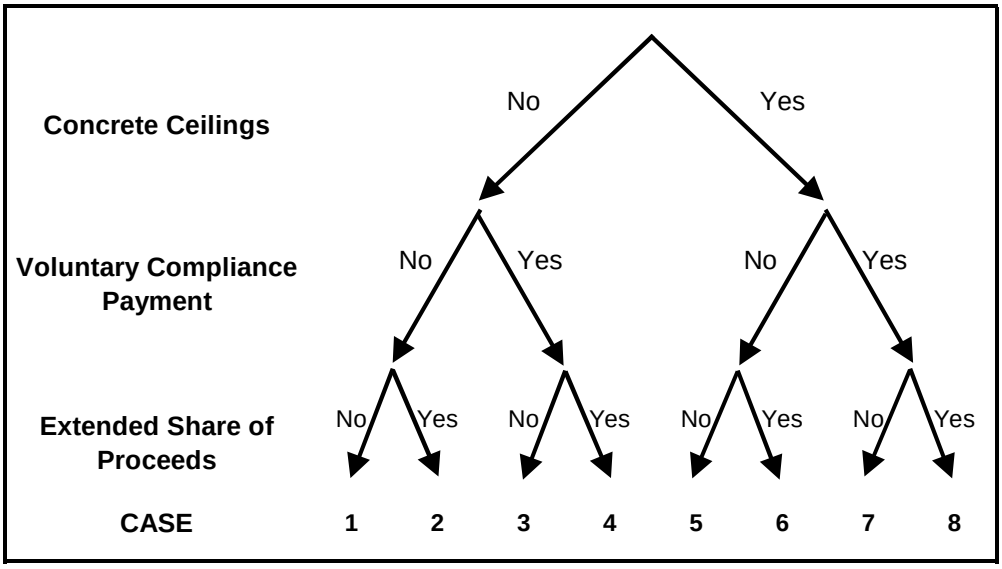
Introduction

The ASPEN-sd software has been developed before COP-6 in order to facilitate the simultaneous testing of different trading rules associated to the Kyoto Protocol Flexibility Mechanisms. Associated to the POLES model Marginal Abatement Cost curves for 32 regions of the world, the software takes advantage of the properties of the aggregated permit supply and demand curves, in order to compute the market equilibrium price under different trade regulation schemes. The current version indeed allows to test:

- the **Concrete Ceilings** on imports and exports (of different types, but in the following exercise expressed accordingly to the EU Environment Council proposals);
- the impact of the **Clean Development Mechanism;** although most modelling studies use, in order to simulate the CDM, transaction costs that are proportional to the direct abatement cost, earlier studies with ASPEN-sd showed that this solution produced unrealistic results, with very large CDM availability, even with high levels of transaction costs; this is why it has rather been decided to introduce a CDM "accessibility factor", which allows to take into account more realistic constraints on CDM projects identification and certification;
- the **Share of Proceeds** is considered in the Kyoto Protocol for CDM projects; it is introduced in absolute value ($ or E/tC) and is also considered as being possibly extended from CDM only to International Emission Trading in Annex B; earlier studies with ASPEN-sd indeed showed that the **Extended Share of Proceeds** (ESP) may have important positive impacts on North-South transfers associated to flexibility mechanisms;
- a **Hot Air Exclusion** option, which may reflect the possibility of reducing the quantities of hot air allowed to enter the permit trading system, or which may also account for the uncertainty on future energy developments and hot air availability in the Countries In Transition;
- finally, the **Safety Valve + Virtual Fund and Reverse Auction system,** initially introduced in the debate by Resources For the Future and which allows to reduce uncertainty by providing an insurance on the maximum level of the permit price that would have to be paid by the different parties; this option is now denominated as the **Voluntary Compliance Payment** system (VCP).

In order to provide a consistent set of hypotheses to be tested before the The Hague conference, it has been decided to build a decision-tree combining the three main options for trading rules – Concrete Ceilings, Voluntary Compliance Payment and Extended Share of Proceeds – in a ranking that corresponds to the chronology of their introduction in the negotiation process. This provides 2^3 cases to be studied, according to Diagram 1 below.

Diagram 1: Cases to be examined as blueprints for negotiation



The very purposes of the exercise are twofold:

to quantify the impacts of the different cases with simple indicators reflecting the different Parties preoccupations, i.e. global environmental effectiveness, global economic effectiveness, supplementarity, burden sharing implications, acceptability from a North-South perspective;

to identify new combined solution, which may present acceptable characteristics for the main parties and thus constitute a basis for a compromise concerning the first commitment period, as well as provide a sound ground for the negotiation on farther time horizons.

Disclaimers:

in this analysis only the net trade between the different regions is considered; evaluations of the impact of the share of proceeds system may be different if it were to be applied to all transactions;

the use of the funds raised by the share of proceeds system (be it “CDM projects booster”, adaptation in vulnerable areas, …) is not identified; the funds are simply considered as available for climate action and may be deduced of the total abatement costs in all cases with share of proceeds (2, 4, 6, 8);

non-CO_2 greenhouse gases and carbon sinks are not considered here as the system of models used doesn’t incorporate this option for the moment.

1.1 Case 1: World Full Trade with CDM

The identification and quantification of the potentials for the CDM mechanism is a particularly difficult issue for large scale models as well as for bottom-up studies. The solution usually proposed in modelling exercises is to introduce a transaction cost (TC) expressed as a percentage of the direct technical cost. There are two reasons for which this approach may neither be relevant from an analytical perspective nor be adequate in pure operational terms:

first of all it is highly controversial to consider that projects with low technical costs will incur low TC (in absolute levels) and that the reverse would also be true; it is on the contrary easily conceivable that high TC may be associated to small dispersed low cost projects while lower TA would be associated large high technology projects;

second it appears from earlier simulations (see Economic Assessment of North-South Transfers from the Kyoto Protocol Flexibility Mechanisms: 7 Case-Studies with the ASPEN-sd software and POLES model MAC curves) that even high TC (100 %) may not alter significantly the shape of the supply curve and thus result in non realistic levels of CDM projects.

From a positive statement perspective (and not a normative one) the quantities of CDM projects thus obtained with proportional transaction costs seem to be far too optimistic. Many abatement options incorporated in the model's MAC curves will obviously not be accessible to CDM projects, particularly the "small many" of behavioural changes, energy efficiency improvements and decentralised clean technology development, which may only be harnessed through national tax systems or appropriate "Policies and Measures".

The solution adopted in this exercise, has thus been to consider a CDM "Accessibility Factor", while the proportional formulation of TC has been conserved for the purpose of comparison with other exercises.

1.1.1 Case 1a: World Full Trade (CDM 10% accessibility)

ASPEN-sd : **CASE 1a Full Trade with CDM 10% AF**

INPUTS :

Concrete Ceil / Imports	100%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	0	$90/tC on IET
	0	$90/tC on CDM
Hot Air Exclusion (HAE)	0	MtC (EU = HA - Targ*5%
Voluntary Compliance Payment (VCP)	200	$90/tC (> 200 for no price ceiling)
	228	E99/tC
	62,3	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	Missing - HAE
798	MtC	324	84	56	334	0	0
2 926	MtCO2	1 186	308	205	1 226	0	0

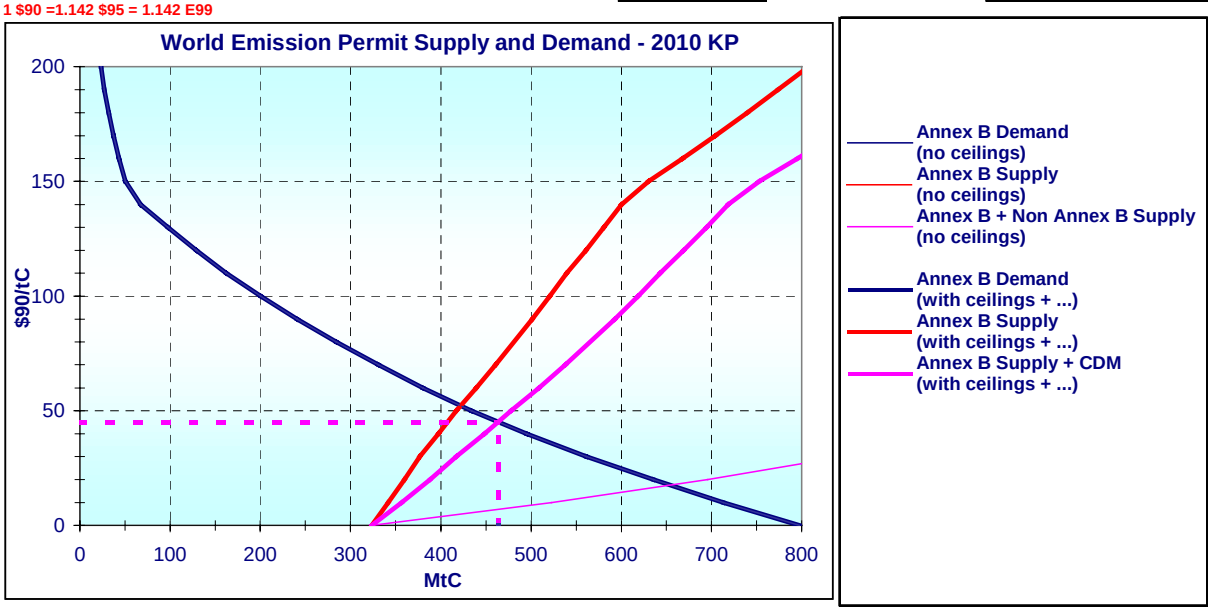
PERMIT PRICE	
45,2	$90/tC
51,6	E99/tC
14,1	E99/tCO2

FUND FROM SP	
0	M$90 of which
0	from IET
0	from CDM

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM VCP	
0	M$90 of which
0	to IET
0	to CDM

1 $90 =1.142 $95 = 1.142 E99



This case reflects the strong impacts of the taking into account of technical constraints to the development of CDM projects. The accessibility factor has been set at a relatively low level – 10 % – in **Case 1a** to account for the different constraints to CDM development, while a more optimistic view is taken in **Case 1b,** with a 30 % factor.

In **Case 1a** the market equilibrium price is of 45 $90 – 52 E99/tC, with a total abatement cost of about 10 b$90 (compared to 55 b$90 in the No Trade Case). The large quantity of available hot air reduces effective reductions to 474 MtC (compared to 798 MtC in the No Trade). On the whole Annex B, 42 % of the total reductions are obtained domestically (70 % if this ratio is measured net of hot air).

While all Annex B permit importing countries benefit from emission trading, with abatement costs reduced by a factor 2 to 3 compared to the No Trade, the Former Soviet Union Annex B regions is the main winner in this case with 16 b$90 of net revenues, mostly from hot air.

Developing countries benefit only marginally of the trading system, as CDM projects represent 56 MtC for a net gain of 1.3 b$90.

INDICATORS	CASE 1a	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	474		798	MtC
Domestic Abatement				
Annex B	42%		100%	
EU	42%		100%	
USA	41%		100%	
Japan	32%		100%	
Economic Efficiency				
Annex B Cost	10 211		55 028	M$90
EU	5 890		15 164	
USA	16 920		29 636	
Japan	2 474		5 463	
CANZ	2 257		3 881	
FSUN Ann B (- Gain)	-16 348		0	
World Market Price	45		0	$90/tC
Volume of net trade	140		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-1 332		0	M$90
Revenues from ESP	0		0	

1.1.2 Case 1b: World Full Trade (CDM 30% accessibility)

ASPEN-sd : **CASE 1b Full Trade with CDM 30% AF**

INPUTS :

Concrete Ceil / Imports	100%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	30%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	0	$90/tC on IET
	0	$90/tC on CDM
Hot Air Exclusion (HAE)	0	MtC (EU = HA - Targ*5%)
Voluntary Compliance Payment (VCP)	200	$90/tC (> 200 for no price ceiling)
	228	E99/tC
	62,3	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	Missing - HAE
798	MtC	324	64	138	272	0	0
2 926	MtCO2	1 186	235	506	999	0	0

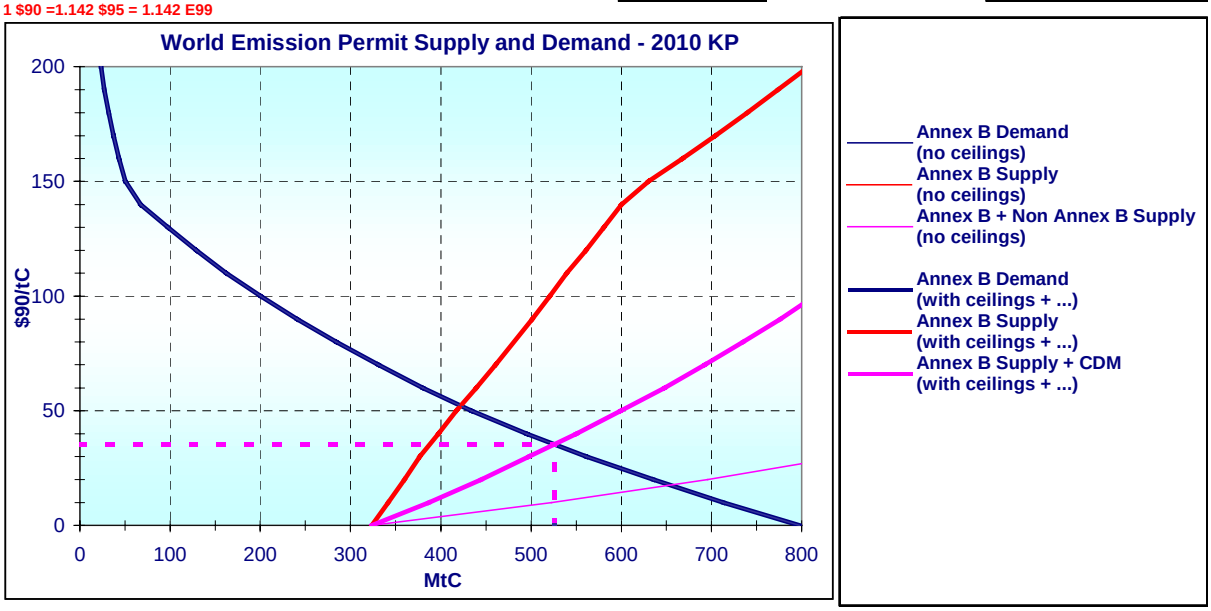
PERMIT PRICE	
35,4	$90/tC
40,4	E99/tC
11,0	E99/tCO2

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM SP
0 M$90 of which
0 from IET
0 from CDM

FUND FROM VCP
0 M$90 of which
0 to IET
0 to CDM

1 $90 =1.142 $95 = 1.142 E99



In this **Case 1b,** where a more optimistic hypothesis is adopted for CDM accessibility, the permit price and the total Annex B abatement program costs are reduced by about 20 %. As a counterpart, the degree of supplementarity is reduced to 34 %, while the total effective reductions are unchanged.

This is obtained through more reductions coming from CDM in Non Annex B countries (138 Mtc for net revenues of 2.5 b$90, i.e. about the double than in Case 1a. As a consequence, the net revenues from Former Soviet Union Annex B are reduced of about 25 %.

INDICATORS	CASE 1b	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	474		798	MtC
Domestic Abatement				
Annex B	34%		100%	
EU	34%		100%	
USA	33%		100%	
Japan	26%		100%	
Economic Efficiency				
Annex B Cost	8 044		55 028	M$90
EU	4 876		15 164	
USA	13 977		29 636	
Japan	2 016		5 463	
CANZ	1 869		3 881	
FSUN Ann B (- Gain)	-12 524		0	
World Market Price	35		0	$90/tC
Volume of net trade	202		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-2 518		0	M$90
Revenues from ESP	0		0	

1.2 Case 2: World Full Trade with Share of Proceeds

1.2.1 Case 2a: World Full Trade with Share of Proceeds on CDM only

ASPEN-sd : **CASE 2a Full Trade with Share of Proceeds on CDM only**

INPUTS :

Concrete Ceil / Imports	100%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	0	$90/tC on IET
	5	$90/tC on CDM
Hot Air Exclusion (HAE)	0	MtC (EU = HA - Targ*5%
Voluntary Compliance Payment (VCP)	200	$90/tC (> 200 for no price ceiling)
	228	E99/tC
	62,3	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	Missing - HAE
798	MtC	324	85	52	338	0	0
2 926	MtCO2	1 186	312	190	1 238	0	0

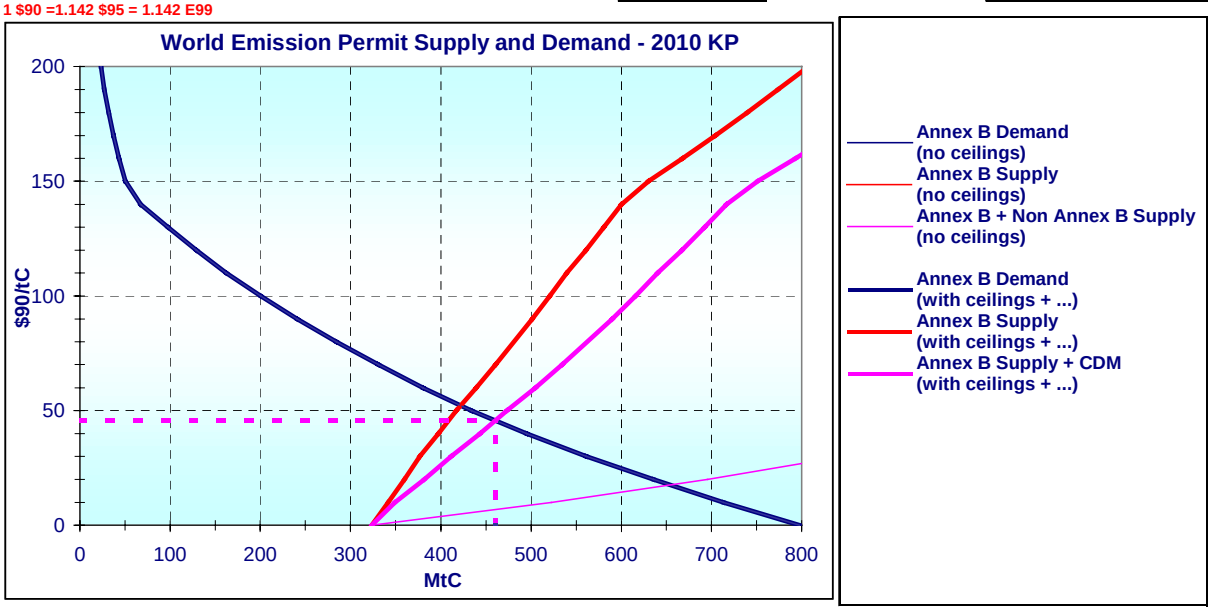
PERMIT PRICE	
45,7	$90/tC
52,2	E99/tC
14,2	E99/tCO2

FUND FROM SP	
259	M$90 of which
0	from IET
259	from CDM

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM VCP	
0	M$90 of which
0	to IET
0	to CDM

1 $90 =1.142 $95 = 1.142 E99



Case 2a illustrates the relatively weak impact of the introduction of a Share of Proceeds of 5$90/tC on CDM only, in the 10% CDM accessibility factor hypothesis. The permit price and most other variables are almost unchanged relatively to **Case 1a.**

The main impact is in the nature of North-South transfers with the new revenues from the Share of Proceeds (0.26 b$90) being partly compensated by the loss in net revenues from CDM projects (- 0.22 b$90) as these are now more expensive, in particular comparatively to Annex B hot air and other permit exports.

INDICATORS	CASE 2a	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	474		798	MtC
Domestic Abatement				
Annex B	42%		100%	
EU	43%		100%	
USA	41%		100%	
Japan	33%		100%	
Economic Efficiency				
Annex B Cost	10 467		55 028	M$90
EU	5 939		15 164	
USA	17 063		29 636	
Japan	2 497		5 463	
CANZ	2 276		3 881	
FSUN Ann B (- Gain)	-16 551		0	
World Market Price	46		0	$90/tC
Volume of net trade	137		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-1 110		0	M$90
Revenues from ESP	-259		0	

1.2.2 Case 2b: World Full Trade with Extended Share of Proceeds on CDM and IET

ASPEN-sd : CASE 2b Full Trade with Extended Share of Proceeds on CDM and IET

INPUTS :

Concrete Ceil / Imports	100%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	5	$90/tC on IET
	5	$90/tC on CDM
Hot Air Exclusion (HAE)	0	MtC (EU = HA - Targ*5%
Voluntary Compliance Payment (VCP)	200	$90/tC (> 200 for no price ceiling)
	228	E99/tC
	62,3	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	Missing - HAE
798	MtC	324	77	53	344	0	0
2 926	MtCO2	1 186	283	194	1 262	0	0

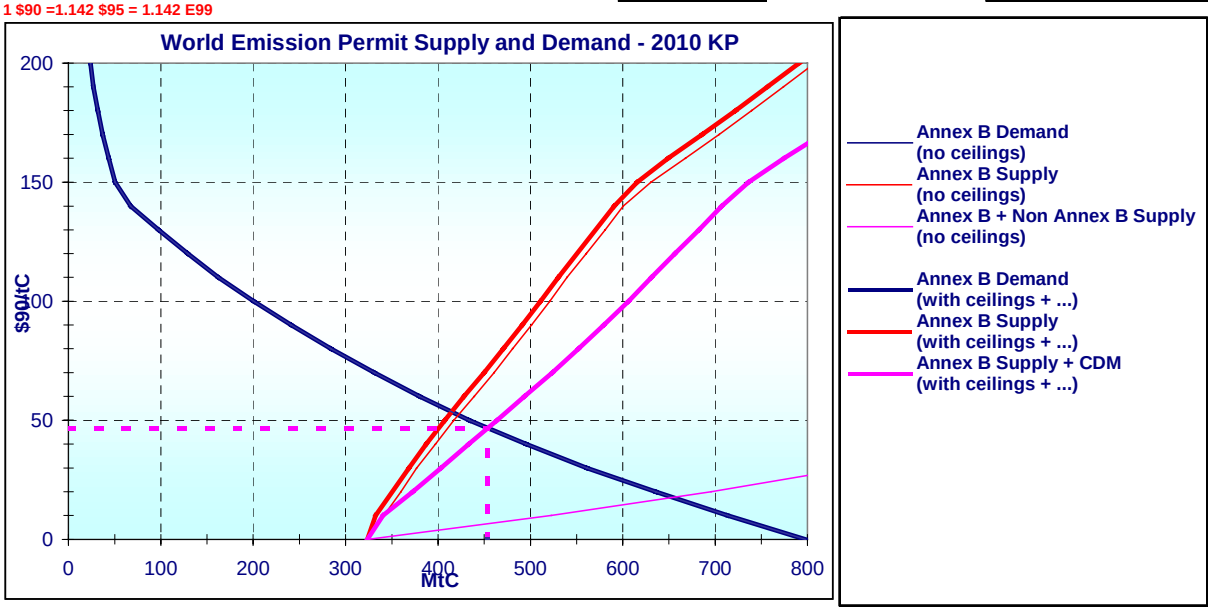
PERMIT PRICE	
46,8	$90/tC
53,4	E99/tC
14,6	E99/tCO2

FUND FROM SP	
2 269	M$90 of which
2 004	from IET
265	from CDM

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM VCP	
0	M$90 of which
0	to IET
0	to CDM

1 $90 =1.142 $95 = 1.142 E99



While **Case 2a** didn't introduce considerable changes, the extension of the 5 $90/tC Share of Proceeds to all Kyoto flexibility mechanisms in **Case 2b** now provides a significantly different picture as all supplies of permits (hot air, permits from true Annex B reductions and CDM) are now affected by a cost increase:

the supplementarity indicator increases to 43 % and so does the permit price, but more markedly still the total Annex B abatement cost; this cost is indeed increased by 25 % comparatively to the Full Trade in **Case 1a;**

as a counterpart, the funds raised by the Extended Share of Proceeds (ESP) are quite significant and amount to 2.25 b$90, while the net revenues from CDM stay superior to 1 b$90.

INDICATORS	CASE 2b	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	474		798	MtC
Domestic Abatement				
Annex B	43%		100%	
EU	44%		100%	
USA	42%		100%	
Japan	33%		100%	
Economic Efficiency				
Annex B Cost	12 493		55 028	M$90
EU	6 043		15 164	
USA	17 366		29 636	
Japan	2 545		5 463	
CANZ	2 316		3 881	
FSUN Ann B (- Gain)	-15 003		0	
World Market Price	47		0	$90/tC
Volume of net trade	130		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-1 167		0	M$90
Revenues from ESP	-2 269		0	

1.3 Case 3: The Voluntary Compliance Payment system

The Voluntary Compliance Payment approach (VCP) introduces a new perspective to the problem of emission permit market regulation. It is based on the concept of “hybrid instruments” for environmental regulation, which supposes that regulation through quantities and regulation through prices can be combined through the introduction of a “safety valve” on the emission permit market. This type of system has been initially elaborated by Resources For the Future for an “early action scheme” in the US (RFF, 1998) and then extended to the international trading scheme and compliance issue (RFF, 2000).

The main aim of the VCP system – responding to the US preoccupation of limiting the cost of compliance to the Kyoto Protocol – is to reduce drastically the uncertainty on the marginal and, as a consequence, total abatement cost. As early identified in the environmental economics literature (Weitzman, 1974) the counterpart is that the environmental outcome or effectiveness turns more uncertain as “missing reductions” appear when the VCP is inferior to the market equilibrium price.

In RFF’s perspective, it is proposed to introduce a safety valve to the market with a Voluntary Compliance Payment at a pre-determined level (50 $90/tC). The VCPs would then feed a Virtual Fund, in turn used to organise a Reverse Auction to promote the permit supply from Annex B or Non Annex B countries.

When the price ceiling is inferior to the market equilibrium price (otherwise the market conditions would properly operate), this system implies a dual price for the ton of carbon: for the importers the maximum carbon value will be the price ceiling exogenously determined but for the exporters it will be the “auction marginal price”. Again, this solution may allow to limit the cost of abatement but would place the uncertainty on the quantities abated, as supply from the auction system will be inferior to that of free market.

1.3.1 Case 3a: Voluntary Compliance Payment (50 $90/tC)

ASPEN-sd : **CASE 3a Voluntary Compliance Payment, no Share of Proceeds**

INPUTS :

Concrete Ceil / Imports	100%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	0	$90/tC on IET
	0	$90/tC on CDM
Hot Air Exclusion (HAE)	0	MtC (EU = HA - Targ*5%
Voluntary Compliance Payment (VCP)	50	$90/tC (> 200 for no price ceiling)
	57	E99/tC
	15,6	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	Missing - HAE
798	MtC	324	84	56	334	0	0
2 926	MtCO2	1 186	308	205	1 226	0	0

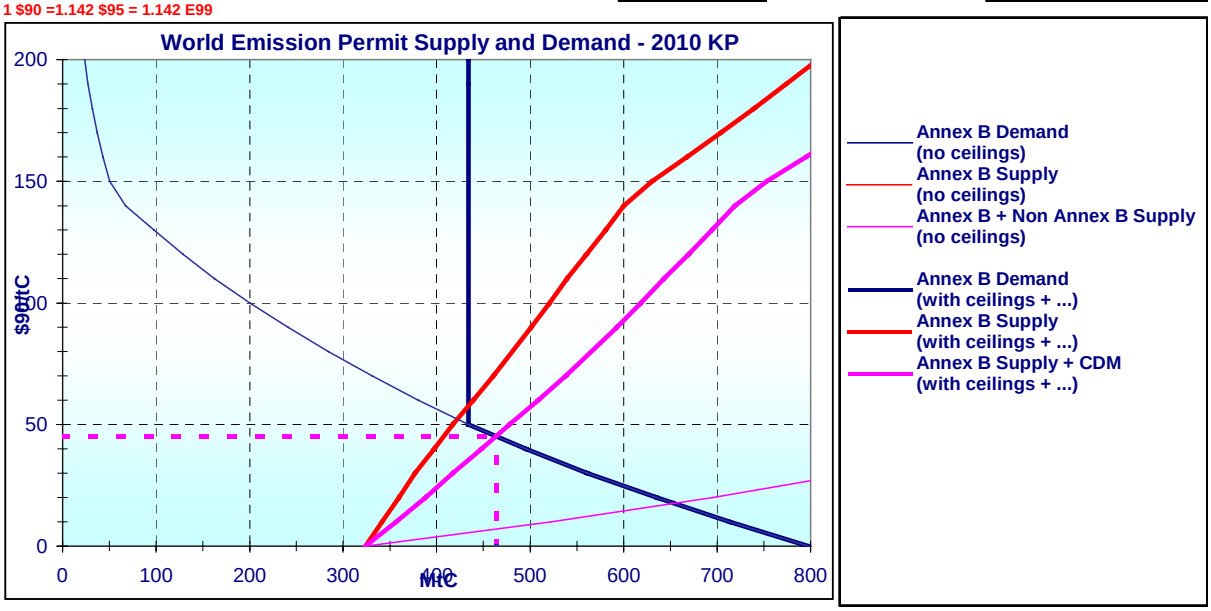
PERMIT PRICE	
45,2	$90/tC
51,6	E99/tC
14,1	E99/tCO2

FUND FROM SP	
0	M$90 of which
0	from IET
0	from CDM

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM VCP	
0	M$90 of which
0	to IET
0	to CDM

1 $90 =1.142 $95 = 1.142 E99



Case 3a illustrates a market configuration in which the VCP is superior to the market equilibrium price. In that case the safety valve is not binding and all indicators and variables are strictly identical to those in **Case 1a** describing the Full trade market.

INDICATORS	CASE 3a	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	474		798	MtC
Domestic Abatement				
Annex B	42%		100%	
EU	42%		100%	
USA	41%		100%	
Japan	32%		100%	
Economic Efficiency				
Annex B Cost	10 211		55 028	M$90
EU	5 890		15 164	
USA	16 920		29 636	
Japan	2 474		5 463	
CANZ	2 257		3 881	
FSUN Ann B (- Gain)	-16 348		0	
World Market Price	45		0	$90/tC
Volume of net trade	140		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-1 332		0	M$90
Revenues from ESP	0		0	

1.3.2 Case 3b: Voluntary Compliance Payment with 50% Hot Air Exclusion

ASPEN-sd : **CASE 3b Voluntary Compliance Payment, no Share of Proceeds, Hot Air Exclusion (50%)**

INPUTS : **OUTPUTS :**

Concrete Ceil / Imports	100%	(Ref-Targ)*x%	(EU = 50%)
/ Exports	100%	(Targ)*x%	(EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions	
with	20%	Transaction Cost	
Share of Proceeds (SP)	0	$90/tC on IET	
	0	$90/tC on CDM	
Hot Air Exclusion (HAE)	162	MtC	(EU = HA - Targ*5%
Voluntary Compliance Payment (VCP)	50	$90/tC	(> 200 for no price ceiling)
	57	E99/tC	
	15,6	E99/tCO2	

CO2 REDUCTIONS		of which:					
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	Missing - HAE
798	MtC	162	119	71	364	83	-79
2 926	MtCO2	592	437	259	1 335	303	-291

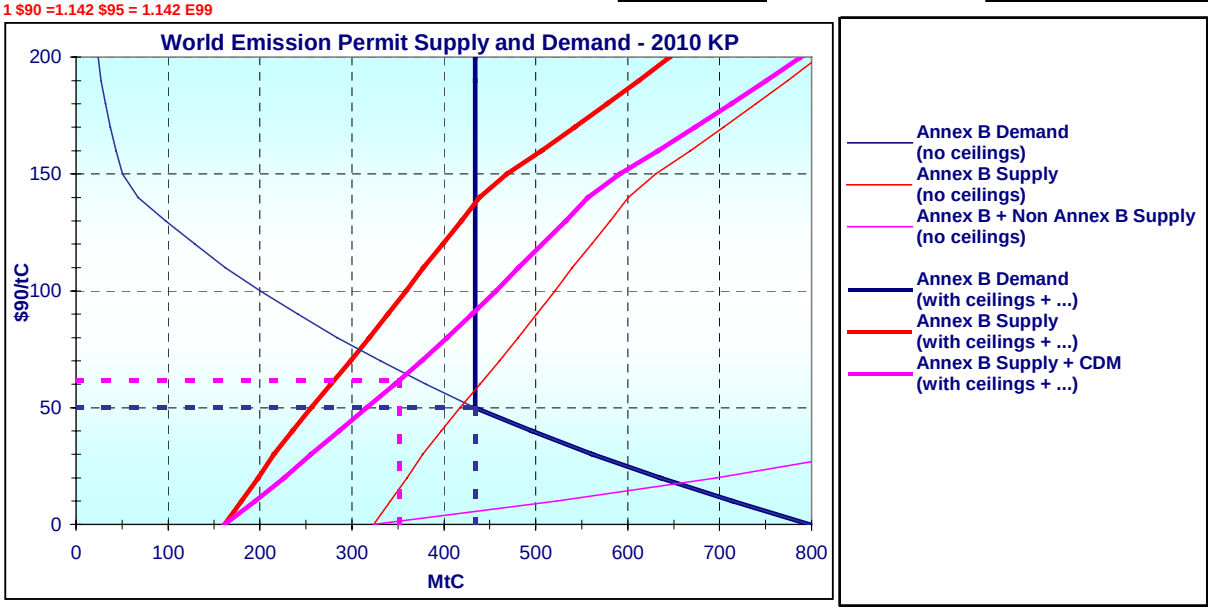
PERMIT PRICE	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM SP	
0	M$90 of which
0	from IET
0	from CDM

REVERSE AUCTION	
61,6	$90/tC
70,4	E99/tC
19,2	E99/tCO2

FUND FROM VCP	
21 700	M$90 of which
17 299	to IET
4 401	to CDM

1 $90 =1.142 $95 = 1.142 E99



The “hot air exclusion option” allows to simulate in **Case 3b** the potential consequences of a less abundant permit supply and the impacts, in that case, of an operative safety valve or VCP. Indeed the VCP turns to be inferior to the market equilibrium price if it is assumed, either that the entry of hot air in the system is limited to 50 % of the base case, or that the hot air is less abundant (in the same quantity) than forecasted by the POLES model, then.

Domestic reductions are then limited to those presenting a cost inferior to the VCP value (50 $90/tC), i.e. to 364 MtC, with a total of VCPs of 21.7 b$90. As concerns the permit acquisition, it is assumed here for simplicity’s sake that this sum goes entirely to the virtual fund and is then used in the reverse auction system.

More in line with RFF proposal it should also be considered that the market exchanges proceed until the price ceiling is reached and that the fund is used only for the permits remaining to be created. This would probably allow to less missing reductions as the differential rent for those exporters selling on the market would be reduced. However this hypothesis poses the difficult question of the anticipations of the suppliers and of their willingness to go to the market if they expect the price of the auction system to be higher than the ceiling / market price.

The outcome of the process, as it is simulated here with a “full virtual fund”, is a total supply of 352 MtC for an auction marginal price of 62 $90 – 70 E99/tC. As a consequence the gap between permit supply and supply amounts to 83 MtC of “missing emission reductions”. These are however missing only if the reduction in hot air corresponds to a forecast error and not if the corresponding hot air is

actually available but excluded from entry in the system. In that latter case, **Case 3b** still shows a positive balance when its effective reductions (554 MtC) are compared to those of **Case 1a** (474 MtC). As a result of the hot air exclusion, the weight of CDM in total supply is also higher. It amounts to 71 MtC instead of 56 MtC in **Case 1a.**

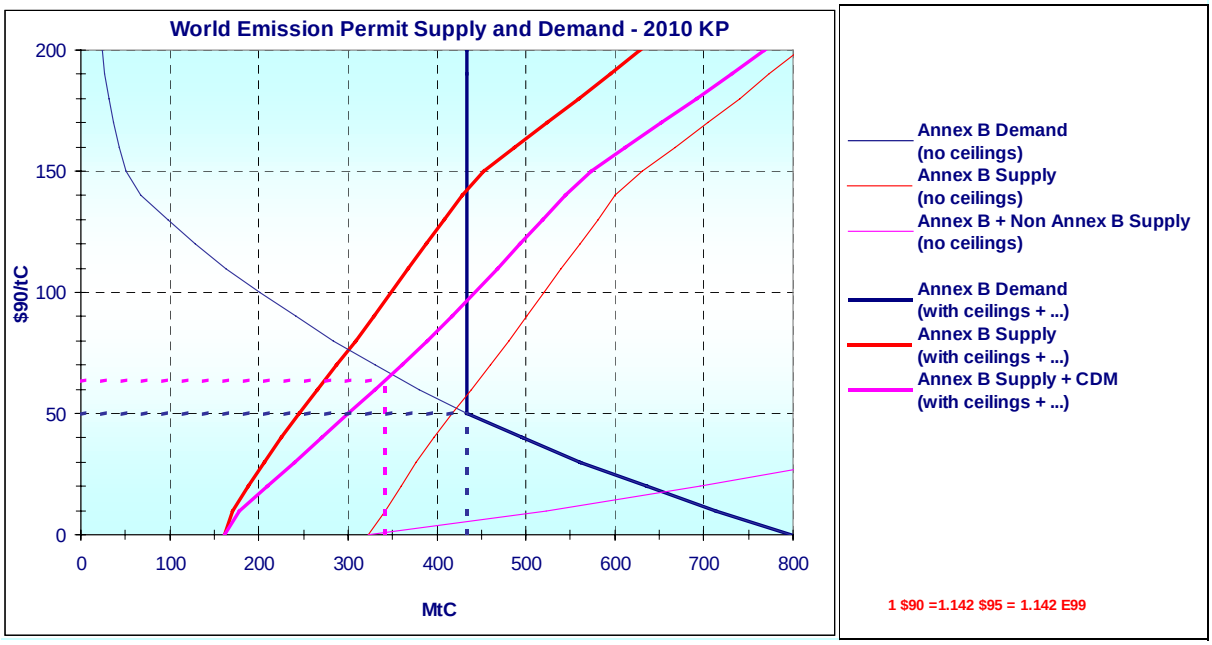
In terms of costs (marginal or total abatement cost) the situation resulting from **Case 3b** doesn't differ significantly from that of the Full trade in **Case 1a,** as the cost increases for the whole Annex B and the main parties is limited to about 10 %, in spite of the significant reduction in hot air. In brief the impacts of hot air exclusion are largely compensated by the existence of the VCP system.

INDICATORS	CASE 3b	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	554		798	MtC
Domestic Abatement				
Annex B	46%		100%	
EU	49%		100%	
USA	45%		100%	
Japan	35%		100%	
Economic Efficiency				
Annex B Cost	11 646		55 028	M$90
EU	6 385		15 164	
USA	18 231		29 636	
Japan	2 684		5 463	
CANZ	2 429		3 881	
FSUN Ann B (- Gain)	-15 814		0	
World Market Price	50		0	$90/tC
Volume of net trade	190		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-2 353		0	M$90
Revenues from ESP	0		0	

1.4 Case 4: Voluntary Compliance Payment with Extended Share of Proceeds

ASPEN-sd : Case 4 Voluntary Compliance Payment, Extended Share of Proceeds, Hot Air Exclusion (50%)

INPUTS :					OUTPUTS :							
CDM Accessibility Factor	10%	of Non Annex B reductions			CO2 Reductions	of which:					Missing
with	20%	Transaction Cost			Kyoto Target	Hot Air	IET	CDM	Domest	Missing	- HAE
					798 MtC	162	112	67	364	93	-69
Concrete Ceiling / Imports	100%	(Ref-Assigned Amount)*x%			2 926 MtCO2	592	411	247	1 335	341	-253
/ Exports	100%	(Assigned Amount)*x%									
					Permit price			Fund from SP		Permits from SP	
Allowable Sinks	0%	of 1990 Base Emissions			0.0 $90/tC			1 701 M$90 of which			
					0.0 E99/tC			1 363 from IET		-93 MtC	
Hot Air Exclusion (HAE)	162	MtC			0.0 E99/tCO2			337 from CDM			
	$90/tC		or % of sales	or % of permits							
Share of Proceeds (SP) on IET	5		0.0%	0%	Reverse Auction			Fund from VCP			
on CDM	5		2.0%		63 $90/tC			21 700 M$90 of which			
	$90/tC	E99/tC	E99/tCO2		72 E99/tC			17 355 to IET			
Voluntary Compliance Payment	50	57	16	(>200 $90 for no VCP)	20 E99/tCO2			4 345 to CDM			



This case is analysed only as associated to the 50 % hot air exclusion option as, in our framework of analysis, the market equilibrium price with ESP and no HAE still remains inferior to the level of the VCP: the key results and indicators would then be identical to those in **Case 2b.**

The main results of this **Case 4,** with 50 % HAE, are very near to those of **Case 3b** (VCP but no ESP) except for what concerns the North-South transfers. While the CDM is slightly affected by the introduction of the ESP (net revenues decreasing from 2.35 to 2.15 b$90), the available revenues from this ESP now amounts to 1.8 b$90, of which 75 % from Annex B IET.

INDICATORS	CASE 4	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	544		798	MtC
Domestic Abatement				
Annex B	46%		100%	
EU	48%		100%	
USA	45%		100%	
Japan	35%		100%	
Economic Efficiency				
Annex B Cost	13 019		55 028	M$90
EU	6 374		15 164	
USA	18 231		29 636	
Japan	2 684		5 463	
CANZ	2 429		3 881	
FSUN Ann B (- Gain)	-14 708		0	
World Market Price	50		0	$90/tC
Volume of net trade	180		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-2 147		0	M$90
Revenues from ESP	-1 783		0	

1.5 Case 5: Concrete Ceilings, no VCP, no ESP

ASPEN-sd : CASE 5 EU Concrete Ceilings, no VCP, no ESP

INPUTS :

Concrete Ceil / Imports	50%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	0	$90/tC on IET
	0	$90/tC on CDM
Hot Air Exclusion (HAE)	283	MtC (EU = HA - Targ*5%)
Voluntary Compliance Payment (VCP)	200	$90/tC (> 200 for no price ceiling)
	228	E99/tC
	62,3	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					Missing
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	- HAE
798	MtC	40	154	84	519	0	-283
2 926	MtCO2	148	566	307	1 905	0	######

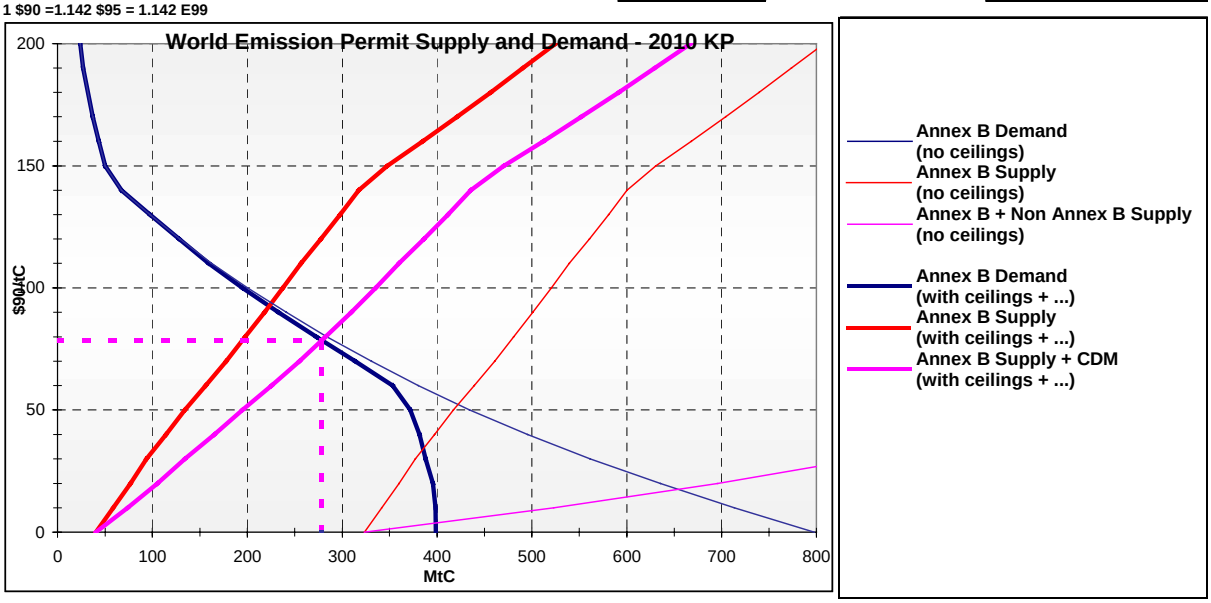
PERMIT PRICE	
78,6	$90/tC
89,7	E99/tC
24,5	E99/tCO2

FUND FROM SP	
0	M$90 of which
0	from IET
0	from CDM

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM VCP	
0	M$90 of which
0	to IET
0	to CDM

1 $90 =1.142 $95 = 1.142 E99



The introduction of Concrete Ceilings to imports and exports significantly changes the shapes of world supply and demand curves. The formula used here to simulate the Concrete Ceilings corresponds to the “However Clause” mentioned in the EU Council proposal of 1999:

as far as demand is concerned, the ceiling on net acquisition is extended up to the level of the verifiable domestic emission reductions; although this clause may pose important problems in the real life verification process, this clause can be easily translated into modelling terms while considering that the acquisition can represent up to 50 % of the “Reference – Target” reductions;

as for supply, it is supposed that only hot air corresponding to 5 % of [2010 Target + 1990 Base]/2 can be transferred, while any domestic emission reduction beyond the national target (net of hot air) can be transferred.

The first consequence of the introduction of ceilings is clearly that the demand curve now strongly bends downwards for low values of the permit market price, in such a way as it reaches 499 MtC (i.e. 50 % of the 798 MtC reductions required by the Kyoto Protocol with no trade) for a zero value of the permit.

The second one is that the permit supply curve is translated to the left side with large quantities of hot air disappearing; the slope of the supply curve however is unchanged from the no ceiling situation as in fact the However Clause is not binding for effective reductions beyond the target[1].

As a result, the permit price in this **Case 5** now settles at quite a higher level than in all no ceiling cases with a market equilibrium at 79 $90 – 90 E99/tC.

The environmental consequences of the ceiling are highly positive with total effective reductions now amounting to 758 MtC (hot air is now reduced to 5 % of 819 MtC, i.e. 41 MtC) and a supplementarity indicator of 65 %.

The counterpart of the environmental performance is a substantial increase in Annex B total abatement cost, which now amounts to 24 b$90 – compared to 10 bn in **Case 1a** – with costs increasing of 40-50 % for each of the main importing Annex B parties.

Because of the drastic hot air exclusion and high permit price and in spite of the high level of supplementarity obtained in this case, the net transfers to Non Annex B countries through CDM are important, amounting to 3.6 b$90 for 84 MtC.

INDICATORS	CASE 5	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	758		798	MtC
Domestic Abatement				
Annex B	65%		100%	
EU	74%		100%	
USA	64%		100%	
Japan	52%		100%	
Economic Efficiency				
Annex B Cost	23 840		55 028	M$90
EU	8 643		15 164	
USA	24 361		29 636	
Japan	3 745		5 463	
CANZ	3 214		3 881	
FSUN Ann B (- Gain)	-12 227		0	
World Market Price	79		0	$90/tC
Volume of net trade	238		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-3 635		0	M$90
Revenues from ESP	0		0	

[1] It can be noted that a similar result in terms of market equilibrium price and corresponding costs and transfers could be obtained through a uniform ceiling on imports and exports, expressed as 20 % of (Base 1990 + Target 2010)/2.

1.6 Case 6: Concrete Ceilings, no VCP, with ESP

ASPEN-sd : **CASE 6 EU Concrete Ceilings, no VCP, with ESP**

INPUTS :

Concrete Ceil / Imports	50%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	5	$90/tC on IET
	5	$90/tC on CDM
Hot Air Exclusion (HAE)	283	MtC (EU = HA - Targ*5%)
Voluntary Compliance Payment (VCP)	200	$90/tC (> 200 for no price ceiling)
	228	E99/tC
	62,3	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					Missing
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	- HAE
798	MtC	40	148	82	527	0	-283
2 926	MtCO2	148	544	300	1 934	0	######

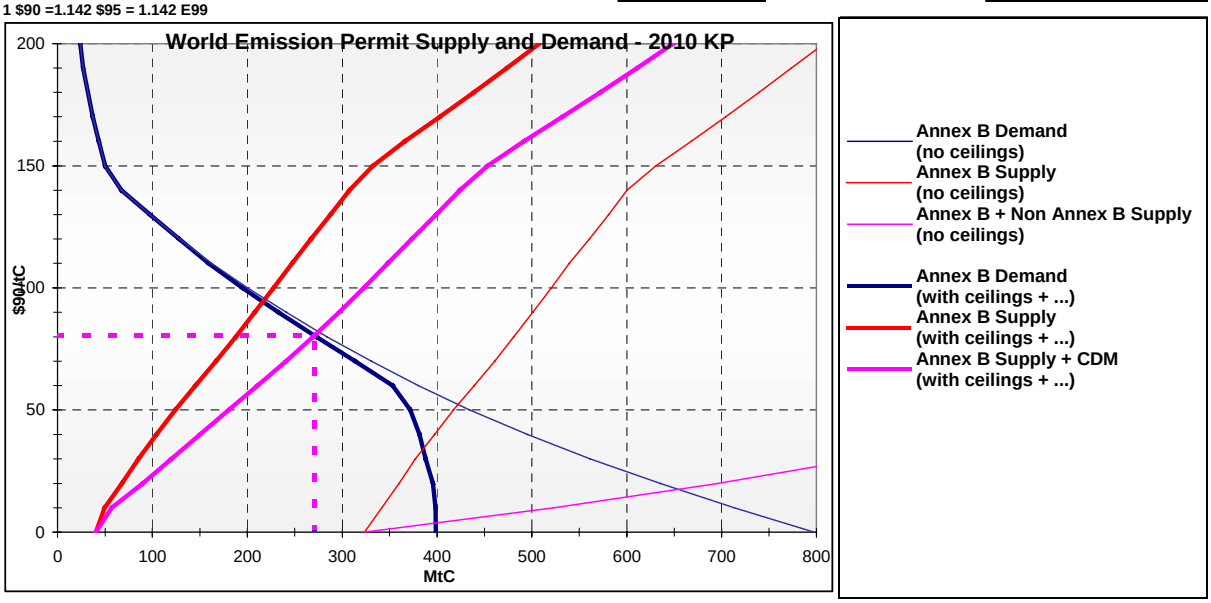
PERMIT PRICE	
80,5	$90/tC
92,0	E99/tC
25,1	E99/tCO2

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM SP	
1 353	M$90 of which
944	from IET
409	from CDM

FUND FROM VCP	
0	M$90 of which
0	to IET
0	to CDM

1 $90 =1.142 $95 = 1.142 E99



The combination of the Concrete Ceilings and Extended Share of Proceeds in **Case 6** do not profoundly alter the situation described for **Case 5,** as concerns the market equilibrium price, which increases only of about 5 % to 81 $90 – 92 E99/tC, and the abatement costs for the main Annex B parties.

However the transfers to Non Annex B countries increase substantially, with 3.4 b$90 from net CDM gains and 1.4 b$90 from the (of which two thirds originating from Annex B IET).

INDICATORS	CASE 6	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	758		798	MtC
Domestic Abatement				
Annex B	66%		100%	
EU	74%		100%	
USA	66%		100%	
Japan	53%		100%	
Economic Efficiency				
Annex B Cost	25 457		55 028	M$90
EU	8 778		15 164	
USA	24 686		29 636	
Japan	3 807		5 463	
CANZ	3 253		3 881	
FSUN Ann B (- Gain)	-11 489		0	
World Market Price	81		0	$90/tC
Volume of net trade	230		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-3 417		0	M$90
Revenues from ESP	-1 353		0	

1.7 Case 7: Concrete Ceilings, with VCP, no ESP

ASPEN-sd : **CASE 7 EU Concrete Ceilings, with VCP no ESP**

INPUTS :

Concrete Ceil / Imports	50%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	0	$90/tC on IET
	0	$90/tC on CDM
Hot Air Exclusion (HAE)	283	MtC (EU = HA - Targ*5%)
Voluntary Compliance Payment (VCP)	50	$90/tC (> 200 for no price ceiling)
	57	E99/tC
	15,6	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					Missing
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	- HAE
798	MtC	40	140	79	426	112	-171
2 926	MtCO2	148	514	288	1 563	412	-626

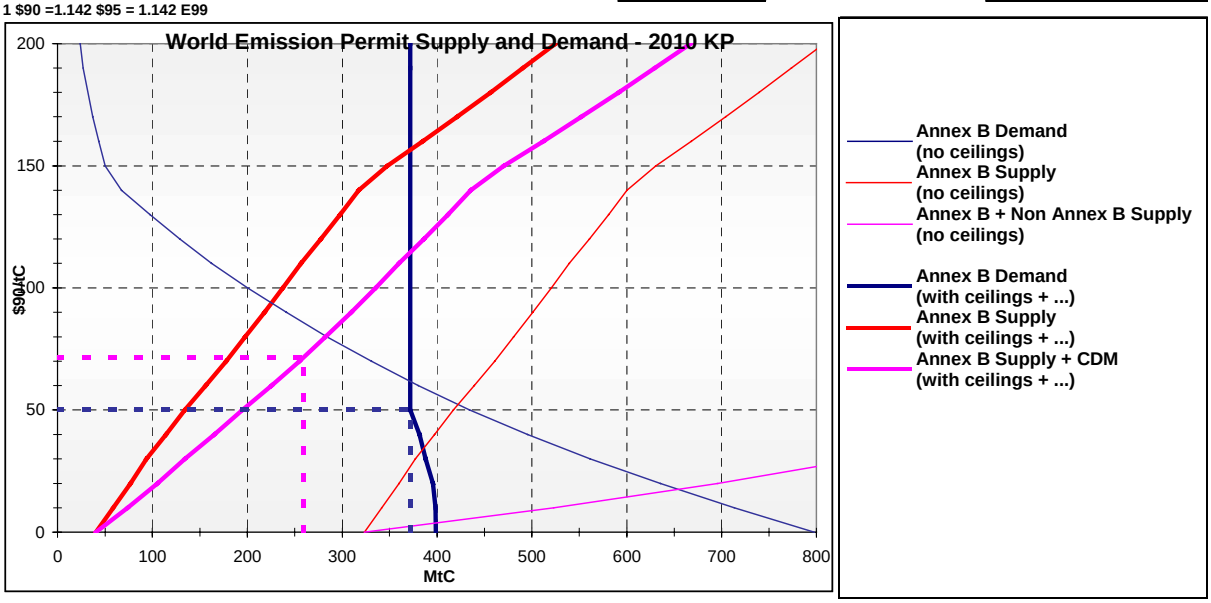
PERMIT PRICE	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

REVERSE AUCTION	
71,5	$90/tC
81,7	E99/tC
22,3	E99/tCO2

FUND FROM SP	
0	M$90 of which
0	from IET
0	from CDM

FUND FROM VCP	
18 585	M$90 of which
12 931	to IET
5 654	to CDM

1 $90 =1.142 $95 = 1.142 E99



Case 7 presents the combination of Concrete Ceilings and Voluntary Compliance Payment.

The key result is that the demand curve is in that case – and in our framework of analysis – very strongly constrained and resembles almost to a vertical straight line. This is because the upper bound of domestic reductions (426 MtC) given by the VCP is very near to the lower bound (399 MtC), given by the ceilings.

For the VCP level considered here (50 $tC), the marginal value of the auction would be of 72 $90 – 82 E99/tC.

The environmental effectiveness is less than in **Case 7** as the VCP introduces missing emissions (112 MtC). This is however more than compensated by the massive hot air exclusion provided by the ceilings system. On the whole, the effective reductions are of 645 MtC, i.e. 80 % and of the No Trade case and of **Cases 5 and 6** (CC, no VCP).

The costs for the main Annex B parties are very near to those of the Full Trade, while the revenues of the Former Soviet Union Annex B decrease of 35 %, due to the massive hot air exclusion. As a counterpart the net gains from CDM are higher than in **Case 1a** and now amount to 3.1 b$90, instead of 1.3 b$90.

On the whole, this solution provides the guarantee against uncertainties brought by the VCP system. Furthermore, the different indicators provided for the environmental and cost effectiveness resemble much to that of the Full Trade case.

It has however to be underlined that this last result is strongly dependent on the set of hypotheses for MAC curves used in this study, as they result in a Full Trade market equilibrium price very near to the VCP considered. In case of a market equilibrium price significantly higher than the VCP (resulting for instance of higher MACs and demand curve than expected here), then the gap between domestic reductions and supply through the Reverse Auction system would widen and the different indicators differ greatly from the Full market case.

INDICATORS	CASE 7	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	645		798	MtC
Domestic Abatement				
Annex B	53%		100%	
EU	65%		100%	
USA	50%		100%	
Japan	50%		100%	
Economic Efficiency				
Annex B Cost	13 050		55 028	M$90
EU	5 428		15 164	
USA	16 988		29 636	
Japan	2 232		5 463	
CANZ	2 256		3 881	
FSUN Ann B (- Gain)	-10 559		0	
World Market Price	50		0	$90/tC
Volume of net trade	219		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-3 073		0	M$90
Revenues from ESP	0		0	

1.8 Case 8: Concrete Ceilings, with VCP and ESP

ASPEN-sd : **CASE 8 EU Concrete Ceilings, with VCP and ESP**

INPUTS :

Concrete Ceil / Imports	50%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	5	$90/tC on IET
	5	$90/tC on CDM
Hot Air Exclusion (HAE)	283	MtC (EU = HA - Targ*5%)
Voluntary Compliance Payment (VCP)	50	$90/tC (> 200 for no price ceiling)
	57	E99/tC
	15,6	E99/tCO2

OUTPUTS :

CO2 REDUCTIONS		of which:					Missing
Kyot Targ		Hot Air	IET	CDM	Domest	Missing	- HAE
798	MtC	40	134	77	426	120	-163
2 926	MtCO2	148	492	281	1 563	442	-596

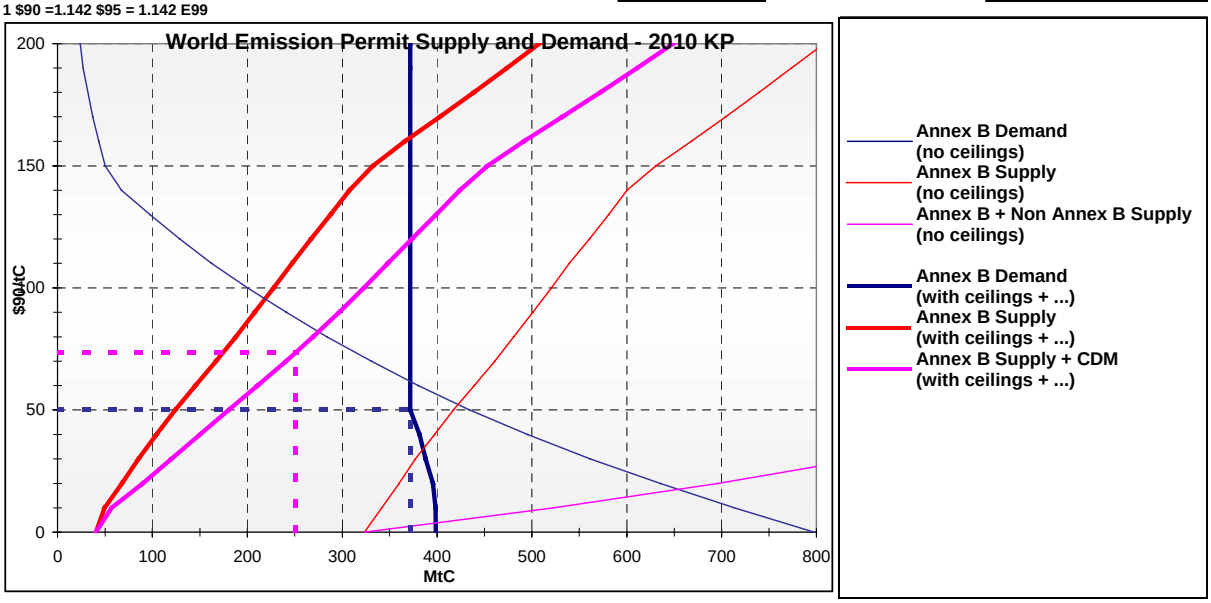
PERMIT PRICE	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

REVERSE AUCTION	
73,7	$90/tC
84,2	E99/tC
23,0	E99/tCO2

FUND FROM SP	
1 341	M$90 of which
868	from IET
383	from CDM

FUND FROM VCP	
18 585	M$90 of which
12 868	to IET
5 717	to CDM

1 $90 =1.142 $95 = 1.142 E99



As the last step in this study, **Case 8** provides a configuration of “full regulation” with combined ceilings, compliance payment and extended share of proceeds. The results in terms of he different indicators are close to those of **Case 7** and the caveats expressed as concerns the similarities with the Full Trade **Case 1a** also applies here.

One outcome of this configuration is clearly that it provides important potential transfers to Non Annex B parties – although inferior to those of **Cases 4, 2b and 6** – with net revenues from CDM of 2.9 b$90 (for 77 MtC) and resources from the ESP of 1.3 b$90. This of course due to the combination of the hot air exclusion through the ceilings and of the ESP.

INDICATORS	CASE 8	vs	NO TRADE	
Environmental Effectiveness				
Annex B abatement	637		798	MtC
Domestic Abatement				
Annex B	53%		100%	
EU	64%		100%	
USA	50%		100%	
Japan	50%		100%	
Economic Efficiency				
Annex B Cost	13 998		55 028	M$90
EU	5 446		15 164	
USA	16 988		29 636	
Japan	2 232		5 463	
CANZ	2 256		3 881	
FSUN Ann B (- Gain)	-9 898		0	
World Market Price	50		0	$90/tC
Volume of net trade	211		0	MtC
North-South Transfers (- Gain)				
Net Gain from CDM	-2 884		0	M$90
Revenues from ESP	-1 341		0	

Synthesis and preliminary conclusions

This paper illustrates how the main consequences of different trading rules and combinations can be studied in a consistent way and relatively great detail, while using marginal abatement cost curves from a detailed world energy sector model and a simple permit market analysis software. The key results are presented for all cases in the following synthesis table and graph.

They show that:

- the **No Trade case** is characterised by a high environmental effectiveness but at a very high cost, while **Cases 5 and 6** (with Concrete Ceilings of the "However Clause" type, i.e. "soft ceilings" except for hot air) achieve almost the same effective reductions at much lower total abatement cost (less than 30 b$99 instead of 67);
- the Full Trade **Case 1a**, minimise the cost (12.5 b$99) but with reduced environmental performances; the results of **Case 2b** are similar, with a slightly higher abatement cost but with important potential transfers to Non Annex B parties;
- **Cases 7 and 8** which combine the Concrete Ceilings and the Voluntary Compliance Payment provide an average level of environmental performance at a cost which remains low; these environmental results may however be highly dependent of the actual shape of the demand and supply curves; these may happen to be different in reality of what is hypothesised in this exercise and thus lead to quite divergent results; indeed the proper of the VCP systems is to reduce uncertainties on costs but leave the uncertainty open as concerns the quantities abated.

Taking into account these conclusions – and although the aim of this paper is to provide insights and not to identify one preferred solution to the international negotiation – it appears instructive to explore a new case, in order to combine a certain degree of simplicity in the trading rules and satisfactory performances in a triple perspective: environmental performance, cost limitation and North- South transfers.

Case 2c is indeed an additional case with all the characteristics of 2b but wit a 50 % hot air exclusion. It provides a simple framework of regulation for a high level of environmental performance, supplementarity and North-South transfers, but of course at a higher total abatement cost – although this cost is limited to 22 b$90. Its characteristics are compared to those of the other cases in the graph and table below, which show that such a configuration may provide an interesting intermediate solution with important North-South transfers potential (5 b$99).

Case 2c: World Full Trade with Extended Share of Proceeds on CDM and IET + 50 % Hot Air Exclusion

ASPEN-sd : CASE 2c Full Trade with Extended Share of Proceeds on CDM and IET + 50 % Hot Air Excl.

INPUTS :

Concrete Ceil / Imports	100%	(Ref-Targ)*x% (EU = 50%)
/ Exports	100%	(Targ)*x% (EU = 100%)
CDM Accessibility Factor	10%	of Non Annex B reductions
with	20%	Transaction Cost
Share of Proceeds (SP)	5	$90/tC on IET
	5	$90/tC on CDM
Hot Air Exclusion (HAE)	162	MtC (EU = HA - Targ*5%
Voluntary Compliance	200	$90/tC (> 200 for no price ceiling)
Payment (VCP)	228	E99/tC
	62,3	E99/tCO2

1 $90 =1.142 $95 = 1.142 E99

OUTPUTS :

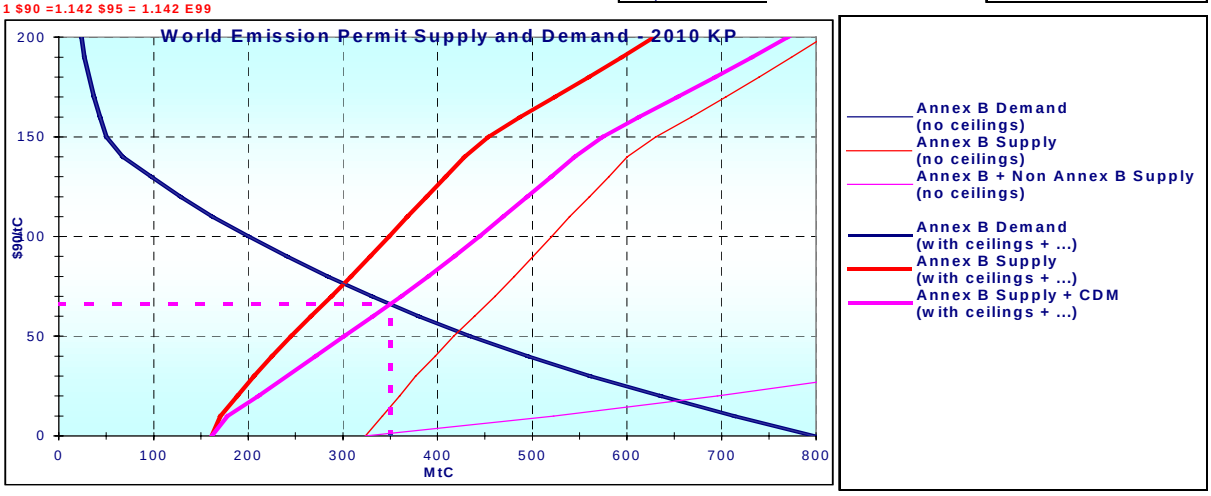
CO2 REDUCTIONS Kyot Targ		of which: Hot Air	IET	CDM	Domest	Missing	Missing - HAE
798	MtC	162	118	71	448	0	-162
2 926	MtCO2	592	432	259	1 642	0	-594

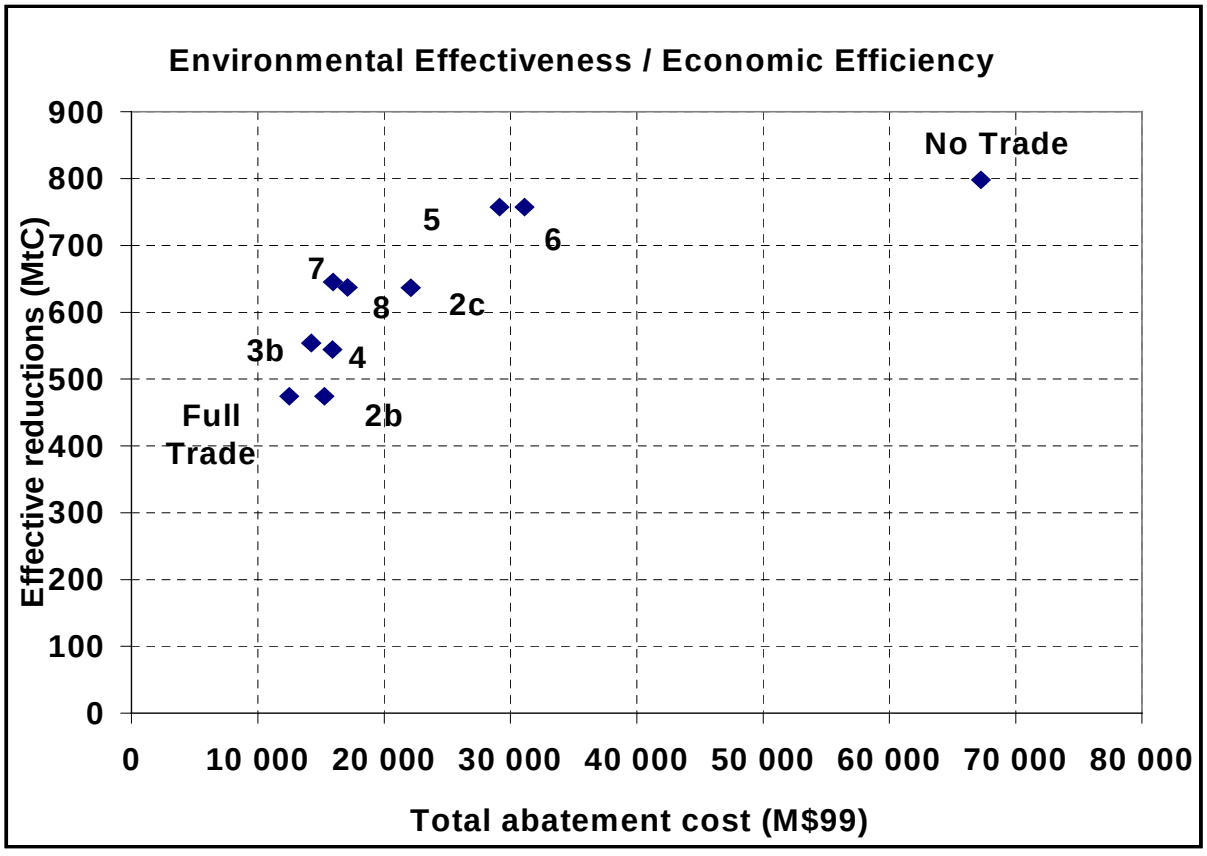
PERMIT PRICE	
66,1	$90/tC
75,5	E99/tC
20,6	E99/tCO2

REVERSE AUCTION	
0,0	$90/tC
0,0	E99/tC
0,0	E99/tCO2

FUND FROM SP	
1 751	M$90 of which
1 397	from IET
353	from CDM

FUND FROM VCP	
0	M$90 of which
0	to IET
0	to CDM





INDICAT($99	NO TRAD	CASE 1a	CASE 1b	CASE 2a	CASE 2b	CASE 3a	CASE 3b	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8	CASE 2c
Environmental Effectiveness													
Annex B Abatement MtC	798	474	474	474	474	474	554	544	758	758	645	637	636
Domestic Abatement													
Annex B	100%	42%	34%	42%	43%	42%	46%	46%	65%	66%	53%	53%	56%
EU	100%	42%	34%	43%	44%	42%	49%	48%	74%	74%	65%	64%	57%
USA	100%	41%	33%	41%	42%	41%	45%	45%	64%	66%	50%	50%	56%
Japan	100%	32%	26%	33%	33%	32%	35%	35%	52%	53%	50%	50%	45%
Economic Efficiency													
Abatement Cost M$99	67 245	12 478	9 830	12 791	15 266	12 478	14 231	15 909	29 132	31 108	15 947	17 106	22 106
EU	18 531	7 198	5 959	7 258	7 385	7 198	7 803	7 789	10 562	10 727	6 633	6 655	9 332
USA	36 215	20 676	17 080	20 851	21 221	20 676	22 278	22 278	29 770	30 167	20 760	20 760	26 900
Japan	6 676	3 023	2 464	3 051	3 110	3 023	3 280	3 280	4 576	4 652	2 727	2 727	4 057
CANZ	4 742	2 758	2 283	2 781	2 830	2 758	2 968	2 968	3 927	3 976	2 756	2 756	3 567
FSUN Ann B (- Gain)	0	-19 978	-15 305	-20 225	-18 334	-19 978	-19 325	-17 974	-14 942	-14 040	-12 903	-12 096	-19 099
World Price (or VCP) $99/tC	0	55	43	56	57	55	61	61	96	98	61	61	81
Volume of net trade MtC	0	140	202	137	130	140	190	180	238	230	219	211	189
North-South Transfers (- Gain)													
Net Gain from CDM M$99	0	-1 627	-3 078	-1 356	-1 426	-1 627	-2 876	-2 624	-4 442	-4 175	-3 756	-3 524	-2 851
Revenues from ESP	0	0	0	-317	-2 772	0	0	-2 179	0	-1 653	0	-1 639	-2 139

***Case 2c** is the additional case with all the characteristics of 2b but with a 50 % hot air exclusion

ANNEX 1: Detailed results for 32 countries

Case 1a: World Full Trade (CDM 10% accessibility)

ASPEN-sd : **CASE 1a Full Trade with CDM 10% AF**

Reminder:		NO TRADE				TRADE		**Permit Price =**	**45,2**	**$90/tC**			GAINS from TRADE	
CC/IMP	POLES 32 regions	REFER	TARGET	MAC	**TAC**	EMISS	DOM / TOT	MAC	DOM AC	TRADE	TRADE	**TAC**		
100%		MtC	MtC	$90/tC	**M$90**	MtC	%	$90/tC	M$90	MtC	M$90	**M$90**	M$90	%
CC/EXP	USA	1 716	1 240	144,6	**29 636**	1 521	41%	45,2	4 223	281,0	12 696	**16 920**	12 716	-43%
100%	Canada	139	109	166,3	**2 181**	128	35%	45,2	217	19,4	876	**1 093**	1 088	-50%
CDM AF	Mexico	163	163	0,0	**0**	162	ns	37,6	20	-0,9	-42	**-21**	21	ns
10%	R Central America	57	57	0,0	**0**	57	ns	37,6	6	-0,3	-13	**-6**	6	ns
CDM TC	Brasil	147	147	0,0	**0**	146	ns	37,6	19	-1,0	-46	**-27**	27	ns
20%	R South America	149	149	0,0	**0**	147	ns	37,6	43	-1,9	-84	**-40**	40	ns
AL/ET	France	121	104	185,1	**1 350**	116	31%	45,2	113	11,3	511	**624**	726	-54%
0	Germany	236	210	52,3	**643**	213	88%	45,2	488	3,2	143	**632**	11	-2%
AL/CDM	Italy	123	103	278,7	**2 454**	118	22%	45,2	98	15,6	704	**802**	1 653	-67%
0	United-Kingdom	168	141	107,8	**1 274**	154	52%	45,2	301	13,1	592	**893**	381	-30%
HA Exclus	R EU North	206	146	381,2	**8 763**	192	22%	45,2	289	46,4	2 096	**2 385**	6 378	-73%
0	R EU South	131	112	82,8	**680**	119	62%	45,2	242	6,9	313	**555**	125	-18%
	R Western Europe	28	21	229,9	**619**	26	28%	45,2	39	4,5	205	**244**	376	-61%
VCP	Turkey	84	84	0,0	**0**	83	ns	37,6	22	-1,1	-48	**-26**	26	ns
200	Egypt	36	36	0,0	**0**	35	ns	37,6	6	-0,3	-12	**-6**	6	ns
	North Africa Non OPEP	18	18	0,0	**0**	18	ns	37,6	2	-0,1	-4	**-2**	2	ns
	North Africa OPEP	31	31	0,0	**0**	31	ns	37,6	7	-0,4	-16	**-9**	9	ns
	Gulf	231	231	0,0	**0**	230	ns	37,6	35	-1,6	-74	**-39**	39	ns
	R Middle-East	48	48	0,0	**0**	48	ns	37,6	8	-0,4	-17	**-9**	9	ns
	South of Sahara Africa	317	317	0,0	**0**	313	ns	37,6	96	-4,3	-192	**-97**	97	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	186	ns	45,2	510	-6,7	-301	**209**	46	-18%
	R East Eur Ann B	67	65	11,6	**9**	61	ns	45,2	127	-4,2	-191	**-64**	73	-770%
	R East Eur Non Ann B	38	38	0,0	**0**	38	ns	37,6	6	-0,3	-13	**-7**	7	ns
	Former SU Ann B	496	819	0,0	**0**	423	ns	45,2	1 575	-396,7	-17 923	**-16 348**	16 348	ns
	Former SU Non Ann B	110	110	0,0	**0**	108	ns	37,6	30	-1,4	-62	**-32**	32	ns
	India	426	426	0,0	**0**	422	ns	37,6	88	-4,1	-185	**-97**	97	ns
	R South Asia	82	82	0,0	**0**	81	ns	37,6	11	-0,5	-22	**-11**	11	ns
	Korea	140	140	0,0	**0**	139	ns	37,6	17	-0,8	-35	**-18**	18	ns
	R South-East Asia	392	392	0,0	**0**	388	ns	37,6	83	-3,8	-170	**-88**	88	ns
	China	1 612	1 612	0,0	**0**	1 579	ns	37,6	660	-33,1	-1 496	**-835**	835	ns
	Japan	345	279	196,1	**5 463**	323	32%	45,2	459	44,6	2 015	**2 474**	2 989	-55%
	Australia + New Zealand	123	88	110,9	**1 700**	106	49%	45,2	370	17,6	794	**1 164**	536	-32%
	WORLD	8 186	7 711		**55 028**	7 711			10 211	0,0	0	**10 211**	44 817	-81%
	JUSCANZ	2 322	1 716	618	**38 980**	2 078	40%		5 270	363	16 381	**21 651**	17 329	-44%
	EU	983	816	83,6	**15 164**	913	42%		1 531	96	4 359	**5 890**	9 274	-61%
	Non Ann B - China	2 322	2 322	0	**0**	2 301	ns		463	-21	-960	**-496**	496	ns
	Non Ann B	3 933	3 933	0	**0**	3 879	ns		1 124	-54	-2 455	**-1 332**	1 332	ns

Case 1b: World Full Trade (CDM 30% accessibility)

ASPEN-sd : **CASE 1b Full Trade with CDM 30% AF**

Reminder:		NO TRADE				TRADE		**Permit Price =**	**35,4**	**$90/tC**			GAINS from TRADE	
CC/IMP 100%	POLES 32 regions	REFER MtC	TARGET MtC	MAC $90/tC	**TAC M$90**	EMISS MtC	DOM / TOT %	MAC $90/tC	DOM AC M$90	TRADE MtC	TRADE M$90	**TAC M$90**	M$90	%
CC/EXP 100%	USA	1 716	1 240	144,6	**29 636**	1 559	33%	35,4	2 682	319,4	11 295	**13 977**	15 659	-53%
CDM AF 30%	Canada	139	109	166,3	**2 181**	130	29%	35,4	139	21,3	755	**893**	1 288	-59%
CDM TC 20%	Mexico	163	163	0,0	**0**	161	ns	29,5	39	-2,2	-78	**-40**	40	ns
AL/ET 0	R Central America	57	57	0,0	**0**	57	ns	29,5	12	-0,7	-23	**-12**	12	ns
AL/CDM 0	Brasil	147	147	0,0	**0**	145	ns	29,5	40	-2,6	-93	**-52**	52	ns
HA Exclus 0	R South America	149	149	0,0	**0**	144	ns	29,5	78	-4,3	-153	**-75**	75	ns
	France	121	104	185,1	**1 350**	117	25%	35,4	71	12,3	437	**508**	842	-62%
	Germany	236	210	52,3	**643**	218	70%	35,4	308	7,7	271	**579**	64	-10%
	Italy	123	103	278,7	**2 454**	119	18%	35,4	61	16,5	583	**644**	1 810	-74%
	United-Kingdom	168	141	107,8	**1 274**	157	42%	35,4	195	15,8	557	**752**	522	-41%
	R EU North	206	146	381,2	**8 763**	195	18%	35,4	184	49,0	1 733	**1 917**	6 846	-78%
	R EU South	131	112	82,8	**680**	121	50%	35,4	155	9,1	322	**477**	204	-30%
	R Western Europe	28	21	229,9	**619**	26	22%	35,4	24	4,9	173	**197**	422	-68%
VCP 200	Turkey	84	84	0,0	**0**	82	ns	29,5	44	-2,6	-93	**-49**	49	ns
	Egypt	36	36	0,0	**0**	35	ns	29,5	11	-0,6	-23	**-12**	12	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	29,5	4	-0,2	-7	**-4**	4	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	29,5	14	-0,9	-31	**-17**	17	ns
	Gulf	231	231	0,0	**0**	227	ns	29,5	68	-4,0	-141	**-74**	74	ns
	R Middle-East	48	48	0,0	**0**	47	ns	29,5	15	-0,9	-32	**-17**	17	ns
	South of Sahara Afr	317	317	0,0	**0**	307	ns	29,5	178	-10,0	-355	**-178**	178	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	191	ns	35,4	321	-1,9	-69	**252**	4	-2%
	R East Eur Ann B	67	65	11,6	**9**	62	ns	35,4	81	-3,1	-109	**-28**	37	-392%
	R East Eur Non Ann	38	38	0,0	**0**	37	ns	29,5	12	-0,7	-24	**-12**	12	ns
	Former SU Ann B	496	819	0,0	**0**	437	ns	35,4	1 004	-382,5	-13 528	**-12 524**	12 524	ns
	Former SU Non Ann	110	110	0,0	**0**	106	ns	29,5	57	-3,3	-117	**-60**	60	ns
	India	426	426	0,0	**0**	416	ns	29,5	169	-9,9	-349	**-180**	180	ns
	R South Asia	82	82	0,0	**0**	81	ns	29,5	20	-1,2	-41	**-21**	21	ns
	Korea	140	140	0,0	**0**	138	ns	29,5	32	-1,8	-65	**-33**	33	ns
	R South-East Asia	392	392	0,0	**0**	383	ns	29,5	157	-9,0	-319	**-162**	162	ns
	China	1 612	1 612	0,0	**0**	1 529	ns	29,5	1 343	-83,0	-2 937	**-1 594**	1 594	ns
	Japan	345	279	196,1	**5 463**	328	26%	35,4	291	48,8	1 725	**2 016**	3 447	-63%
	Australia + New Zea	123	88	110,9	**1 700**	109	40%	35,4	236	20,9	740	**975**	724	-43%
	WORLD	8 186	7 711		**55 028**	7 711			8 044	0,0	0	**8 044**	46 984	-85%
	JUSCANZ	2 322	1 716	618	**38 980**	2 126	32%		3 348	410	14 514	**17 862**	21 118	-54%
	EU	983	816	83,6	**15 164**	927	34%		974	110	3 902	**4 876**	10 288	-68%
	Non Ann B - China	2 322	2 322	0	**0**	2 271	ns		881	-51	-1 806	**-924**	924	ns
	Non Ann B	3 933	3 933	0	**0**	3 799	ns		2 224	-134	-4 743	**-2 518**	2 518	ns

Case 2a: World Full Trade with Share of Proceeds on CDM only

ASPEN-sd : **CASE 2a Full Trade with Share of Proceeds on CDM only**

Reminder:		NO TRADE				TRADE			**Permit Price =**	**45,7**	**$90/tC**		GAINS from TRADE	
CC/IMP 100%	POLES 32 regions	REFER MtC	TARGET MtC	MAC $90/tC	**TAC M$90**	EMISS MtC	DOM / TOT %	MAC $90/tC	DOM AC M$90	TRADE MtC	TRADE M$90	**TAC M$90**	M$90	%
CC/EXP 100%	USA	1 716	1 240	144,6	**29 636**	1 519	41%	45,7	4 311	279,1	12 751	**17 063**	12 574	-42%
CDM AF 10%	Canada	139	109	166,3	**2 181**	128	35%	45,7	221	19,3	882	**1 103**	1 078	-49%
CDM TC 20%	Mexico	163	163	0,0	**0**	162	ns	33,9	17	-0,8	-34	**-18**	18	ns
AL/ET 0	R Central America	57	57	0,0	**0**	57	ns	33,9	5	-0,3	-10	**-5**	5	ns
AL/CDM 5	Brasil	147	147	0,0	**0**	146	ns	33,9	16	-1,0	-39	**-22**	22	ns
HA Exclus 0	R South America	149	149	0,0	**0**	147	ns	33,9	35	-1,7	-69	**-34**	34	ns
	France	121	104	185,1	**1 350**	116	32%	45,7	116	11,2	514	**630**	721	-53%
	Germany	236	210	52,3	**643**	213	88%	45,7	499	2,9	134	**633**	10	-1%
	Italy	123	103	278,7	**2 454**	118	22%	45,7	100	15,5	710	**810**	1 645	-67%
	United-Kingdom	168	141	107,8	**1 274**	154	53%	45,7	307	13,0	592	**900**	374	-29%
	R EU North	206	146	381,2	**8 763**	192	23%	45,7	294	46,3	2 114	**2 408**	6 354	-73%
	R EU South	131	112	82,8	**680**	119	62%	45,7	247	6,8	312	**558**	122	-18%
	R Western Europe	28	21	229,9	**619**	26	28%	45,7	39	4,5	207	**246**	373	-60%
VCP 200	Turkey	84	84	0,0	**0**	83	ns	33,9	19	-1,0	-40	**-22**	22	ns
	Egypt	36	36	0,0	**0**	35	ns	33,9	5	-0,2	-10	**-5**	5	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	33,9	2	-0,1	-3	**-2**	2	ns
	North Africa OPEP	31	31	0,0	**0**	31	ns	33,9	6	-0,3	-14	**-7**	7	ns
	Gulf	231	231	0,0	**0**	230	ns	33,9	29	-1,5	-61	**-33**	33	ns
	R Middle-East	48	48	0,0	**0**	48	ns	33,9	7	-0,3	-14	**-7**	7	ns
	South of Sahara Afr	317	317	0,0	**0**	313	ns	33,9	78	-3,8	-157	**-79**	79	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	186	ns	45,7	521	-6,9	-315	**206**	50	-19%
	R East Eur Ann B	67	65	11,6	**9**	61	ns	45,7	130	-4,3	-196	**-66**	75	-793%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	33,9	5	-0,3	-11	**-5**	5	ns
	Former SU Ann B	496	819	0,0	**0**	422	ns	45,7	1 607	-397,4	-18 158	**-16 551**	16 551	ns
	Former SU Non Ann	110	110	0,0	**0**	108	ns	33,9	25	-1,3	-51	**-27**	27	ns
	India	426	426	0,0	**0**	422	ns	33,9	73	-3,7	-152	**-80**	80	ns
	R South Asia	82	82	0,0	**0**	81	ns	33,9	9	-0,4	-18	**-9**	9	ns
	Korea	140	140	0,0	**0**	140	ns	33,9	14	-0,7	-28	**-14**	14	ns
	R South-East Asia	392	392	0,0	**0**	389	ns	33,9	68	-3,4	-140	**-72**	72	ns
	China	1 612	1 612	0,0	**0**	1 581	ns	33,9	558	-30,9	-1 258	**-700**	700	ns
	Japan	345	279	196,1	**5 463**	323	33%	45,7	469	44,4	2 028	**2 497**	2 966	-54%
	Australia + New Zea	123	88	110,9	**1 700**	106	50%	45,7	378	17,4	795	**1 173**	527	-31%
	WORLD	8 186	7 711		**55 028**	7 711			10 208	0,0	259	**10 467**	44 561	-81%
	JUSCANZ	2 322	1 716	618	**38 980**	2 076	41%		5 379	360	16 456	**21 835**	17 145	-44%
	EU	983	816	83,6	**15 164**	912	43%		1 563	96	4 376	**5 939**	9 225	-61%
	Non Ann B - China	2 322	2 322	0	**0**	2 302	ns		381	-19	-790	**-410**	410	ns
	Non Ann B	3 933	3 933	0	**0**	3 883	ns		939	-50	-2 048	**-1 110**	1 110	ns

Case 2b: World Full Trade with Extended Share of Proceeds on CDM and IET

ASPEN-sd : **CASE 2b Full Trade with Extended Share of Proceeds on CDM and IET**

Reminder:		NO TRADE				TRADE			**Permit Price =**	**46,8**	**$90/tC**		GAINS from TRADE	
CC/IMP	POLES 32 regions	REFER	TARGET	MAC	**TAC**	EMISS	DOM / TOT	MAC	DOM AC	TRADE	TRADE	**TAC**		
100%		MtC	MtC	$90/tC	**M$90**	MtC	%	$90/tC	M$90	MtC	M$90	**M$90**	M$90	%
CC/EXP	USA	1 716	1 240	144,6	**29 636**	1 515	42%	46,8	4 503	274,9	12 863	**17 366**	12 270	-41%
100%	Canada	139	109	166,3	**2 181**	128	36%	46,8	231	19,1	893	**1 124**	1 057	-48%
CDM AF	Mexico	163	163	0,0	**0**	162	ns	34,8	18	-0,9	-36	**-18**	18	ns
10%	R Central America	57	57	0,0	**0**	57	ns	34,8	5	-0,3	-11	**-6**	6	ns
CDM TC	Brasil	147	147	0,0	**0**	146	ns	34,8	17	-1,0	-41	**-23**	23	ns
20%	R South America	149	149	0,0	**0**	147	ns	34,8	37	-1,8	-73	**-36**	36	ns
AL/ET	France	121	104	185,1	**1 350**	116	32%	46,8	121	11,1	521	**642**	708	-52%
5	Germany	236	210	52,3	**643**	213	90%	46,8	522	2,4	114	**636**	7	-1%
AL/CDM	Italy	123	103	278,7	**2 454**	118	23%	46,8	104	15,4	722	**827**	1 628	-66%
5	United-Kingdom	168	141	107,8	**1 274**	154	54%	46,8	320	12,7	593	**914**	360	-28%
HA Exclus	R EU North	206	146	381,2	**8 763**	192	23%	46,8	308	46,0	2 151	**2 459**	6 304	-72%
0	R EU South	131	112	82,8	**680**	119	64%	46,8	257	6,6	308	**566**	115	-17%
	R Western Europe	28	21	229,9	**619**	26	29%	46,8	41	4,5	210	**251**	368	-59%
VCP	Turkey	84	84	0,0	**0**	83	ns	34,8	19	-1,0	-42	**-23**	23	ns
200	Egypt	36	36	0,0	**0**	35	ns	34,8	5	-0,2	-10	**-5**	5	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	34,8	2	-0,1	-3	**-2**	2	ns
	North Africa OPEP	31	31	0,0	**0**	31	ns	34,8	6	-0,3	-14	**-8**	8	ns
	Gulf	231	231	0,0	**0**	230	ns	34,8	30	-1,5	-65	**-34**	34	ns
	R Middle-East	48	48	0,0	**0**	48	ns	34,8	7	-0,3	-15	**-8**	8	ns
	South of Sahara Afr	317	317	0,0	**0**	313	ns	34,8	82	-4,0	-165	**-83**	83	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	187	ns	41,8	441	-5,1	-215	**226**	30	-12%
	R East Eur Ann B	67	65	11,6	**9**	61	ns	41,8	111	-3,8	-160	**-49**	59	-620%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	34,8	5	-0,3	-11	**-6**	6	ns
	Former SU Ann B	496	819	0,0	**0**	428	ns	41,8	1 368	-391,8	-16 371	**-15 003**	15 003	ns
	Former SU Non Ann	110	110	0,0	**0**	108	ns	34,8	26	-1,3	-54	**-28**	28	ns
	India	426	426	0,0	**0**	422	ns	34,8	77	-3,8	-160	**-84**	84	ns
	R South Asia	82	82	0,0	**0**	81	ns	34,8	9	-0,5	-19	**-10**	10	ns
	Korea	140	140	0,0	**0**	140	ns	34,8	15	-0,7	-30	**-15**	15	ns
	R South-East Asia	392	392	0,0	**0**	389	ns	34,8	71	-3,5	-147	**-76**	76	ns
	China	1 612	1 612	0,0	**0**	1 580	ns	34,8	582	-31,5	-1 317	**-735**	735	ns
	Japan	345	279	196,1	**5 463**	323	33%	46,8	490	43,9	2 055	**2 545**	2 918	-53%
	Australia + New Zea	123	88	110,9	**1 700**	105	51%	46,8	395	17,0	797	**1 192**	508	-30%
	WORLD	8 186	7 711		**55 028**	7 711			10 224	0,0	2 269	**12 493**	42 535	-77%
	JUSCANZ	2 322	1 716	618	**38 980**	2 071	41%		5 618	355	16 608	**22 227**	16 753	-43%
	EU	983	816	83,6	**15 164**	911	44%		1 633	94	4 411	**6 043**	9 121	-60%
	Non Ann B - China	2 322	2 322	0	**0**	2 302	ns		400	-20	-832	**-432**	432	ns
	Non Ann B	3 933	3 933	0	**0**	3 882	ns		982	-51	-2 149	**-1 167**	1 167	ns

Case 3a: Voluntary Compliance Payment (50 $90/tC)

ASPEN-sd : **CASE 3a Voluntary Compliance Payment, no Share of Proceeds**

Reminder:		NO TRADE				TRADE				**Permit Price =**	**45,2**	**$90/tC**		GAINS from TRADE	
CC/IMP 100%	POLES 32 regions	REFER MtC	TARGET MtC	MAC $90/tC	**TAC M$90**	EMISS MtC	DOM / TOT %	MAC $90/tC	DOM AC M$90	TRADE MtC	TRADE M$90	**TAC M$90**		M$90	%
CC/EXP 100%	USA	1 716	1 240	144,6	**29 636**	1 521	41%	45,2	4 223	281,0	12 696	**16 920**		12 716	-43%
CDM AF 10%	Canada	139	109	166,3	**2 181**	128	35%	45,2	217	19,4	876	**1 093**		1 088	-50%
CDM TC 20%	Mexico	163	163	0,0	**0**	162	ns	37,6	20	-0,9	-42	**-21**		21	ns
AL/ET 0	R Central America	57	57	0,0	**0**	57	ns	37,6	6	-0,3	-13	**-6**		6	ns
AL/CDM 0	Brasil	147	147	0,0	**0**	146	ns	37,6	19	-1,0	-46	**-27**		27	ns
HA Exclus 0	R South America	149	149	0,0	**0**	147	ns	37,6	43	-1,9	-84	**-40**		40	ns
	France	121	104	185,1	**1 350**	116	31%	45,2	113	11,3	511	**624**		726	-54%
	Germany	236	210	52,3	**643**	213	88%	45,2	488	3,2	143	**632**		11	-2%
	Italy	123	103	278,7	**2 454**	118	22%	45,2	98	15,6	704	**802**		1 653	-67%
	United-Kingdom	168	141	107,8	**1 274**	154	52%	45,2	301	13,1	592	**893**		381	-30%
	R EU North	206	146	381,2	**8 763**	192	22%	45,2	289	46,4	2 096	**2 385**		6 378	-73%
	R EU South	131	112	82,8	**680**	119	62%	45,2	242	6,9	313	**555**		125	-18%
	R Western Europe	28	21	229,9	**619**	26	28%	45,2	39	4,5	205	**244**		376	-61%
VCP 50	Turkey	84	84	0,0	**0**	83	ns	37,6	22	-1,1	-48	**-26**		26	ns
	Egypt	36	36	0,0	**0**	35	ns	37,6	6	-0,3	-12	**-6**		6	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	37,6	2	-0,1	-4	**-2**		2	ns
	North Africa OPEP	31	31	0,0	**0**	31	ns	37,6	7	-0,4	-16	**-9**		9	ns
	Gulf	231	231	0,0	**0**	230	ns	37,6	35	-1,6	-74	**-39**		39	ns
	R Middle-East	48	48	0,0	**0**	48	ns	37,6	8	-0,4	-17	**-9**		9	ns
	South of Sahara Afr	317	317	0,0	**0**	313	ns	37,6	96	-4,3	-192	**-97**		97	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	186	ns	45,2	510	-6,7	-301	**209**		46	-18%
	R East Eur Ann B	67	65	11,6	**9**	61	ns	45,2	127	-4,2	-191	**-64**		73	-770%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	37,6	6	-0,3	-13	**-7**		7	ns
	Former SU Ann B	496	819	0,0	**0**	423	ns	45,2	1 575	-396,7	-17 923	**-16 348**		16 348	ns
	Former SU Non Ann	110	110	0,0	**0**	108	ns	37,6	30	-1,4	-62	**-32**		32	ns
	India	426	426	0,0	**0**	422	ns	37,6	88	-4,1	-185	**-97**		97	ns
	R South Asia	82	82	0,0	**0**	81	ns	37,6	11	-0,5	-22	**-11**		11	ns
	Korea	140	140	0,0	**0**	139	ns	37,6	17	-0,8	-35	**-18**		18	ns
	R South-East Asia	392	392	0,0	**0**	388	ns	37,6	83	-3,8	-170	**-88**		88	ns
	China	1 612	1 612	0,0	**0**	1 579	ns	37,6	660	-33,1	-1 496	**-835**		835	ns
	Japan	345	279	196,1	**5 463**	323	32%	45,2	459	44,6	2 015	**2 474**		2 989	-55%
	Australia + New Zea	123	88	110,9	**1 700**	106	49%	45,2	370	17,6	794	**1 164**		536	-32%
	WORLD	8 186	7 711		**55 028**	7 711			10 211	0,0	0	**10 211**		44 817	-81%
	JUSCANZ	2 322	1 716	618	**38 980**	2 078	40%		5 270	363	16 381	**21 651**		17 329	-44%
	EU	983	816	83,6	**15 164**	913	42%		1 531	96	4 359	**5 890**		9 274	-61%
	Non Ann B - China	2 322	2 322	0	**0**	2 301	ns		463	-21	-960	**-496**		496	ns
	Non Ann B	3 933	3 933	0	**0**	3 879	ns		1 124	-54	-2 455	**-1 332**		1 332	ns

Case 3b: Voluntary Compliance Payment with 50% Hot Air Exclusion

ASPEN-sd : **CASE 3b Voluntary Compliance Payment, no Share of Proceeds, Hot Air Exclusion (50%)**

Reminder:		NO TRADE				TRADE				**Permit Price =**	**0,0**	**$90/tC**		GAINS from TRADE	
CC/IMP 100%	POLES 32 regions	REFER MtC	TARGET MtC	MAC $90/tC	**TAC M$90**	EMISS MtC	DOM / TOT %	MAC $90/tC	DOM AC M$90	TRADE MtC	TRADE M$90	**TAC M$90**		M$90	%
CC/EXP 100%	USA	1 716	1 240	144,6	**29 636**	1 503	45%	50,0	5 093	262,8	13 138	**18 231**		11 405	-38%
CDM AF 10%	Canada	139	109	166,3	**2 181**	127	38%	50,0	261	18,5	923	**1 184**		997	-46%
CDM TC 20%	Mexico	163	163	0,0	**0**	162	ns	51,4	37	-1,2	-76	**-39**		39	ns
AL/ET 0	R Central America	57	57	0,0	**0**	57	ns	51,4	11	-0,4	-23	**-12**		12	ns
AL/CDM 0	Brasil	147	147	0,0	**0**	146	ns	51,4	32	-1,3	-78	**-46**		46	ns
HA Exclus 162	R South America	149	149	0,0	**0**	146	ns	51,4	68	-2,3	-144	**-76**		76	ns
	France	121	104	185,1	**1 350**	115	34%	50,0	137	10,8	540	**677**		673	-50%
	Germany	236	210	52,3	**643**	207	ns	61,6	871	-3,0	-183	**688**		-45	7%
	Italy	123	103	278,7	**2 454**	118	24%	50,0	118	15,1	757	**876**		1 578	-64%
	United-Kingdom	168	141	107,8	**1 274**	153	57%	50,0	361	11,8	592	**953**		320	-25%
	R EU North	206	146	381,2	**8 763**	191	24%	50,0	348	45,2	2 258	**2 605**		6 157	-70%
	R EU South	131	112	82,8	**680**	118	67%	50,0	290	5,9	296	**586**		94	-14%
	R Western Europe	28	21	229,9	**619**	26	31%	50,0	47	4,4	218	**265**		354	-57%
VCP 50	Turkey	84	84	0,0	**0**	83	ns	51,4	37	-1,3	-83	**-46**		46	ns
	Egypt	36	36	0,0	**0**	35	ns	51,4	10	-0,3	-21	**-11**		11	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	51,4	3	-0,1	-7	**-4**		4	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	51,4	12	-0,4	-27	**-16**		16	ns
	Gulf	231	231	0,0	**0**	229	ns	51,4	60	-2,1	-131	**-71**		71	ns
	R Middle-East	48	48	0,0	**0**	47	ns	51,4	14	-0,5	-30	**-16**		16	ns
	South of Sahara Afr	317	317	0,0	**0**	311	ns	51,4	174	-5,7	-353	**-179**		179	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	178	ns	61,6	909	-14,1	-872	**38**		218	-85%
	R East Eur Ann B	67	65	11,6	**9**	59	ns	61,6	222	-6,0	-370	**-148**		158	-1660%
	R East Eur Non Anr	38	38	0,0	**0**	38	ns	51,4	11	-0,4	-23	**-12**		12	ns
	Former SU Ann B	496	819	0,0	**0**	496	ns	61,6	0	-256,6	-15 814	**-15 814**		15 814	ns
	Former SU Non Anr	110	110	0,0	**0**	108	ns	51,4	53	-1,8	-111	**-59**		59	ns
	India	426	426	0,0	**0**	421	ns	51,4	155	-5,4	-330	**-175**		175	ns
	R South Asia	82	82	0,0	**0**	81	ns	51,4	19	-0,6	-39	**-21**		21	ns
	Korea	140	140	0,0	**0**	139	ns	51,4	30	-1,0	-63	**-32**		32	ns
	R South-East Asia	392	392	0,0	**0**	387	ns	51,4	145	-4,9	-305	**-160**		160	ns
	China	1 612	1 612	0,0	**0**	1 571	ns	51,4	1 067	-40,9	-2 518	**-1 451**		1 451	ns
	Japan	345	279	196,1	**5 463**	321	35%	50,0	554	42,6	2 130	**2 684**		2 778	-51%
	Australia + New Zea	123	88	110,9	**1 700**	104	54%	50,0	447	16,0	798	**1 245**		455	-27%
	WORLD	8 186	7 711		**55 028**	7 727			11 595	82,5	51	**11 646**		43 383	-79%
	JUSCANZ	2 322	1 716	618	**38 980**	2 056	44%		6 354	340	16 990	**23 344**		15 636	-40%
	EU	983	816	83,6	**15 164**	902	49%		2 125	86	4 260	**6 385**		8 779	-58%
	Non Ann B - China	2 322	2 322	0	**0**	2 294	ns		806	-28	-1 709	**-903**		903	ns
	Non Ann B	3 933	3 933	0	**0**	3 865	ns		1 873	-69	-4 227	**-2 353**		2 353	ns

Case 4: Voluntary Compliance Payment with Extended Share of Proceeds

ASPEN-sd : **CASE 4 Voluntary Compliance Payment, Extended Share of Proceeds, Hot Air Exclusion (50%)**

Reminder:		NO TRADE				TRADE				**Permit Price =**	**0,0**	**$90/tC**		GAINS from TRADE	
CC/IMP	POLES 32 regions	REFER	TARGET	MAC	**TAC**	EMISS	DOM / TOT	MAC	DOM AC	TRADE	TRADE	**TAC**			
100%		MtC	MtC	$90/tC	**M$90**	MtC	%	$90/tC	M$90	MtC	M$90	**M$90**		M$90	%
CC/EXP	USA	1 716	1 240	144,6	**29 636**	1 503	45%	50,0	5 093	262,8	13 138	**18 231**		11 405	-38%
100%	Canada	139	109	166,3	**2 181**	127	38%	50,0	261	18,5	923	**1 184**		997	-46%
CDM AF	Mexico	163	163	0,0	**0**	162	ns	48,6	33	-1,2	-68	**-35**		35	ns
10%	R Central America	57	57	0,0	**0**	57	ns	48,6	10	-0,4	-21	**-11**		11	ns
CDM TC	Brasil	147	147	0,0	**0**	146	ns	48,6	29	-1,2	-71	**-42**		42	ns
20%	R South America	149	149	0,0	**0**	146	ns	48,6	64	-2,3	-135	**-71**		71	ns
AL/ET	France	121	104	185,1	**1 350**	115	34%	50,0	137	10,8	540	**677**		673	-50%
5	Germany	236	210	52,3	**643**	208	ns	58,3	785	-1,9	-109	**676**		-34	5%
AL/CDM	Italy	123	103	278,7	**2 454**	118	24%	50,0	118	15,1	757	**876**		1 578	-64%
5	United-Kingdom	168	141	107,8	**1 274**	153	57%	50,0	361	11,8	592	**953**		320	-25%
HA Exclus	R EU North	206	146	381,2	**8 763**	191	24%	50,0	348	45,2	2 258	**2 605**		6 157	-70%
162	R EU South	131	112	82,8	**680**	118	67%	50,0	290	5,9	296	**586**		94	-14%
	R Western Europe	28	21	229,9	**619**	26	31%	50,0	47	4,4	218	**265**		354	-57%
VCP	Turkey	84	84	0,0	**0**	83	ns	48,6	34	-1,3	-76	**-42**		42	ns
50	Egypt	36	36	0,0	**0**	35	ns	48,6	9	-0,3	-19	**-10**		10	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	48,6	3	-0,1	-6	**-3**		3	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	48,6	11	-0,4	-25	**-14**		14	ns
	Gulf	231	231	0,0	**0**	229	ns	48,6	55	-2,0	-119	**-64**		64	ns
	R Middle-East	48	48	0,0	**0**	47	ns	48,6	12	-0,5	-27	**-14**		14	ns
	South of Sahara Afr	317	317	0,0	**0**	312	ns	48,6	157	-5,5	-318	**-161**		161	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	180	ns	58,3	822	-12,6	-738	**84**		172	-67%
	R East Eur Ann B	67	65	11,6	**9**	59	ns	58,3	202	-5,7	-330	**-128**		138	-1448%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	48,6	10	-0,4	-21	**-11**		11	ns
	Former SU Ann B	496	819	0,0	**0**	496	ns	58,3	0	-252,3	-14 708	**-14 708**		14 708	ns
	Former SU Non Ann	110	110	0,0	**0**	108	ns	48,6	48	-1,7	-101	**-53**		53	ns
	India	426	426	0,0	**0**	421	ns	48,6	140	-5,1	-299	**-158**		158	ns
	R South Asia	82	82	0,0	**0**	81	ns	48,6	17	-0,6	-35	**-19**		19	ns
	Korea	140	140	0,0	**0**	139	ns	48,6	27	-1,0	-57	**-29**		29	ns
	R South-East Asia	392	392	0,0	**0**	387	ns	48,6	132	-4,7	-276	**-145**		145	ns
	China	1 612	1 612	0,0	**0**	1 572	ns	48,6	982	-39,6	-2 310	**-1 328**		1 328	ns
	Japan	345	279	196,1	**5 463**	321	35%	50,0	554	42,6	2 130	**2 684**		2 778	-51%
	Australia + New Zea	123	88	110,9	**1 700**	104	54%	50,0	447	16,0	798	**1 245**		455	-27%
	WORLD	8 186	7 711		**55 028**	7 732			11 236	92,3	1 783	**13 019**		42 009	-76%
	JUSCANZ	2 322	1 716	618	**38 980**	2 056	44%		6 354	340	16 990	**23 344**		15 636	-40%
	EU	983	816	83,6	**15 164**	903	48%		2 040	87	4 334	**6 374**		8 790	-58%
	Non Ann B - China	2 322	2 322	0	**0**	2 295	ns		733	-27	-1 552	**-819**		819	ns
	Non Ann B	3 933	3 933	0	**0**	3 867	ns		1 714	-66	-3 862	**-2 147**		2 147	ns

Case 5: Concrete Ceilings, no VCP, no ESP

ASPEN-sd : **CASE 5 EU Concrete Ceilings, no VCP, no ESP**

Reminder:		NO TRADE				TRADE		**Permit Price =**	**78,6**	**$90/tC**			GAINS from TRADE	
CC/IMP	POLES 32 regions	REFER	TARGET	MAC	**TAC**	EMISS	DOM / TOT	MAC	DOM AC	TRADE	TRADE	**TAC**		
50%		MtC	MtC	$90/tC	**M$90**	MtC	%	$90/tC	M$90	MtC	M$90	**M$90**	M$90	%
CC/EXP	USA	1 716	1 240	144,6	**29 636**	1 409	64%	78,6	11 080	169,0	13 281	**24 361**	5 275	-18%
100%	Canada	139	109	166,3	**2 181**	122	56%	78,6	599	13,2	1 036	**1 636**	546	-25%
CDM AF	Mexico	163	163	0,0	**0**	161	ns	65,5	57	-1,5	-120	**-63**	63	ns
10%	R Central America	57	57	0,0	**0**	57	ns	65,5	17	-0,5	-36	**-19**	19	ns
CDM TC	Brasil	147	147	0,0	**0**	146	ns	65,5	48	-1,5	-117	**-69**	69	ns
20%	R South America	149	149	0,0	**0**	146	ns	65,5	78	-2,5	-195	**-117**	117	ns
AL/ET	France	121	104	185,1	**1 350**	112	51%	79,6	319	8,0	626	**946**	404	-30%
0	Germany	236	210	52,3	**643**	200	ns	78,6	1 315	-10,3	-813	**502**	141	-22%
AL/CDM	Italy	123	103	278,7	**2 454**	113	50%	114,1	535	10,0	786	**1 321**	1 133	-46%
0	United-Kingdom	168	141	107,8	**1 274**	146	80%	78,6	771	5,4	426	**1 197**	77	-6%
HA Exclus	R EU North	206	146	381,2	**8 763**	176	50%	125,8	1 651	29,9	2 348	**3 998**	4 764	-54%
283	R EU South	131	112	82,8	**680**	113	96%	78,6	621	0,7	58	**679**	2	0%
	R Western Europe	28	21	229,9	**619**	25	50%	89,6	131	3,2	248	**378**	241	-39%
VCP	Turkey	84	84	0,0	**0**	83	ns	65,5	54	-1,6	-125	**-71**	71	ns
200	Egypt	36	36	0,0	**0**	35	ns	65,5	15	-0,4	-33	**-18**	18	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	65,5	5	-0,1	-11	**-6**	6	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	65,5	17	-0,5	-41	**-24**	24	ns
	Gulf	231	231	0,0	**0**	229	ns	65,5	91	-2,6	-201	**-111**	111	ns
	R Middle-East	48	48	0,0	**0**	47	ns	65,5	20	-0,6	-45	**-25**	25	ns
	South of Sahara Afr	317	317	0,0	**0**	310	ns	65,5	272	-7,2	-562	**-289**	289	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	171	ns	78,6	1 409	-21,3	-1 673	**-263**	519	-203%
	R East Eur Ann B	67	65	11,6	**9**	57	ns	78,6	336	-7,6	-600	**-264**	273	-2879%
	R East Eur Non Ann	38	38	0,0	**0**	37	ns	65,5	17	-0,5	-36	**-19**	19	ns
	Former SU Ann B	496	819	0,0	**0**	496	ns	78,6	0	-155,6	-12 227	**-12 227**	12 227	ns
	Former SU Non Ann	110	110	0,0	**0**	107	ns	65,5	81	-2,2	-174	**-93**	93	ns
	India	426	426	0,0	**0**	420	ns	65,5	239	-6,6	-515	**-276**	276	ns
	R South Asia	82	82	0,0	**0**	81	ns	65,5	29	-0,8	-61	**-33**	33	ns
	Korea	140	140	0,0	**0**	139	ns	65,5	47	-1,3	-99	**-52**	52	ns
	R South-East Asia	392	392	0,0	**0**	386	ns	65,5	220	-6,0	-474	**-254**	254	ns
	China	1 612	1 612	0,0	**0**	1 564	ns	65,5	1 521	-47,5	-3 730	**-2 208**	2 208	ns
	Japan	345	279	196,1	**5 463**	310	52%	79,4	1 263	31,6	2 482	**3 745**	1 718	-31%
	Australia + New Zea	123	88	110,9	**1 700**	96	78%	78,6	980	7,6	598	**1 578**	122	-7%
	WORLD	8 186	7 711		**55 028**	7 544			23 840	0,0	0	**23 840**	31 189	-57%
	JUSCANZ	2 322	1 716	618	**38 980**	1 937	63%		13 923	221	17 397	**31 320**	7 660	-20%
	EU	983	816	83,6	**15 164**	860	74%		5 213	44	3 430	**8 643**	6 521	-43%
	Non Ann B - China	2 322	2 322	0	**0**	2 288	ns		1 209	-34	-2 636	**-1 427**	1 427	ns
	Non Ann B	3 933	3 933	0	**0**	3 852	ns		2 731	-81	-6 366	**-3 635**	3 635	ns

Case 6: Concrete Ceilings, no VCP, with ESP

ASPEN-sd : **CASE 6 EU Concrete Ceilings, no VCP, with ESP**

Reminder:		NO TRADE				TRADE		**Permit Price =**	**80,5**	**$90/tC**			GAINS from TRADE	
CC/IMP	POLES 32 regions	REFER	TARGET	MAC	**TAC**	EMISS	DOM / TOT	MAC	DOM AC	TRADE	TRADE	**TAC**		
50%		MtC	MtC	$90/tC	**M$90**	MtC	%	$90/tC	M$90	MtC	M$90	**M$90**	M$90	%
CC/EXP	USA	1 716	1 240	144,6	**29 636**	1 403	66%	80,5	11 551	163,1	13 135	**24 686**	4 950	-17%
100%	Canada	139	109	166,3	**2 181**	121	57%	80,5	627	12,8	1 034	**1 661**	520	-24%
CDM AF	Mexico	163	163	0,0	**0**	161	ns	62,9	53	-1,5	-112	**-59**	59	ns
10%	R Central America	57	57	0,0	**0**	57	ns	62,9	16	-0,4	-34	**-18**	18	ns
CDM TC	Brasil	147	147	0,0	**0**	146	ns	62,9	45	-1,5	-110	**-65**	65	ns
20%	R South America	149	149	0,0	**0**	146	ns	62,9	76	-2,5	-186	**-110**	110	ns
AL/ET	France	121	104	185,1	**1 350**	112	52%	80,5	326	7,9	635	**961**	389	-29%
5	Germany	236	210	52,3	**643**	201	ns	75,5	1 229	-9,2	-697	**532**	110	-17%
AL/CDM	Italy	123	103	278,7	**2 454**	113	50%	114,1	535	10,0	805	**1 341**	1 114	-45%
5	United-Kingdom	168	141	107,8	**1 274**	146	82%	80,5	803	5,0	404	**1 207**	67	-5%
HA Exclus	R EU North	206	146	381,2	**8 763**	176	50%	125,8	1 651	29,9	2 406	**4 057**	4 706	-54%
283	R EU South	131	112	82,8	**680**	113	98%	80,3	645	0,4	35	**680**	0	0%
	R Western Europe	28	21	229,9	**619**	25	50%	89,7	131	3,2	254	**385**	234	-38%
VCP	Turkey	84	84	0,0	**0**	83	ns	62,9	51	-1,6	-118	**-67**	67	ns
200	Egypt	36	36	0,0	**0**	35	ns	62,9	14	-0,4	-31	**-17**	17	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	62,9	5	-0,1	-10	**-6**	6	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	62,9	16	-0,5	-38	**-22**	22	ns
	Gulf	231	231	0,0	**0**	229	ns	62,9	85	-2,5	-188	**-104**	104	ns
	R Middle-East	48	48	0,0	**0**	47	ns	62,9	19	-0,6	-43	**-23**	23	ns
	South of Sahara Afr	317	317	0,0	**0**	310	ns	62,9	254	-7,0	-525	**-271**	271	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	172	ns	75,5	1 313	-20,0	-1 513	**-200**	456	-178%
	R East Eur Ann B	67	65	11,6	**9**	58	ns	75,5	314	-7,3	-555	**-241**	251	-2637%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	62,9	16	-0,4	-34	**-18**	18	ns
	Former SU Ann B	496	819	0,0	**0**	496	ns	75,5	0	-152,1	-11 489	**-11 489**	11 489	ns
	Former SU Non Ann	110	110	0,0	**0**	107	ns	62,9	75	-2,2	-162	**-87**	87	ns
	India	426	426	0,0	**0**	420	ns	62,9	223	-6,4	-481	**-258**	258	ns
	R South Asia	82	82	0,0	**0**	81	ns	62,9	27	-0,8	-57	**-30**	30	ns
	Korea	140	140	0,0	**0**	139	ns	62,9	44	-1,2	-92	**-48**	48	ns
	R South-East Asia	392	392	0,0	**0**	386	ns	62,9	206	-5,9	-444	**-238**	238	ns
	China	1 612	1 612	0,0	**0**	1 565	ns	62,9	1 438	-46,6	-3 519	**-2 081**	2 081	ns
	Japan	345	279	196,1	**5 463**	310	53%	80,5	1 295	31,2	2 512	**3 807**	1 656	-30%
	Australia + New Zea	123	88	110,9	**1 700**	95	79%	80,5	1 021	7,1	571	**1 592**	107	-6%
	WORLD	8 186	7 711		**55 028**	7 540			24 104	0,0	1 353	**25 457**	29 572	-54%
	JUSCANZ	2 322	1 716	618	**38 980**	1 930	65%		14 494	214	17 252	**31 746**	7 234	-19%
	EU	983	816	83,6	**15 164**	860	74%		5 190	44	3 588	**8 778**	6 386	-42%
	Non Ann B - China	2 322	2 322	0	**0**	2 289	ns		1 132	-33	-2 468	**-1 336**	1 336	ns
	Non Ann B	3 933	3 933	0	**0**	3 854	ns		2 570	-79	-5 987	**-3 417**	3 417	ns

Case 7: Concrete Ceilings, with VCP, no ESP

ASPEN-sd : **CASE 7 EU Concrete Ceilings, with VCP no ESP**

Reminder:		NO TRADE				TRADE		**Permit Price =**	**0,0**	**$90/tC**			GAINS from TRADE	
CC/IMP	POLES 32 regions	REFER	TARGET	MAC	**TAC**	EMISS	DOM / TOT	MAC	DOM AC	TRADE	TRADE	**TAC**		
50%		MtC	MtC	$90/tC	**M$90**	MtC	%	$90/tC	M$90	MtC	M$90	**M$90**	M$90	%
CC/EXP	USA	1 716	1 240	144,6	**29 636**	1 478	50%	50,0	5 093	237,9	11 896	**16 988**	12 648	-43%
100%	Canada	139	109	166,3	**2 181**	124	50%	50,0	263	15,0	748	**1 011**	1 170	-54%
CDM AF	Mexico	163	163	0,0	**0**	161	ns	59,6	48	-1,4	-100	**-52**	52	ns
10%	R Central America	57	57	0,0	**0**	57	ns	59,6	15	-0,4	-30	**-16**	16	ns
CDM TC	Brasil	147	147	0,0	**0**	146	ns	59,6	41	-1,4	-100	**-59**	59	ns
20%	R South America	149	149	0,0	**0**	146	ns	59,6	73	-2,4	-173	**-100**	100	ns
AL/ET	France	121	104	185,1	**1 350**	113	50%	50,0	144	8,2	411	**555**	795	-59%
0	Germany	236	210	52,3	**643**	203	ns	71,5	1 125	-6,8	-486	**638**	5	-1%
AL/CDM	Italy	123	103	278,7	**2 454**	113	50%	50,0	153	10,0	500	**653**	1 801	-73%
0	United-Kingdom	168	141	107,8	**1 274**	153	57%	50,0	361	11,8	592	**953**	320	-25%
HA Exclus	R EU North	206	146	381,2	**8 763**	176	50%	50,0	548	29,9	1 494	**2 042**	6 720	-77%
283	R EU South	131	112	82,8	**680**	118	67%	50,0	290	5,9	296	**586**	94	-14%
	R Western Europe	28	21	229,9	**619**	25	50%	50,0	52	3,2	158	**210**	410	-66%
VCP	Turkey	84	84	0,0	**0**	83	ns	59,6	47	-1,5	-107	**-60**	60	ns
50	Egypt	36	36	0,0	**0**	35	ns	59,6	13	-0,4	-28	**-15**	15	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	59,6	4	-0,1	-9	**-5**	5	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	59,6	15	-0,5	-35	**-20**	20	ns
	Gulf	231	231	0,0	**0**	229	ns	59,6	78	-2,4	-171	**-93**	93	ns
	R Middle-East	48	48	0,0	**0**	47	ns	59,6	17	-0,5	-38	**-21**	21	ns
	South of Sahara Afr	317	317	0,0	**0**	311	ns	59,6	230	-6,6	-470	**-240**	240	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	174	ns	71,5	1 192	-18,4	-1 316	**-124**	380	-148%
	R East Eur Ann B	67	65	11,6	**9**	58	ns	71,5	287	-7,0	-499	**-213**	222	-2338%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	59,6	14	-0,4	-30	**-16**	16	ns
	Former SU Ann B	496	819	0,0	**0**	496	ns	71,5	0	-147,6	-10 559	**-10 559**	10 559	ns
	Former SU Non Ann	110	110	0,0	**0**	108	ns	59,6	69	-2,0	-147	**-78**	78	ns
	India	426	426	0,0	**0**	420	ns	59,6	202	-6,1	-434	**-231**	231	ns
	R South Asia	82	82	0,0	**0**	81	ns	59,6	24	-0,7	-52	**-27**	27	ns
	Korea	140	140	0,0	**0**	139	ns	59,6	40	-1,2	-83	**-43**	43	ns
	R South-East Asia	392	392	0,0	**0**	387	ns	59,6	188	-5,6	-400	**-212**	212	ns
	China	1 612	1 612	0,0	**0**	1 567	ns	59,6	1 332	-44,9	-3 210	**-1 878**	1 878	ns
	Japan	345	279	196,1	**5 463**	312	50%	50,0	587	32,9	1 645	**2 232**	3 231	-59%
	Australia + New Zea	123	88	110,9	**1 700**	104	54%	50,0	447	16,0	798	**1 245**	455	-27%
	WORLD	8 186	7 711		**55 028**	7 648			12 993	112,4	57	**13 050**	41 978	-76%
	JUSCANZ	2 322	1 716	618	**38 980**	2 018	50%		6 389	302	15 086	**21 476**	17 504	-45%
	EU	983	816	83,6	**15 164**	875	65%		2 622	59	2 806	**5 428**	9 736	-64%
	Non Ann B - China	2 322	2 322	0	**0**	2 291	ns		1 036	-31	-2 232	**-1 196**	1 196	ns
	Non Ann B	3 933	3 933	0	**0**	3 857	ns		2 368	-76	-5 442	**-3 073**	3 073	ns

Case 8: Concrete Ceilings, with VCP and ESP

ASPEN-sd : **CASE 8 EU Concrete Ceilings, with VCP and ESP**

Reminder:		NO TRADE				TRADE		**Permit Price =**	**0,0**	**$90/tC**			GAINS from TRADE	
CC/IMP	POLES 32 regions	REFER	TARGET	MAC	**TAC**	EMISS	DOM / TOT	MAC	DOM AC	TRADE	TRADE	**TAC**		
50%		MtC	MtC	$90/tC	**M$90**	MtC	%	$90/tC	M$90	MtC	M$90	**M$90**	M$90	%
CC/EXP	USA	1 716	1 240	144,6	**29 636**	1 478	50%	50,0	5 093	237,9	11 896	**16 988**	12 648	-43%
100%	Canada	139	109	166,3	**2 181**	124	50%	50,0	263	15,0	748	**1 011**	1 170	-54%
CDM AF	Mexico	163	163	0,0	**0**	161	ns	57,3	45	-1,4	-93	**-49**	49	ns
10%	R Central America	57	57	0,0	**0**	57	ns	57,3	14	-0,4	-28	**-15**	15	ns
CDM TC	Brasil	147	147	0,0	**0**	146	ns	57,3	38	-1,4	-94	**-55**	55	ns
20%	R South America	149	149	0,0	**0**	146	ns	57,3	72	-2,4	-165	**-93**	93	ns
AL/ET	France	121	104	185,1	**1 350**	113	50%	50,0	144	8,2	411	**555**	795	-59%
5	Germany	236	210	52,3	**643**	204	ns	68,7	1 047	-5,7	-390	**656**	-14	2%
AL/CDM	Italy	123	103	278,7	**2 454**	113	50%	50,0	153	10,0	500	**653**	1 801	-73%
5	United-Kingdom	168	141	107,8	**1 274**	153	57%	50,0	361	11,8	592	**953**	320	-25%
HA Exclus	R EU North	206	146	381,2	**8 763**	176	50%	50,0	548	29,9	1 494	**2 042**	6 720	-77%
283	R EU South	131	112	82,8	**680**	118	67%	50,0	290	5,9	296	**586**	94	-14%
	R Western Europe	28	21	229,9	**619**	25	50%	50,0	52	3,2	158	**210**	410	-66%
VCP	Turkey	84	84	0,0	**0**	83	ns	57,3	44	-1,5	-100	**-57**	57	ns
50	Egypt	36	36	0,0	**0**	35	ns	57,3	12	-0,4	-26	**-14**	14	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	57,3	4	-0,1	-9	**-5**	5	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	57,3	14	-0,5	-33	**-19**	19	ns
	Gulf	231	231	0,0	**0**	229	ns	57,3	72	-2,3	-159	**-87**	87	ns
	R Middle-East	48	48	0,0	**0**	47	ns	57,3	16	-0,5	-36	**-20**	20	ns
	South of Sahara Afr	317	317	0,0	**0**	311	ns	57,3	213	-6,4	-437	**-224**	224	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	175	ns	68,7	1 108	-17,2	-1 179	**-71**	327	-128%
	R East Eur Ann B	67	65	11,6	**9**	58	ns	68,7	268	-6,7	-460	**-192**	202	-2124%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	57,3	13	-0,4	-28	**-15**	15	ns
	Former SU Ann B	496	819	0,0	**0**	496	ns	68,7	0	-144,1	-9 898	**-9 898**	9 898	ns
	Former SU Non Ann	110	110	0,0	**0**	108	ns	57,3	64	-2,0	-137	**-73**	73	ns
	India	426	426	0,0	**0**	420	ns	57,3	188	-5,9	-404	**-216**	216	ns
	R South Asia	82	82	0,0	**0**	81	ns	57,3	23	-0,7	-48	**-25**	25	ns
	Korea	140	140	0,0	**0**	139	ns	57,3	37	-1,1	-77	**-40**	40	ns
	R South-East Asia	392	392	0,0	**0**	387	ns	57,3	175	-5,4	-374	**-199**	199	ns
	China	1 612	1 612	0,0	**0**	1 568	ns	57,3	1 252	-44,0	-3 020	**-1 768**	1 768	ns
	Japan	345	279	196,1	**5 463**	312	50%	50,0	587	32,9	1 645	**2 232**	3 231	-59%
	Australia + New Zea	123	88	110,9	**1 700**	104	54%	50,0	447	16,0	798	**1 245**	455	-27%
	WORLD	8 186	7 711		**55 028**	7 652			12 657	120,4	1 341	**13 998**	41 030	-75%
	JUSCANZ	2 322	1 716	618	**38 980**	2 018	50%		6 389	302	15 086	**21 476**	17 504	-45%
	EU	983	816	83,6	**15 164**	876	64%		2 544	60	2 902	**5 446**	9 718	-64%
	Non Ann B - China	2 322	2 322	0	**0**	2 291	ns		966	-30	-2 083	**-1 116**	1 116	ns
	Non Ann B	3 933	3 933	0	**0**	3 859	ns		2 219	-74	-5 103	**-2 884**	2 884	ns

Case 2c: World Full Trade with Extended Share of Proceeds on CDM and IET + 50 % Hot Air Exclusion

ASPEN-sd : **CASE 2c Full Trade with Extended Share of Proceeds on CDM and IET + 50 % Hot Air Excl.**

Reminder:		NO TRADE				TRADE			**Permit Price =**	**66,1**	**$90/tC**		GAINS from TRADE	
CC/IMP 100%	POLES 32 regions	REFER MtC	TARGET MtC	MAC $90/tC	**TAC M$90**	EMISS MtC	DOM / TOT %	MAC $90/tC	DOM AC M$90	TRADE MtC	TRADE M$90	**TAC M$90**	M$90	%
CC/EXP 100%	USA	1 716	1 240	144,6	**29 636**	1 448	56%	66,1	8 262	208,0	13 751	**22 013**	7 623	-26%
CDM AF 10%	Canada	139	109	166,3	**2 181**	124	48%	66,1	436	15,4	1 021	**1 457**	724	-33%
CDM TC 20%	Mexico	163	163	0,0	**0**	162	ns	50,9	36	-1,2	-75	**-39**	39	ns
AL/ET 5	R Central America	57	57	0,0	**0**	57	ns	50,9	11	-0,4	-23	**-12**	12	ns
AL/CDM 5	Brasil	147	147	0,0	**0**	146	ns	50,9	32	-1,3	-77	**-45**	45	ns
HA Exclus 162	R South America	149	149	0,0	**0**	146	ns	50,9	67	-2,3	-143	**-75**	75	ns
	France	121	104	185,1	**1 350**	114	44%	66,1	229	9,2	609	**838**	512	-38%
	Germany	236	210	52,3	**643**	206	ns	61,1	854	-3,8	-235	**619**	24	-4%
	Italy	123	103	278,7	**2 454**	116	31%	66,1	199	13,8	909	**1 108**	1 346	-55%
	United-Kingdom	168	141	107,8	**1 274**	149	70%	66,1	579	8,1	534	**1 113**	161	-13%
	R EU North	206	146	381,2	**8 763**	187	31%	66,1	568	41,4	2 734	**3 301**	5 461	-62%
	R EU South	131	112	82,8	**680**	115	84%	66,1	465	2,9	191	**656**	24	-4%
	R Western Europe	28	21	229,9	**619**	25	39%	66,1	77	3,8	254	**331**	288	-47%
VCP 200	Turkey	84	84	0,0	**0**	83	ns	50,9	37	-1,3	-82	**-46**	46	ns
	Egypt	36	36	0,0	**0**	35	ns	50,9	10	-0,3	-21	**-11**	11	ns
	North Africa Non OP	18	18	0,0	**0**	18	ns	50,9	3	-0,1	-7	**-4**	4	ns
	North Africa OPEP	31	31	0,0	**0**	30	ns	50,9	12	-0,4	-27	**-15**	15	ns
	Gulf	231	231	0,0	**0**	229	ns	50,9	59	-2,1	-129	**-70**	70	ns
	R Middle-East	48	48	0,0	**0**	47	ns	50,9	13	-0,5	-29	**-16**	16	ns
	South of Sahara Afr	317	317	0,0	**0**	311	ns	50,9	171	-5,7	-348	**-177**	177	ns
	Pol+Hung+Cs+Slov	209	193	31,4	**256**	179	ns	61,1	895	-13,9	-848	**47**	208	-82%
	R East Eur Ann B	67	65	11,6	**9**	59	ns	61,1	219	-5,9	-363	**-144**	154	-1617%
	R East Eur Non Ann	38	38	0,0	**0**	38	ns	50,9	11	-0,4	-23	**-12**	12	ns
	Former SU Ann B	496	819	0,0	**0**	496	ns	61,1	0	-255,8	-15 629	**-15 629**	15 629	ns
	Former SU Non Ann	110	110	0,0	**0**	108	ns	50,9	52	-1,8	-110	**-58**	58	ns
	India	426	426	0,0	**0**	421	ns	50,9	153	-5,3	-326	**-173**	173	ns
	R South Asia	82	82	0,0	**0**	81	ns	50,9	18	-0,6	-39	**-20**	20	ns
	Korea	140	140	0,0	**0**	139	ns	50,9	30	-1,0	-62	**-32**	32	ns
	R South-East Asia	392	392	0,0	**0**	387	ns	50,9	143	-4,9	-301	**-159**	159	ns
	China	1 612	1 612	0,0	**0**	1 571	ns	50,9	1 054	-40,8	-2 495	**-1 440**	1 440	ns
	Japan	345	279	196,1	**5 463**	315	45%	66,1	915	36,4	2 405	**3 320**	2 143	-39%
	Australia + New Zea	123	88	110,9	**1 700**	99	68%	66,1	729	11,1	733	**1 462**	238	-14%
	WORLD	8 186	7 711		**55 028**	7 644			16 339	0,0	1 751	**18 090**	36 939	-67%
	JUSCANZ	2 322	1 716	618	**38 980**	1 987	55%		10 342	271	17 910	**28 252**	10 728	-28%
	EU	983	816	83,6	**15 164**	888	57%		2 894	71	4 742	**7 636**	7 528	-50%
	Non Ann B - China	2 322	2 322	0	**0**	2 294	ns		795	-28	-1 688	**-893**	893	ns
	Non Ann B	3 933	3 933	0	**0**	3 865	ns		1 849	-68	-4 182	**-2 333**	2 333	ns

2 BLUEPRINTS FOR THE INTERNATIONAL CLIMATE NEGOTIATION - BEFORE AND AFTER COP6 BIS IN BONN

Introduction

The ASPEN-sd2 software used in this second study is an extension of the ASPEN-sd software described in the part II of this document. Although it is based on exactly the same principles, it has some extra features.

First of all there are now 38 countries/regions studied, instead of 32 previously. The 6 new countries come from the (almost) complete desegregation of the EU (the only remaining aggregate is Belgium + Luxembourg).

In addition to the previous tests (concrete ceilings, CDM, Share of Proceeds, Safety Valve and Hot Air Exclusion), this version allows to test:

the use by the different parties of any quantity of **Sinks,** through Article 3.3, 3.4 or through CDM projects. The quantity is added to the Party's Assigned Amount. Are tested combinations of the proposed quantities for sinks under Art. 3.4 forest management, Art. 3.4 agriculture management, Art. 3.3 credits and sinks through CDM projects for the different countries

following the US withdrawal from the negotiation process, ASPEN-sd2 allows to simulate the impact of the **Participation or non-Participation** of any Party

the set of **Objectives** for 2010 other than Kyoto's

finally the application of the **Share of Proceeds** can now be differentiated following a Annex B / Non-Annex B / Least Developed Countries partition.

Two studies have been carried out with that tool: before and after the Bonn Conference in Bonn in July 2001.

In the first part of this chapter we present a preparatory study for the "COP-6 II" Conference in Bonn with the assessment of five exploratory climate negotiation scenarios.

The second part is an analysis of the political agreement reached in Bonn and draws some conclusions on outstanding issues that will have to be dealt with in the future COP meetings.

2.1 On the road to Marrakech, coming from the Hague via Bonn: Economic Assessment of Five Exploratory Climate Negotiation Scenarios

This study aims at identifying and assessing a limited set of scenarios for the international climate negotiation. In particular it explores, after the The Hague failure, new paths for negotiation while looking into two clearly distinct – but probably complementary – directions: on one hand the re-negotiation of the Kyoto Protocol quantitative targets and on the other, the building of a “Limited Protocol” that would be based on the Kyoto targets, but in which not all the Annex B countries would participate.

Section 1. describes the situation after the COP-6 Conference and provides a comparison of a simple “Kyoto Full-Trade” case (1a.) with a more complex case (1b.) incorporating all the specific features of the Pronk Package II[2]. The latter case 1b. will in all occurrences be considered as the initial or “Reference” case for the assessment of alternative scenarios. It allows to describe the structure of performance and costs for emission reduction policies that may have resulted from an agreement in the The Hague conference, including the corresponding subsequent adjustments. It may also

[2] As defined in the “New Proposals by President of COP6” paper of April 09, 2001

represent a scenario – maybe still possible, but highly unlikely – of a new negotiation and decision, on the very grounds that led to a no agreement situation in last November.

The study then considers, respectively in **Section 2.** and **Section 3.**, the possibility of the US deciding not to ratify the Kyoto Protocol as it is but:

either requiring a re-negotiation of the quantitative targets that in some sense constituted the pillars of the Kyoto Protocol,

or deciding not to participate for the moment in any international Protocol on Climate Change, leaving the other Annex B parties to their decision of advancing or not in the building of an international system for reducing GHG emissions.

In **Section 2.**, the "Kyoto re-negotiation" family of scenarios describes two simple options – among a quasi-infinity of alternative possibilities. Both result from a redefinition of the base for the calculation of targets, which is now considered not as the 1990 emissions, but as the average 1990-1998 emissions for each party[3] (see **Annex 2** for the details of the new targets):

the first case (2a.) is called "Hard Target" and applies the reduction targets of the Kyoto Protocol to the average 1990-1998 yearly emissions, instead of merely to the 1990 level;

the second (2b.) is a "Soft Target" case and only considers a stabilisation of emissions in 2010, relatively to the 1990-1998 average; it is thus – at least at this stage – an undifferentiated flat rate scenario.

In **Section 3.**, the "Limited Protocol" perspective is explored while assuming that the US do not participate, while the other Annex B Parties stick to their Kyoto commitments. In the first case (3a), a full-trade system is simulated, which includes however a hot air exclusion process, as the amount of hot air is superior to the emission reductions required from the other parties (see **Annex 3** for further details on the impacts of US withdrawal). The second case (3b.) is a very similar one, except that it is supposed that, in order to limit potential negative economic effects, the parties to the "Limited Protocol" decide to introduce a "compliance payment" system, which then feeds a Climate Investment Fund for emission reduction projects in JI and CDM[4].

It probably has to be emphasised that in all "without US" scenarios the issue of the "Technology-Ratification Linkage", as introduced by B. Müller[5] appears of the highest importance : this concept implies that the selling of clean technologies, in the context of Kyoto flexibility mechanisms, would only be open to companies with corresponding manufacturing activities located in countries having ratified the Protocol. This would be particularly important in the case of a "compliance payment + investment fund" scheme, where a multinational institution, representing the parties to the Protocol may have to certify and finance a large quantity of CDM-JI projects.

All the different cases – which cover a broad but in no way exhaustive range of options – are simulated while using the POLES model results and analysing them with the ASPENsd2 software[6].

One of the preliminary conclusions of this study is that levels of emission reductions comparable to those of the "pure" Kyoto Protocol may be reached either through a re-negotiation, or a "limited Protocol" solution. Costs would of course significantly vary for the different partners according to the case considered, but it can be considered in this analysis that – except maybe in the "re-negotiation + hard targets" case – both the total Annex B cost and the costs for each Party remain in an a priori acceptable range.

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[3] This idea stems from a discussion with J.M. Salmon, D4E, Ministère de l'Aménagement du Territoire et de l'Environnement. The fact of calculating the base for targets as an average of the 1990-1998 emissions (by lack of full commonly agreed data on emissions for the entire decade) allows to better take into account the on-going trends of the nineties, be it for countries with high emission profiles (e.g. the US) or for those with low or decreasing emission profiles (e.g. the Economies In Transition).

[4] The basic concepts of the Compliance Payment + Investment Fund system are described in Kopp R., Morgenstern R. and Pizer W. [2000] "Limiting Cost, Assuring Effort and Encouraging Ratification: Compliance under the Kyoto Protocol ", Resources For the Future

[5] B. Müller [2001], "The Kyoto Mechanisms: Linking Technology to Ratification", Oxford Institute for Energy Studies

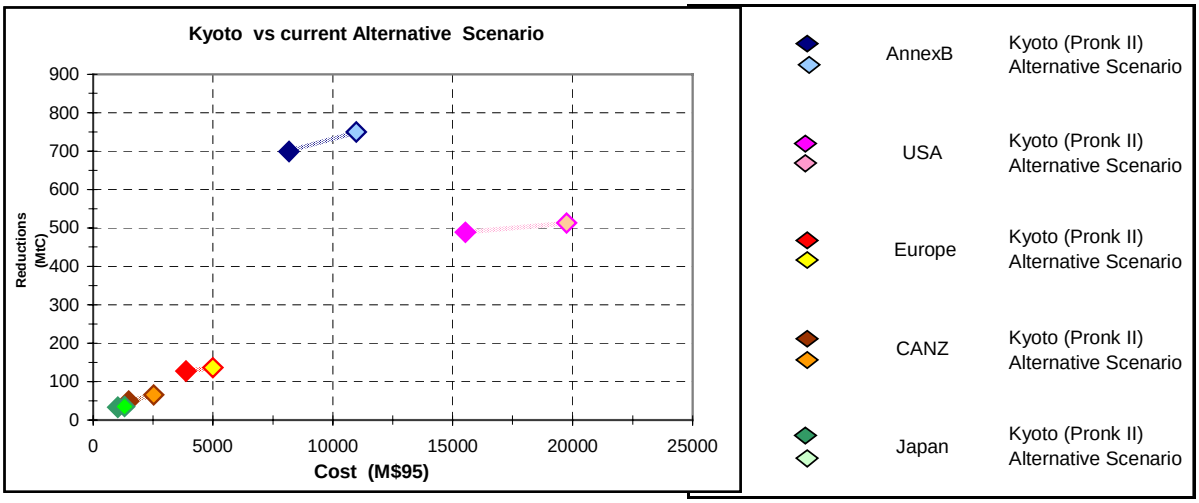
2.1.1 The "Kyoto Protocol + Pronk Package" case, compared with a simple "Kyoto Full-Trade" case

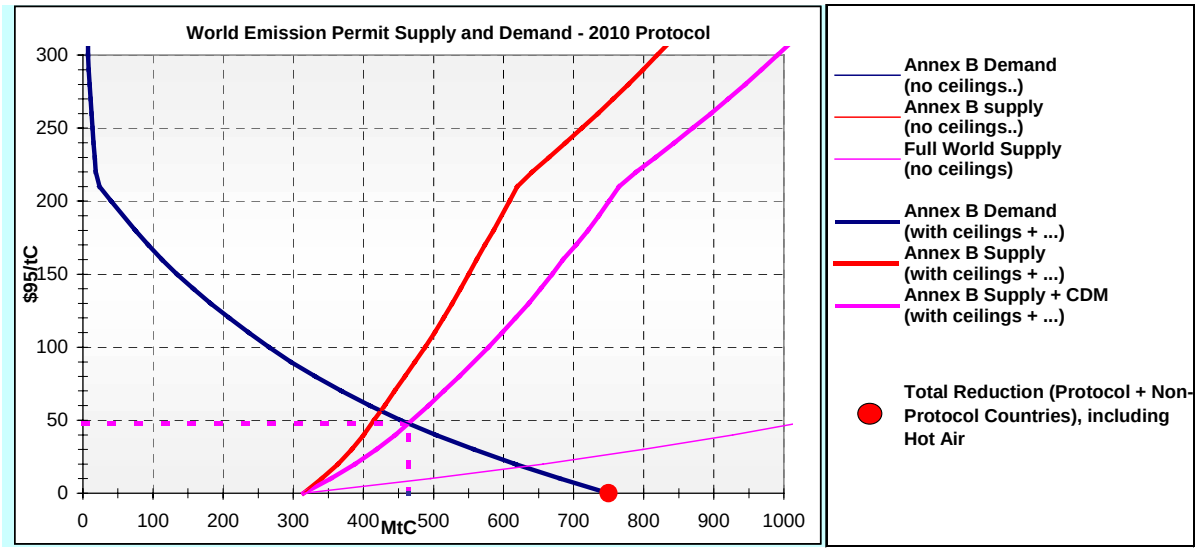
- *Case 1a: a simple Kyoto Full-Trade case*

This scenario describes a full trade Kyoto Protocol, with no sinks introduction and no Share of Proceeds. The access to CDM projects in Non-Annex B countries is set at 10% of the potential total emissions reductions in these countries. Transaction costs for CDM are arbitrarily set at 20% of the reductions costs.

Results summary of current scenario

	KYOTO + Pronk II		NEW PROTOCOL								
Countries	TAC	Reductions	Participation to Protocol	MAC (permit price or SV)	TAC	Effective Reductions	Domestic Reductions	Hot Air	IET / JI	CDM	Sinks
USA	15523	489	**Yes**	**47.8**	**19755**	**513**					
Europe	3878	128	**Yes**	**47.8**	**4990**	**136**					
CANZ	1488	49	**Yes**	**47.8**	**2538**	**66**					
Japan	1035	33	**Yes**	**47.8**	**1321**	**35**					
FSU	-11955	0	**Yes**	**47.8**	**-15286**	**0**					
EEE	-1795	0	**Yes**	**47.8**	**-2343**	**0**					
Protocol Countries	8174	699		**47.8**	**10974**	**750**	**286**	**315**	**97**	**52**	**0**
Non-Protocol Countries	0	0		**-**	**0**	**0**	**0**				
Annex B	8174	699			**10974**	**750**	**286**				





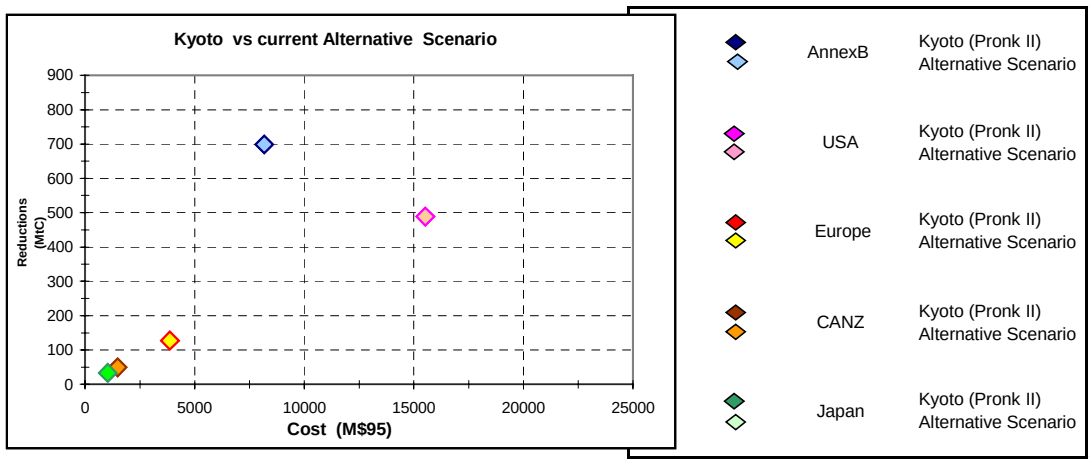
- *Case 1b: the "Kyoto Protocol + Pronk Package" case*

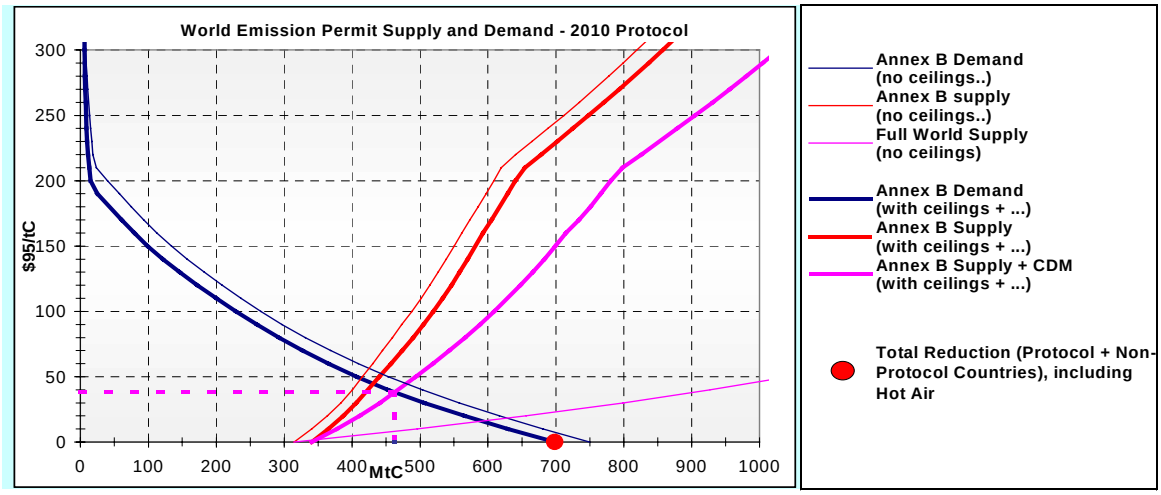
This case describes fully the Kyoto Protocol and incorporates all the elements of the 09/04/2001 Pronk proposal (referred to as "Pronk II"). As in the Scenario 1a. above, the access to CDM projects in Non-Annex B countries is set at 10% and transaction costs for CDM are set at 20% of the reductions costs.

This scenario includes sinks as in the Pronk II paper (figures for art.3.4 are based on FAO data in the 2nd tier). The Share of Proceeds is limited to 2% on the CERs generated by CDM, as in the Pronk II paper (page 3), and is set at 6% on the CERs generated by IET in order to reach the 1 billion 95$ fund for the less developed countries mentioned in the Pronk II paper (page 4). The Least Developed Countries are exempted from any Share of Proceeds.

Results summary of current scenario

	KYOTO + Pronk II		NEW PROTOCOL								
Countries	TAC	Reductions	Participation to Protocol	MAC (permit price or SV)	TAC	Effective Reductions	Domestic Reductions	Hot Air	IET / JI	CDM	Sinks
USA	15523	489	**Yes**	**38.2**	**15523**	**489**					
Europe	3878	128	**Yes**	**38.2**	**3878**	**128**					
CANZ	1488	49	**Yes**	**38.2**	**1488**	**49**					
Japan	1035	33	**Yes**	**38.2**	**1035**	**33**					
FSU	-11955	0	**Yes**	**38.2**	**-11955**	**0**					
EEE	-1795	0	**Yes**	**38.2**	**-1795**	**0**					
Protocol Countries	8174	699		**38.2**	**8174**	**699**	**236**	**341**	**79**	**43**	**52**
Non-Protocol Countries	0	0		**-**	**0**	**0**	**0**				
Annex B	8174	699			**8174**	**699**	**236**				





All the costs are lower in the Pronk proposal than in the 'full trade - no sinks option' (-22% for Western Europe and Japan, -41% for CANZ and -21% for the US) while the overall environmental effectiveness is not much affected (700 MtC reductions vs 750 MtC, for energy only reductions, i.e. net from sinks). The permit price is lower than in the 'full trade - no sinks' option: 38.2$/tC vs 47.8$/tC. Because of

lower trade and permit prices, the benefits for hot air exporting countries, the FSU and the EEE, are less important.

The presence of sinks implies a decrease in the emissions reductions required, but also an increase of the volume of hot air available due to the importance of sinks in hot air exporting countries, Russia in particular. It adds a volume of 26.2 MtC behaving like hot air. Therefore, not only is the demand for permits slightly lower but also is the supply of 'zero cost' emissions reductions more important, explaining the lower permit price as well as the reduced Total Abatement Cost for the different Parties.

It appears from this comparison that, thanks to the different constraints introduced for the inclusion of sinks, the results of the Pronk Package II do not show large differences with the simple Kyoto full-trade no-sinks case: in brief it reduces the price and costs for the energy sector of about 20 % for a decrease of only 7% in the energy sector emission reductions.

2.1.2 The “Kyoto re-negotiation” cases

As stated above, individual targets are recalculated, or 'renegotiated', but the overall architecture of the protocol remains (full participation, full trading within the Annex B, CDM, etc..). In the two cases examined below, all the other parameters are set as in the Kyoto scenario: 10% CDM access with transaction costs at 20%, Shares of proceeds: 2% for CDM, 6% for IET, 0% in the case of LDCs. All available hot air is traded during the first commitment period.

QERLOs for 2010 are renegotiated as such (the detailed hypotheses and results in terms of targets can be found in **Annex 2**):

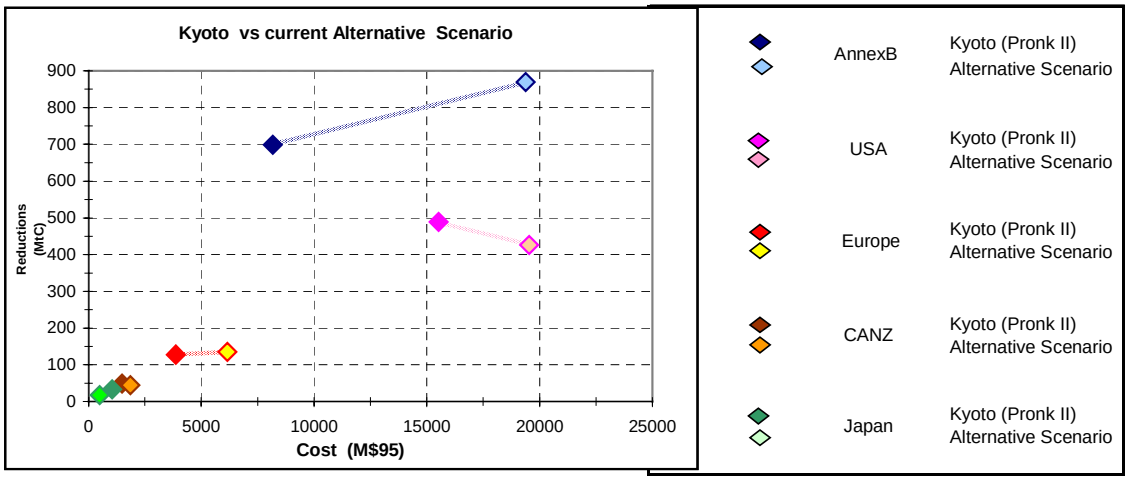
a. 'Hard Target': Kyoto QELROs applied on the 1990-1998 average emission

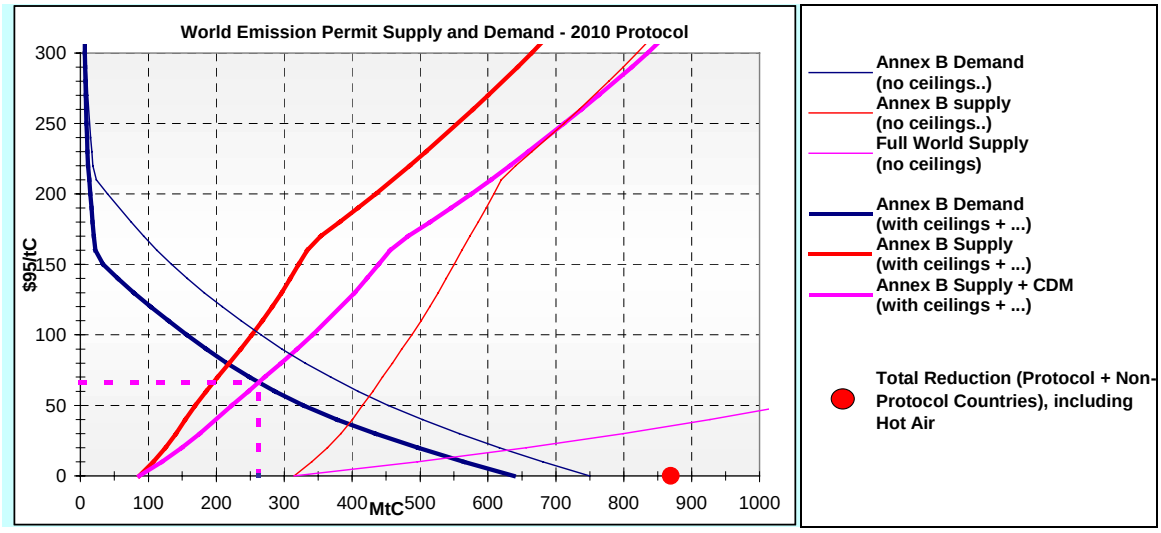
b. 'Soft Target': 100% of the 1990-1998 average emissions

- *Case 2a. "Re-negotiation + Hard Targets"*

Results summary of current scenario

Countries	KYOTO + Pronk II		NEW PROTOCOL								
	TAC	Reductions	Participation to Protocol	MAC (permit price or SV)	TAC	Effective Reductions	Domestic Reductions	Hot Air	IET / JI	CDM	Sinks
USA	15523	489	**Yes**	**66.4**	**19530**	**426**					
Europe	3878	128	**Yes**	**66.4**	**6148**	**135**					
CANZ	1488	49	**Yes**	**66.4**	**1846**	**44**					
Japan	1035	33	**Yes**	**66.4**	**495**	**18**					
FSU	-11955	0	**Yes**	**66.4**	**-8670**	**213**					
EEE	-1795	0	**Yes**	**66.4**	**43**	**33**					
Protocol Countries	8174	699		**66.4**	**19391**	**869**	**376**	**318**	**109**	**67**	**56**
Non-Protocol Countries	0	0		**-**	**0**	**0**	**0**				
Annex B	8174	699			**19391**	**869**	**376**				

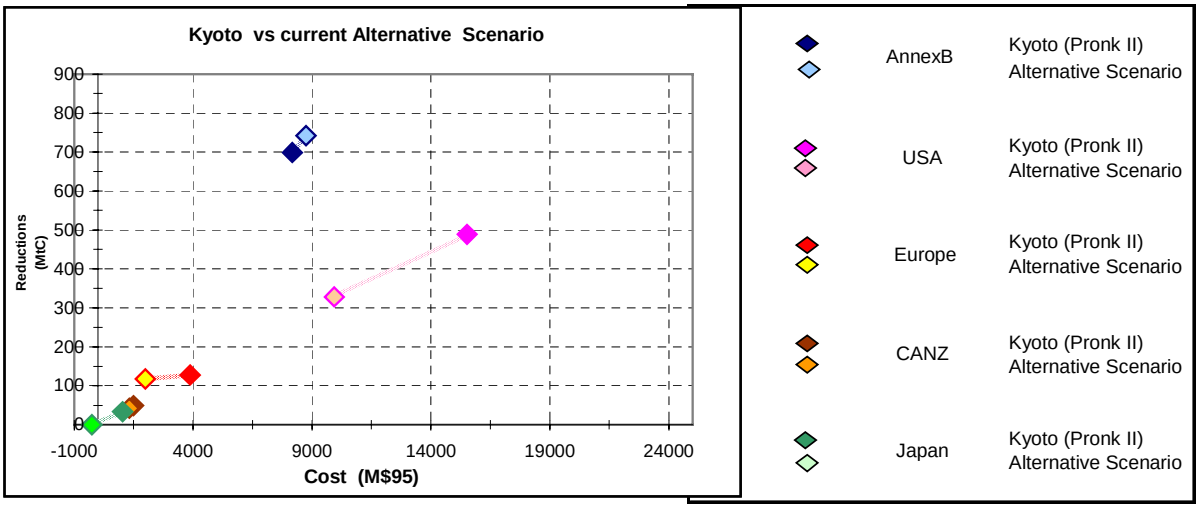


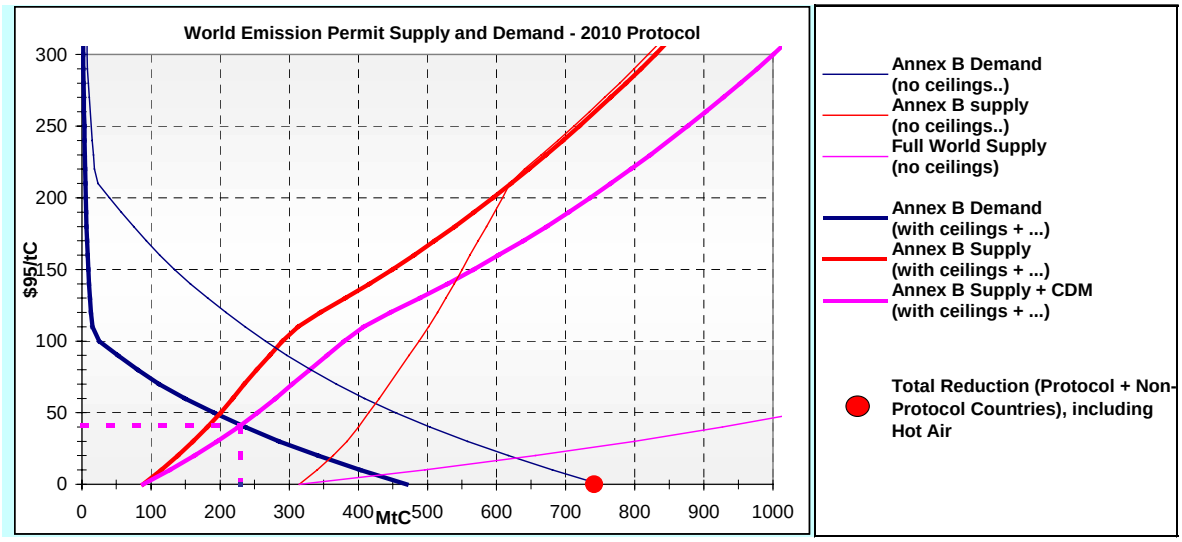


- *Case 2b. "Re-negotiation + Soft Targets"*

Results summary of current scenario

Countries	KYOTO + Pronk II		NEW PROTOCOL								
	TAC	Reductions	Participation to Protocol	MAC (permit price or SV)	TAC	Effective Reductions	Domestic Reductions	Hot Air	IET / JI	CDM	Sinks
USA	15523	489	**Yes**	**41.4**	**9933**	**328**					
Europe	3878	128	**Yes**	**41.4**	**1991**	**117**					
CANZ	1488	49	**Yes**	**41.4**	**1314**	**43**					
Japan	1035	33	**Yes**	**41.4**	**-261**	**0**					
FSU	-11955	0	**Yes**	**41.4**	**-4778**	**213**					
EEE	-1795	0	**Yes**	**41.4**	**543**	**41**					
Protocol Countries	8174	699		**41.4**	**8743**	**741**	**239**	**360**	**96**	**46**	**56**
Non-Protocol Countries	0	0		**-**	**0**	**0**	**0**				
Annex B	8174	699			**8743**	**741**	**239**				





In these cases two parameters act in opposite directions: the impact of objectives modification on the demand of emissions reductions and the impact on the supply of hot air. These effects move the supply and demand curves to the left, with higher total reductions and price in the "hard target" case than in the Kyoto Pronk II, but for the "soft target" very similar levels.

First of all, the traditionally importing countries see their target become less stringent, as most of them had an increase in their CO2 emissions since 1990. On the other hand, the redefinition of the QERLOs reduces the volume of tradable hot air coming from the traditionally exporting countries: Ann B-FSU and Eastern Europe (the latter even becomes an importer of permits in both the 'soft target' and the 'hard target' cases).

We can see that in the 'soft target' case the gain from the set of new targets exceeds the loss due to the reduction of the volume of hot air, ie due to the reduction of cheap emissions reductions. To meet the objective is much less costly for the US, Western Europe, CANZ and Japan. However, revenues to the FSU and EE are much less important in that case, in particular the EE have now a positive cost to meet their new objective. While the permit price is now of 41.4$/tC, the environmental effectiveness of such an agreement is about the same as in the Kyoto-Pronk proposal (however it must be noticed that only 106 MtC of the present 360 MtC of 'natural' hot air are traded, there remains then 254 MtC of unused 'natural' hot air that are included in the overall 741 MtC of emission reductions -as they contribute indeed to the reduction of emissions flux towards the atmosphere- (see **Annex 3** for the detailed procedure used to calculate 'natural' and tradable Hot Air in the particular case of the Bonn Agreement).

In the 'hard target' case, the new targets are more stringent for importing countries and the impact is amplified hot air reduction. In that case, only Japan reduces its TAC. The overall cost is more than twice the cost in the Kyoto Pronk II case. The permit price is 66.4$/tC and the total reduction is much larger than in the Kyoto Pronk II case: 869MtC vs 699MtC (although, as above, 213 MtC + 41 MtC of the 869 MtC are unused hot air coming from FSU and EEE).

2.1.3 The Limited Participation Protocol cases

This last option was only considered as the remaining option for Europe and the other Parties if the on-going negotiation cannot lead to a full Annex B agreement. The agreement achieved in Bonn has made the analysis obsolete.

In these cases it is assumed that the US do not participate to the protocol and only introduce a relatively modest purely domestic policy, which is simulated here by means of a "Safety Valve" established at a low level of 25$/tC. As identified in **Annex 3** the withdrawal of the US results in a Hot Air surplus, relatively to the reduction required from other parties. This is why these cases also suppose that some agreement is reached with the "hot air countries" in order to limit the quantity of hot air in the market, but intensify large scale projects in Joint Implementation schemes. The Share of Proceeds is set at 2% for CDM (0% in the case of LDCs) and 6% for IET. Sinks are set following Pronk II, except for sinks generating some additional hot air (in FSU and EEE), which are set to zero.

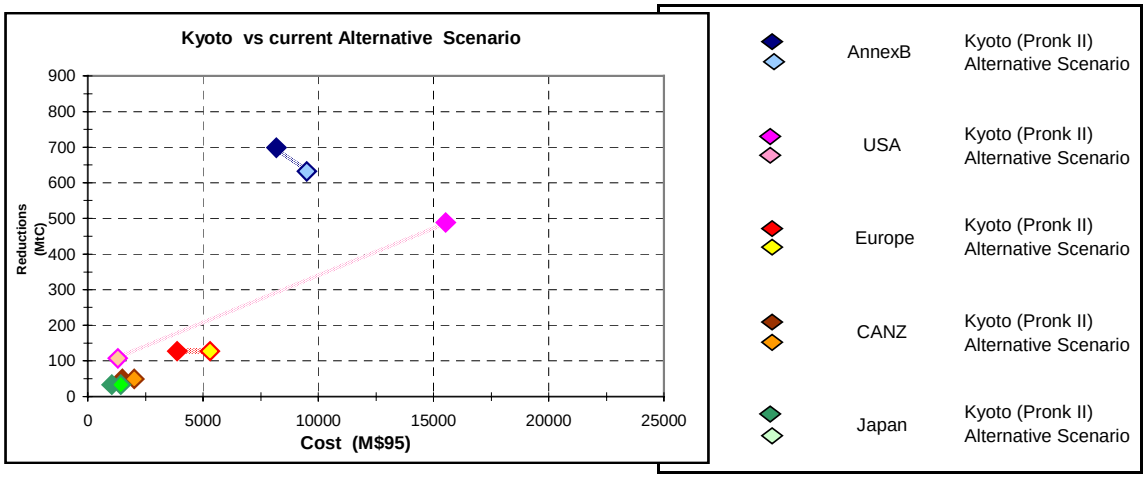
Two cases are then identified: the first one is a full-trade case among the Protocol Parties (i.e. Annex B parties minus the US), with only the above mentioned restriction on hot air; in the second one it is assumed that in order to reduce the risks of adverse economic effects relatively to countries that do not participate in the Protocol, the Parties decide to introduce a "compliance payment" or "safety valve" at 50$/tC; it is also assumed that the money channelled through the compliance payment system is directed to a "Climate Investment Fund" that organises, through a reverse auction system the certification and financing of JI-CDM projects[7].

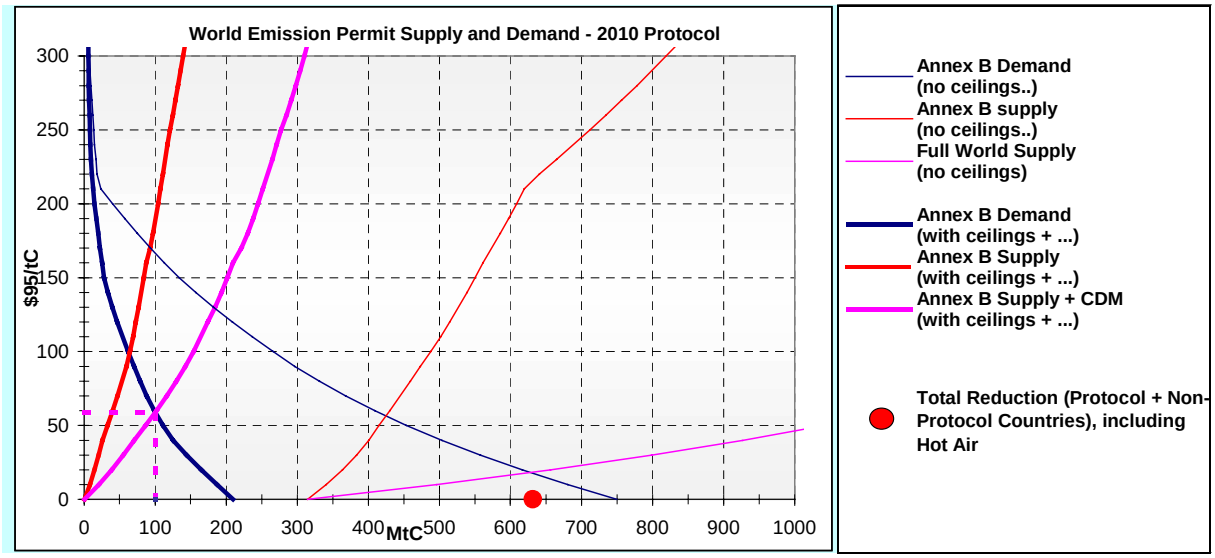
[7] Kopp R., Morgenstern R. and Pizer W. [2000], op.cit.

- *Case 3a. a "Limited Protocol + Full-Trade"*

Results summary of current scenario

	KYOTO + Pronk II		NEW PROTOCOL								
Countries	TAC	Reductions	Participation to Protocol	MAC (permit price or SV)	TAC	Effective Reductions	Domestic Reductions	Hot Air	IET / JI	CDM	Sinks
USA	15523	489	**No**	**25.0**	**1291**	**107**					
Europe	3878	128	**Yes**	**58.8**	**5299**	**128**					
CANZ	1488	49	**Yes**	**58.8**	**2010**	**49**					
Japan	1035	33	**Yes**	**58.8**	**1426**	**33**					
FSU	-11955	0	**Yes**	**58.8**	**-1388**	**277**					
EEE	-1795	0	**Yes**	**58.8**	**-439**	**38**					
Protocol Countries	8174	699		**58.8**	**8199**	**524**	**110**	**315**	**39**	**61**	**28**
Non-Protocol Countries	0	0		**25**	**1291**	**107**	**107**				
Annex B	8174	699			**9491**	**632**	**217**				



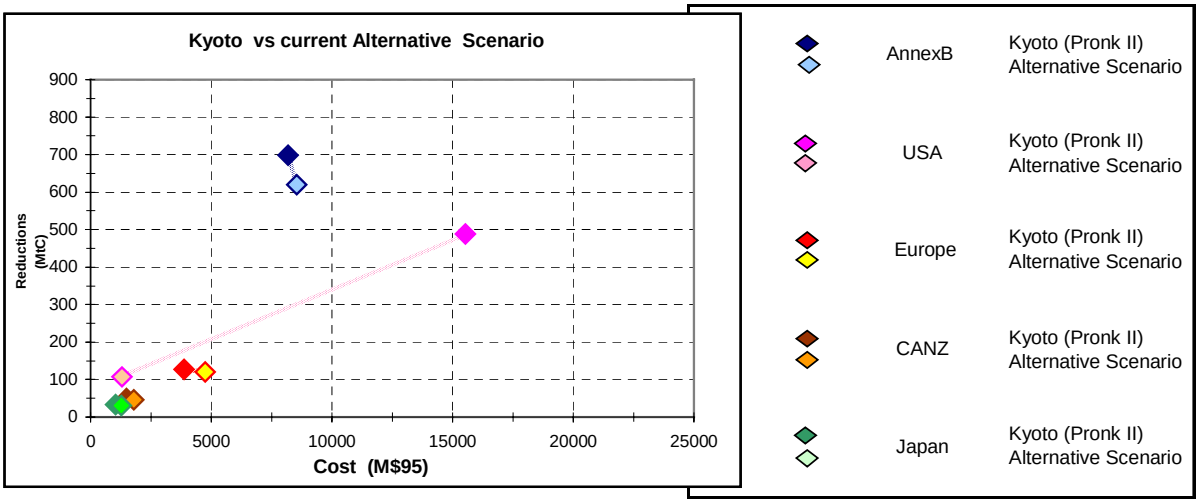


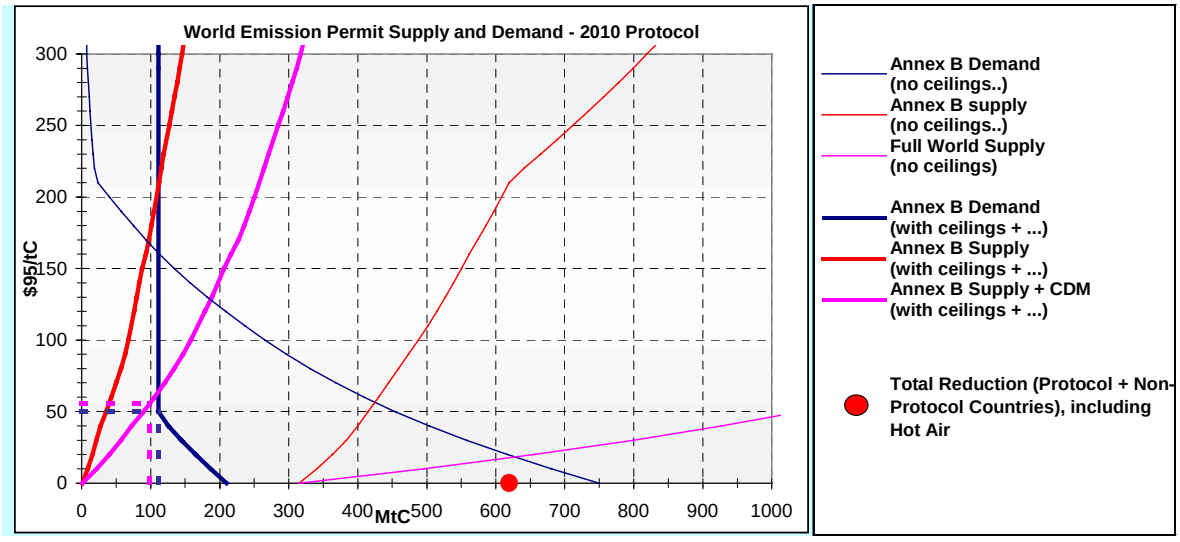
In that case, 315 MtC (277 MtC + 38 MtC) of the reductions (that amount to 632 MtC) come from the unused hot air coming from the FSU and EEE (no hot air is traded in this scenario).Indeed, although hot air is not traded, the reductions in emissions of 315 MtC that occur in FSU and EEE anyway have to be taken into account in the overall reductions.

- *Case 3b. a "Limited Protocol + Compliance Payment and Climate Investment Fund"*

Results summary of current scenario

	KYOTO + Pronk II		NEW PROTOCOL								
Countries	TAC	Reductions	Participation to Protocol	MAC (permit price or SV)	TAC	Effective Reductions	Domestic Reductions	Hot Air	IET / JI	CDM	Sinks
USA	15523	489	**No**	**25.0**	**1291**	**107**					
Europe	3878	128	**Yes**	**50.0**	**4752**	**120**					
CANZ	1488	49	**Yes**	**50.0**	**1781**	**46**					
Japan	1035	33	**Yes**	**50.0**	**1272**	**31**					
FSU	-11955	0	**Yes**	**50.0**	**-1408**	**277**					
EEE	-1795	0	**Yes**	**50.0**	**-445**	**38**					
Protocol Countries	8174	699		**50.0**	**7242**	**512**	**99**	**315**	**39**	**59**	**28**
Non-Protocol Countries	0	0		**25**	**1291**	**107**	**107**				
Annex B	8174	699			**8534**	**620**	**206**				





Both cases present higher TACs, or lower benefits, for all Protocol Parties than the Pronk Package. The impact of the introduction of a 50$/tC is clear in that it reduces the cost for all Parties to meet their targets. As a counterpart, the introduction of the compliance payment also lowers slightly the environmental effectiveness, with a total reduction of 620 MtC in Case 3b vs 632 MtC in the Case 3a. In the two configurations however and assuming that the US sticks to an internal "safety valve" at 25$/tC (and does all its 107 MtC reductions, corresponding to the total reductions with a MAC below 25 $/tC), although lower, the reductions keep fairly close to the reductions achieved in the Pronk Package. Of course it has to be emphasised that the domestic reduction undertaken by the US – that

very probably cannot be counted as zero – strongly affects the overall environmental efficiency of the "Limited Protocol + individual countries scheme".

2.2 Analysis of the Bonn Agreement

This part gives a quantitative analysis of the political agreement reached in Bonn in July 2001 with the use of ASPEN-sd2.

After reminding the situation of the different Parties at the end of "COP 6 II" in Bonn and stressing the importance of sinks for some of them, the paper examines the consequence of the US withdrawal and underlines the necessity to deal with the issue of hot air from the Former Soviet Union (FSU) and the Eastern Europe Economies (EEEs).

Eventually we quantify an agreement with no US participation and where Parties would agree upon the withdrawal of hot air from the trading during the first commitment period (through its banking for subsequent commitment period for instance) to 'compensate' for the US withdrawal from the process. The FSU and EEEs then still participate to the market through JI reductions only.

As in the Bonn agreement a 2% share of proceeds on CDM projects has been introduced.

The access to CDM projects is still limited to 10% of the potential emission reductions from non-Annex B parties' energy sector and associated transaction costs have been set to 20%.

2.2.1 The situation after Bonn

The Table 1 below presents the situation of the different Annex B Parties at the end of the Bonn conference (although the USA is now out the process, it is included in the table as an indication).

Table 1. General situation before trading (POLES data and projections - CO_2 emissions from the energy sector)

	Reductions objectives for 2010	Sinks (MtC) (domestic + CDM)		Remaining required emissions reductions	Surplus (MtC)
		Annex II countries	for FSU and EEE		
Europe	136	9 +11	-	116	-
CANZ	66	27 + 3	-	36	-
Japan	35	13 + 3	-	19	-
FSU	-	-	19	-	277
EEE	-	-	4	-	38
USA	513	*38 +17*	-	458	-

The figures for sinks are the sum of the capped credits under Article 3.4 'forest management' that have been agreed upon at the Bonn conference and projections for Article 3.4 'agriculture management ' and Article 3.3 credits. The maximum potential for sinks through CDM (1% base year emissions) is also mentioned except for the FSU and EEES as it is considered that these Parties will not undertake CDM projects in non-Annex B Parties, and therefore cannot be credited for sinks through CDM projects. Therefore in that table, and for all the following study, the quantity of sinks allocated to the FSU and the EEE is limited to sinks under Article 3.3 and Article 3.4.

Detailed data on sinks are given in **Annex 5**.

Sinks are assumed to be a zero cost means to increase Parties' assigned amounts. This is not to say that we believe the costs for sink enhancement to be zero. It was chosen as a technical solution as no marginal sequestration costs estimates for sinks are available in POLES yet. Implicitly this assumes that all sink enhancements come cheaper than the most attractive option to cut energy sector emissions.

The sinks for FSU and EEE add to hot air to give the amount of zero-cost emission reduction units, and given the previous assumption, the total zero-cost emission reduction units coming from these countries is 338 MtC (315 + 23 MtC).

The table III.1.b below stresses the importance of sinks for some Parties. Indeed, given the POLES projections, they represent more than 40% of the total reductions required for Canada, Japan and Australia/New Zealand in 2010 on the one hand, and only 15% for Europe and 10% for the US (assuming the US does participate to the process) on the other hand.

Table 2. Objectives vs Sinks - POLES data and projections, CO2 from energy sector

	USA	Europe	Japan	Canada	Australia + NZ
/ 1990 level *(POLES - energy CO2)*					
Reduction Objective	7.00%	8.00%	6.00%	6%	-6.80%
Sinks	4.13%	2.27%	5.63%	16%	14.15%
Proportion of sinks	***59.05%***	***28.36%***	***93.76%***	***263.97%***	
/ 2010 level (POLES - energy CO2)					
Reduction Objective	29.33%	13.73%	11.36%	28.66%	20.12%
Sinks	3.14%	2.12%	5.30%	12.02%	10.59%
Proportion of sinks	***10.71%***	***15.48%***	***46.67%***	***41.94%***	***52.62%***

Remark: the negative figure for Australia + NZ means that these countries together can increase their emissions compared with their 1990 level (while the others have to decrease their emissions compared to 1990 levels).

Table 3. Objectives vs Sinks - IPCC data, all GHGs

	USA	Europe	Japan	Canada	Australia + NZ
/ 1990 level (IPCC data - all GHGs)					
Reduction Objective	7.00%	8.00%	6.00%	6.00%	-6.80%
Sinks	3.32%	1.71%	4.89%	11.16%	7.69%
Proportion of sinks	***47.46%***	***21.37%***	***81.46%***	***186.00%***	

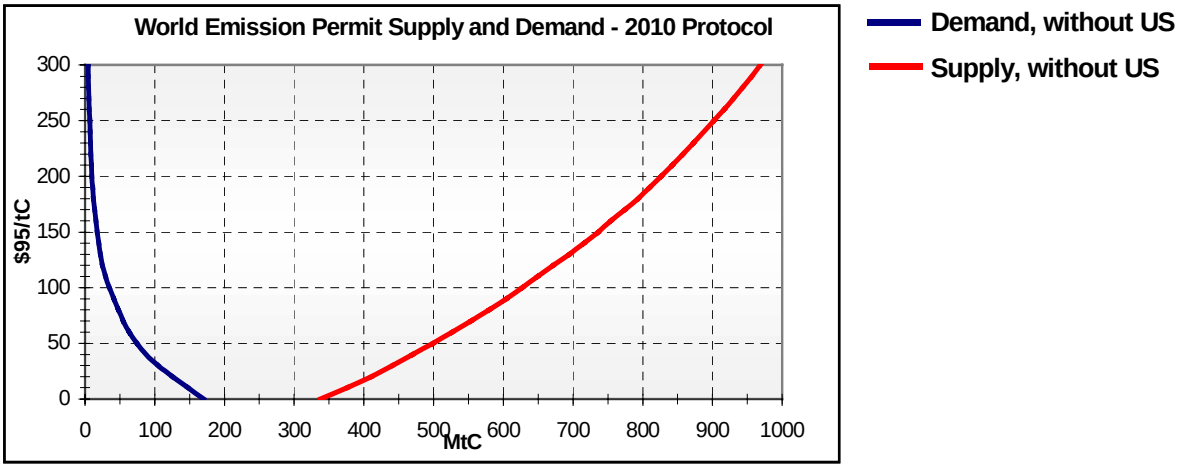
Although percentages are slightly lower when considering all greenhouse gases (see the table III.1.c) figures are still very high for Japan, Canada and Australia/ New Zealand.

2.2.2 The withdrawal of the US and the absence of market equilibrium

2.2.2.1 Analysis

The first effect of the withdrawal of the US is the sudden over-supply of hot air coming from the FSU and the EEEs. The Graph 1 below shows that in case hot air is not restricted, no market equilibrium takes place (at least with a positive equilibrium price).

Graph 1. Word Emission Permit Supply and Demand – 201 Protocol



In theory it means that the overall hot air in FSU and EEEs allows Annex B parties (the US having no commitment anymore) to reach the Kyoto objectives without doing any domestic effort.

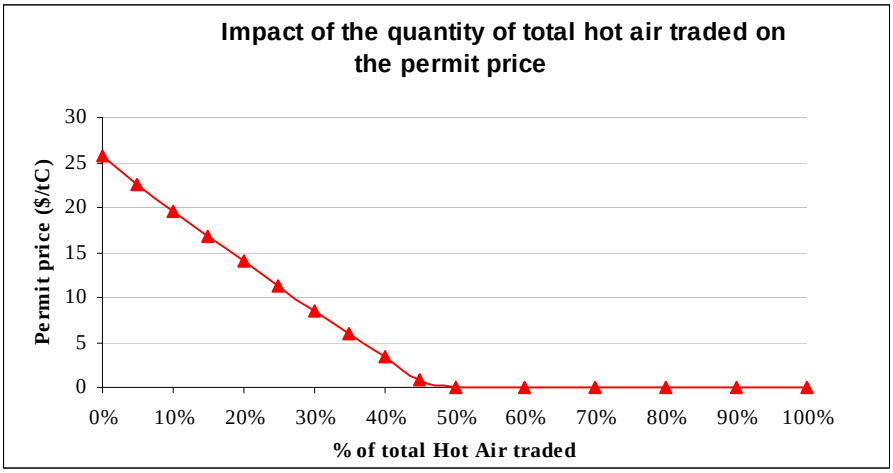
In practice however it is unlikely that, on one hand, hot air suppliers will be willing to 'sell' their hot air at a zero price, and will thus limit the amount traded and on the other hand that the rest of Annex B, particularly Europe, will accept the nil environmental integrity resulting from such a situation.

The part first examines the evolution of the market with the introduction of limited quantities of hot air in the market and then analyses a hypothetical scenario where no hot air is traded during the first commitment period studied here.

2.2.2.2 Limited quantities of hot air:

Firstly it must be noted that all the graphs and tables below correspond to the situation of the simulated Bonn agreement as described above: 2% Share of Proceeds, CDM: 10% access, 20% transaction costs, sinks as in Annex 4. This is important, especially with regards to the quantity of sinks, which has a great impact on the quantitative results. However the general trends would remain the same with different value of sinks, or with costs associated to sink projects.

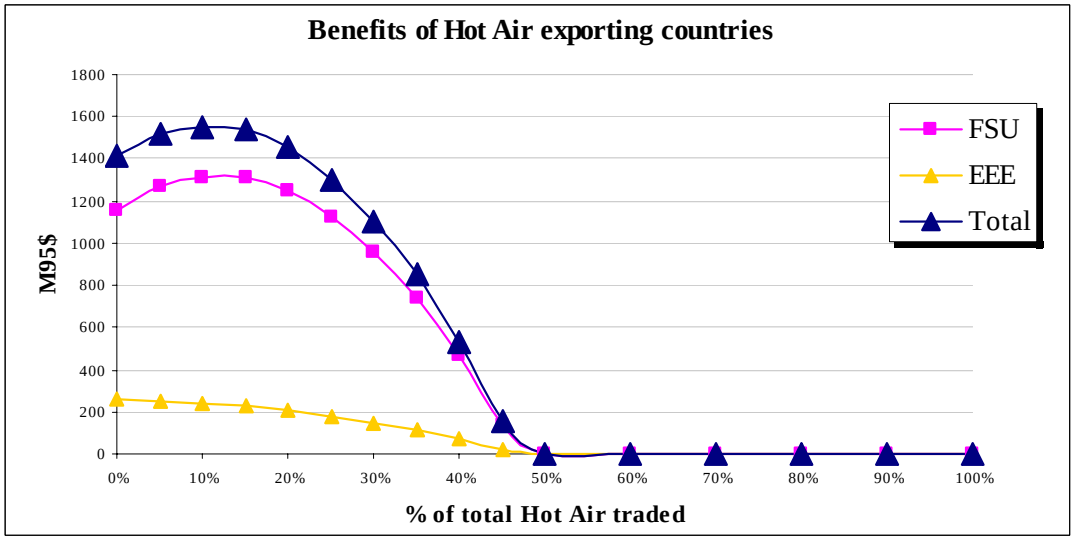
Graph 2. Impact of the quantity of total hot air traded on the permit price



The supply of hot air exceeds the demand for emission reduction units from 50% upwards of the quantity of hot air. The permit price rapidly falls to reach a nil price.

This Graph 2 shows the relation between the quantity of hot air to be put on the market to reach the price for an emission reduction unit that could be decided by sellers or agreed upon by sellers and buyers.

Graph 3. Benefits of hot air exporting countries



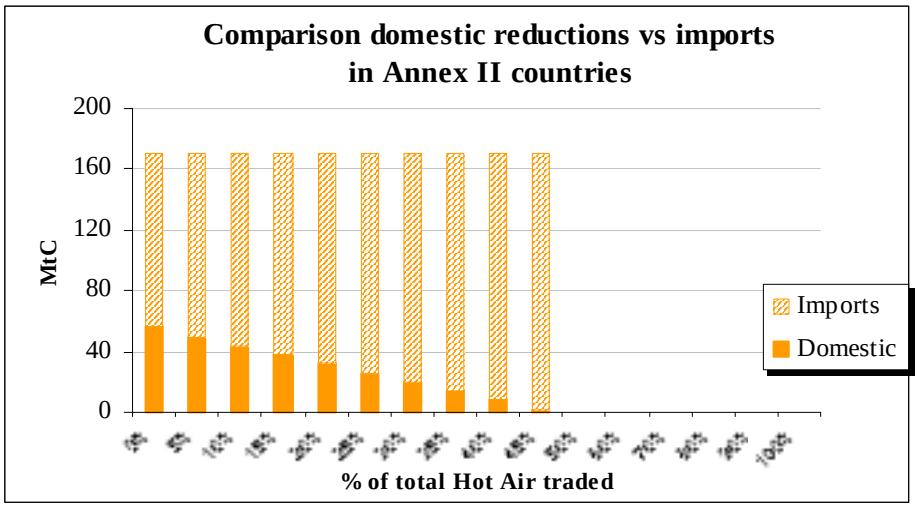
Interestingly the Graph 3 above shows that the maximum benefits for Hot Air exporting countries are reached for around 10% - 15% of hot air traded. The benefits keep close to their maximum in the range 0%-20%. The case '0%' of hot air corresponds to the selling of emission reductions coming exclusively from projects of CO_2 emission reductions within the countries' energy sectors ('Joint Implementation' projects).

This result is explained by the POLES projections that show a high supply of hot air from the FSU and EEE on the one hand and a quite low demand from some other Annex B Parties such as Japan for instance.

Some other models calculate that hot air exporters maximise their welfare for a higher proportion of hot air put in the market (around 30% - 40% of the total available hot air). These results stem from either lower estimates of hot air, higher estimates of BAU emissions for demanders (i.e. higher estimates of demand for permits), or both.

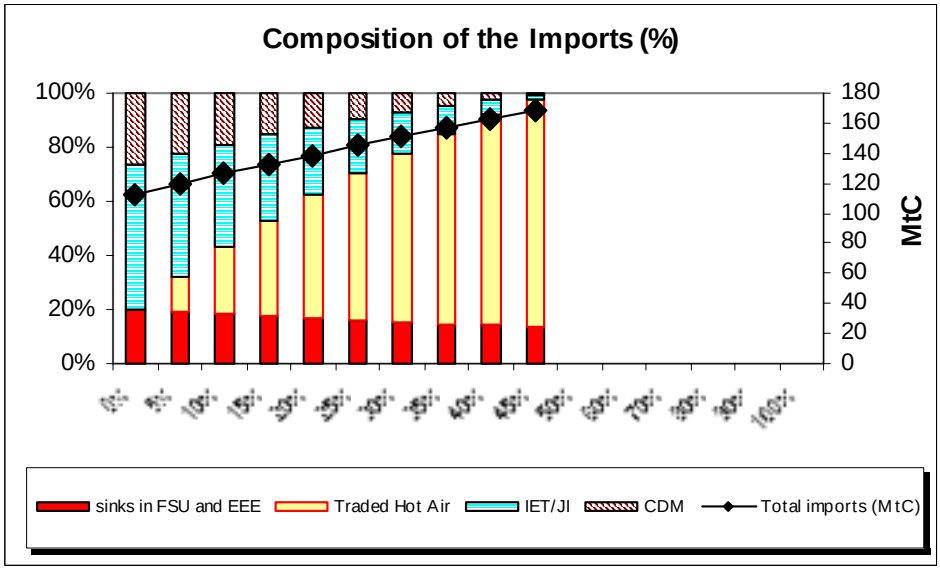
This result is an argument for the limitation of hot air sales during the first commitment period: profits for the FSU and the EEEs are maximised with a limited quantity of hot air in the market.

Graph 4. Comparison domestic reductions vs. Imports in Annex II countries



Most of the objective is fulfilled with imports of emission reductions (seeGraph 4). The composition of these imports is shown on the graph below.

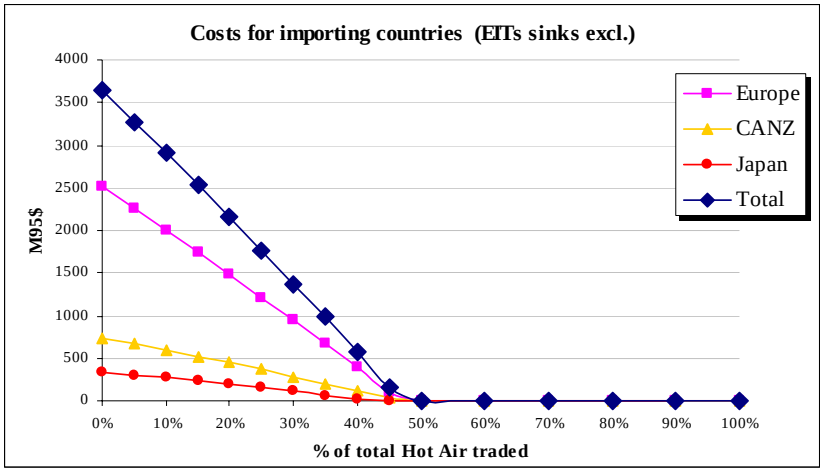
Graph 5. Composition of the Imports



Hot Air rapidly becomes the main source of imports of reductions, while the CDM share decreases to reach less than 5% above 30% of hot air traded and the IET/JI share, which by the way comes mostly from the FSU and EEEs, decreases to 5% only of the imports for 40% of the hot air traded.

Meanwhile, the more hot air is traded, the cheaper the commitment effort becomes.

Graph 6. Costs for importing countries (EITs sinks excluded)



2.2.2.3 The 'Bonn without hot air' scenario:

We examine here a Bonn agreement situation where no hot air is traded.

Graph 7. World emission permit Supply and Demand – 2010 Protocol

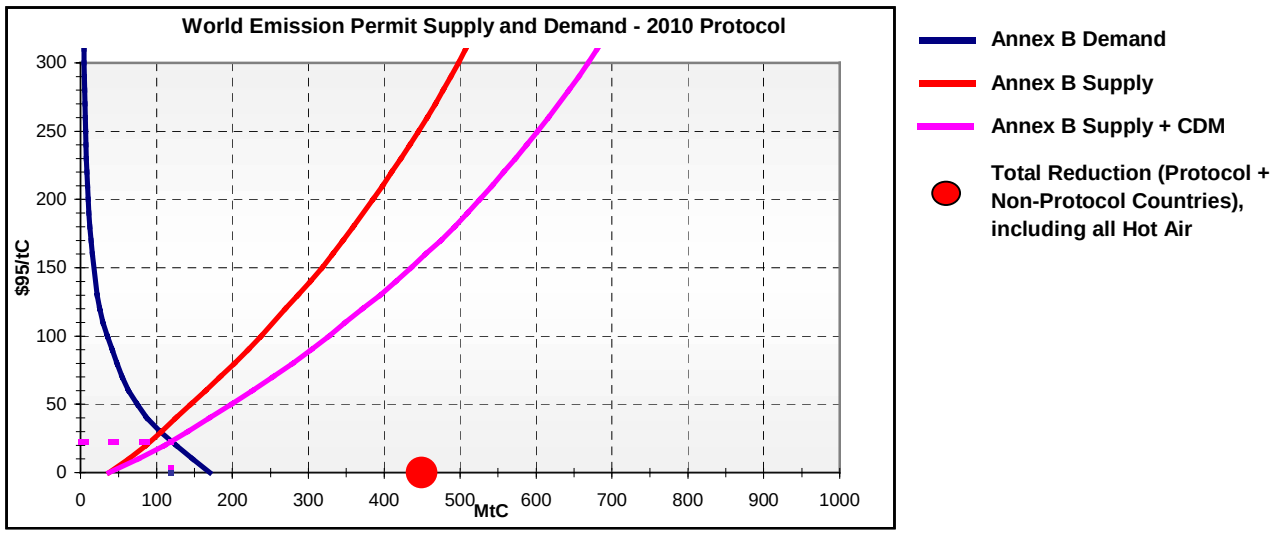


Table 4. Bonn (without US participation) without Hot Air

Permit Price at equilibrium ($/tC)	**26**

Results summary of current scenari		***Purchasers (MtC)***				***Sellers (MtC)***				
Countries	TAC (M95$)	Required emissions reductions =	Dom. Red. to reach target	+ Imports	+ Sinks *(dom. + CDM)*	Exports: CDM (without sinks)	Exports: Dom. Red. for IET / JI	Exports: Traded Hot Air	Exports: Sinks in EEE and FSU	HA balance
USA	**0**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Europe	**2521**	**136**	**35**	**81**	**20**	**-**	**-**	**-**	**-**	**-**
CANZ	**742**	**66**	**14**	**22**	**30**	**-**	**-**	**-**	**-**	**-**
Japan	**373**	**35**	**8**	**11**	**16**	**-**	**-**	**-**	**-**	**-**
FSU	**-1155**	**-**	**-**	**-**	**-**	**-**	**48**	**-**	**19**	**277**
EEE	**-257**	**-**	**-**	**-**	**-**	**-**	**12**	**-**	**4**	**40**
Non-Annex B countries						***30***				

Annex B results	**TAC (M95$)**	**Actual Emission reductions (required + untraded HA - sinks)**	Dom. Red. to reach target	Imports	Untraded Hot Air	**Sinks (incl. CDM)**	**Nature of Imports**: CDM (without sinks)	Dom. Red. for IET / JI	Traded Hot Air	Sinks in EEE and FSU
Demanders	**3636**	**170**	**57**	**114**	-	**66**	**30**	**60**	**0**	**23**
Suppliers	**-1412**	**317**	**-**	-	**317**					
Total Annex B	**2224**	**487**	**57**	**114**	**317**					

Notes: Purchasers - Reamining required emissions reductions : *actual required reductions - sinks = domestic reductions to reach target + Imports*

Purchasers - Imports : *CDM + IET/JI + Traded Hot Air + Sinks from FSU and EEE*

Suppliers - HA Balance : *untraded emissions reductions occuring in FSU and Eastern Europe because of economic recession*

In the hypothesis that there is no hot air in the trading, permit price is 26 $/tC.

In that case and if the unused hot air is included as 'emission reductions' (as indeed it is a 'reduction of emissions'), the environmental integrity remains significant (487 MtC) compared with a protocol with the US and with all hot air traded (631 MtC, see table III.2.b below) (the same hypothesis on sinks remains - see the last column of the table in Annex 4).

Table 5. Bonn with US participation, with Hot Air

Permit Price at equilibrium ($/tC)	**29**

Results summary of current scenari		***Purchasers (MtC)***				***Sellers (MtC)***				
Countries	TAC (M95$)	Required emissions reductions =	Dom. Red. to reach target	+ Imports	+ Sinks *(dom. + CDM)*	Exports CDM (without sinks)	Exports Dom. Red. for IET / JI	Exports Traded Hot Air	Exports Sinks in EEE and FSU	HA balance
USA	**11581**	**513**	**124**	**334**	**55**	**-**	**-**	**-**	**-**	**-**
Europe	**2816**	**136**	**40**	**76**	**20**	**-**	**-**	**-**	**-**	**-**
CANZ	**821**	**66**	**15**	**20**	**30**	**-**	**-**	**-**	**-**	**-**
Japan	**411**	**35**	**9**	**9**	**16**	**-**	**-**	**-**	**-**	**-**
FSU	**-9566**	**-**	**-**	**-**	**-**	**-**	**54**	**277**	**19**	**-**
EEE	**-1436**	**-**	**-**	**-**	**-**	**-**	**14**	**38**	**4**	**2**
Non-Annex B countries						***34***				

Annex B results	**TAC (M95$)**	**Actual Emission reductions (required + untraded HA - sinks)**	Dom. Red. to reach target	Imports	Untraded Hot Air	**Sinks (incl. CDM)**	**Nature of Imports** CDM (without sinks)	Dom. Red. for IET / JI	Traded Hot Air	Sinks in EEE and FSU
Demanders	**15629**	**629**	**189**	**440**	-	**121**	**34**	**68**	**315**	**23**
Suppliers	**-11002**	**2**	**-**	-	**2**					
Total Annex B	**4627**	**631**	**189**	**440**	**2**					

Notes: Purchasers - Reamining required emissions reductions : *actual required reductions - sinks = domestic reductions to reach target + Imports*

Purchasers - Imports : *CDM + IET/JI + Traded Hot Air + Sinks from FSU and EEE*

Suppliers - HA Balance : *untraded emissions reductions occuring in FSU and Eastern Europe because of economic recession*

It can be noted that Europe, CANZ and Japan are in similar situations when the US does not participate and hot air is not traded and when the US is in and hot air is traded (see tables III.2.a and table III.2b).

2.2.2.4 The impact of sinks on commitment efforts

Keeping the previous assumption of all hot air banked for subsequent commitment periods, we now analyse the effect of the quantity of sinks allocated to the different parties.

Three main cases have been studied: no sinks at all, no sinks in EITs (the FSU and EEEs) only, and sinks for all countries. In the cases where there are sinks, we distinguish two sub-cases: domestic sinks only and domestic + CDM sinks (with the assumption that there is no consideration of sinks through CDM for the FSU and EEEs).

Table 6: Impact of sinks on the permit price

Permit price ($/tC)	***domestic+CDM sinks***	***domestic sinks only***
Without sinks	**45**	
No sinks for EITs	**30**	**34**
Sinks for all countries	**26**	**29**

The permit price is almost halved by the introduction of sinks for all countries.

Table 7: Impact of sinks on the effort rates

Costs / GDP	Sinks in all countries		No sinks in EITs		No sinks
	domestic + CDM	*domestic only*	*domestic + CDM*	*domestic only*	
Europe	0.03%	0.03%	0.03%	0.04%	0.05%
Canada + Australia + NZ	0.04%	0.05%	0.05%	0.06%	0.14%
Japan	0.01%	0.01%	0.01%	0.02%	0.04%

The effort rate is about three time less important for Japan with the use of sinks and four times less important for CANZ. However, Europe benefit much less from the use of sinks, with an effort rate still equal to 60% the effort rate without sinks.

These results bear out the conclusion drawn from tables III.1.a/b/c on the importance of sinks for the umbrella countries.

Conclusions

We can easily understand the importance of sinks in the success of the Bonn conference, in particular in keeping the hesitating countries at the negotiation table to ensure that a political agreement will gather a sufficient number of Annex B countries to meet the minimum of 55% of 1990 CO_2 emissions condition for the Protocol to be enforceable.

Indeed, sinks are likely to have a major impact on the commitment efforts of Japan, Canada, and Australia - New Zealand. The willingness of the EU to keep the process on track despite the US withdrawal probably helped much in adopting soft positions on this issue.

However, the issue of sinks still faces many technical difficulties, which are to be seriously dealt with if these means of sequestration are to be considered as reliable ways of mitigating climate change in the mid to long-term. Although these questions go beyond the scope of this study, it is important to bear them in mind.

Along with large scientific and technical uncertainties with regards to the accounting of carbon stocks, there remains to define precise rules and to design tools to ensure that the proper monitoring of the projects is guaranteed and that the non-permanence of the sinks (concerning either the physical presence of the forest or its role as a sink rather than a source) is taken into account in the crediting accorded to Parties. The phenomenon of carbon leakage will also have to be prevented.

The second main conclusion of this study on the Bonn agreement is that 'a Kyoto Protocol without the US is like musical chairs with one too many chair' as R.J. Kopp puts it (Kopp R.J., "A climate accord without the US", Resources For the Future Weathervane, 2001, available on http://www.weathervane.rff.org/features/feature135.htm). If the agreement is to be environmentally meaningful, the amount of hot air should be limited, at least partially, through the banking for subsequent commitment periods or by the use of schemes making the FSU and EEE maximise their benefits (and therefore limit the quantity of hot air put in the market). The present study shows that, assuming the US does not take part to the Protocol, the trading of emission reduction units from Joint Implementation projects only in Economies In Transitions (FSU and EEE), in addition to the Certified Emissions Reductions from CDM projects, does not affect much the different Parties: as an effect of the higher permit price and because there is a large potential for JI projects, the benefits for EITs are close to their maximum (see graph III.2.c) while the buyers' commitment effort is similar to a situation where the US participates and all available hot air is traded (see tables III.2.a and III.2.b). Moreover, the use of banking by FSU and EEE and the use of unsold hot air for a subsequent commitment period should help them to meet future objectives.

In the meantime, and providing hot air is traded only partially, the environmental result of such an agreement remains significant.

ANNEX 2. Calculations of Soft and Hard Targets

Soft T : ($\sum_{x=0-8}$(199x emissions)/9)* 100%

Hard T : ($\sum_{x=0-8}$(199x emissions)/9) * Kyoto QELROs

Remark: in the exercise, the EU is considered as a Party, therefore the new targets are calculated first on the EU total emissions, with the burden sharing agreement (expressed as the percentage of each individual countries in total EU entitlements) then applied proportionally to each member country. The Soft and Hard targets for each EU member is as burden sharing applied to 100% and 93% of the 1990-1998 average for the EU.

	Soft Target	Hard Target	Kyoto
USA	105.1%	97.7%	93.0%
Canada	105.7%	99.4%	94.0%
EU	97.9%	91.1%	92.0%
France	106.5%	99.0%	100.0%
Germany	84.1%	78.2%	79.0%
Italy	99.5%	92.6%	93.5%
UK	93.2%	86.6%	87.5%
Austria	92.6%	86.1%	87.0%
Belg.-Lux	98.5%	91.6%	92.5%
Denmark	84.1%	78.2%	79.0%
Finland	106.5%	99.0%	100.0%
Ireland	120.3%	111.9%	113.0%
Netherlands	100.1%	93.1%	94.0%
Sweden	110.7%	104.0%	104.0%
Spain	122.4%	113.9%	115.0%
Greece	133.1%	123.8%	125.0%
Portugal	135.2%	125.7%	127.0%
Swiz. + Norway	100.4%	96.3%	95.9%
Pol+Hun+Czech+Slova.	79.9%	85.2%	106.7%
Rest Cent. Europe (AnnB)	71.1%	68.9%	97.0%
FSU (AnnB)	74.0%	74.0%	100.0%
Japan	105.6%	99.3%	94.0%
Aust.+ NZ	98.2%	104.9%	106.8%

Figures calculated on FCCC data (excluding LUC&Forestry, except for Australia) for all six GHGs.

remarks:

Bulgaria : average on 1990-1995 +1997+1998

Japan : average on 1990-1997

Lithuania : average on 1990+1998

Luxemburg : average on 1990+1994+1995

Romania : average on 1990+1994

Russian Federation: average on 1990+ 1994-1996

Slovenia : 1990 value

Sweden : the 'hard target' is set arbitrarily at 104%, instead of the 102.6% calculated, in order to make sure the MAC does not exceed 600$/tC (upper limit for the MAC curves given by POLES).

ANNEX 3. The Hot Air issue

The table below gives the supply of hot air from the FSU and EEES and the demand for emission reduction units from Europe, Canada, Japan, Australia and New-Zealand according to the POLES model projections. The table does not take sinks into account.

	Reductions objectives for 2010	Hot Air (MtC)
Europe	136	-
CANZ	66	-
Japan	35	-
FSU	-	277
EEE	-	38
Total:	237	315

Hot Air calculations: 'natural' vs. 'tradable' hot air

Due to severe economic slowdown, the POLES business as usual (BAU) projections to 2010 for the FSU and EEE energy CO_2 emissions are 305 MtC lower than their 1990 emissions. This represents a substantial reduction of emissions referred to as 'natural Hot Air' in the table below.

Furthermore the Kyoto Protocol 2010 entitlements of Poland - Hungary - Czech Republic - Slovakia are globally 106.8% those of 1990[8]. This allows them to bring 12 MtC of additional Hot Air to the 9 MtC of 'natural' Hot Air in the market.

On the other hand Bulgaria – Romania - Slovenia's Kyoto Protocol target in 2010 is overall 97 % of 1990 emissions[9]. This reduces their volume of tradable Hot Air by 2 MtC.

The total tradable Hot Air amounts to **315** MtC.

		1990 level	2010 level (BaU emissions)	Natural Hot Air	Target (2010 objective / 1990 emissions)	***Resulting tradable Hot Air***	***HA not tradable***
FSU	Russia/ Ukraine/ Baltic States	816	540	277	100%	***277***	***-***
EEE	Poland/ Czech Rep./ Hungary/ Slovakia	174	165	9	106.8%	***21***	***-***
	Bulgaria/ Slovenia/ Romania	67	48	19	97%	***17***	***2***
Total				305		***315***	***2***

Source : POLES model

The 2 MtC of untradable hot air from Bulgaria-Romania-Slovakia are mentioned under the 'HA balance' label in the forthcoming tables. They are included in the calculation of the total 'emission reductions', as indeed they are actual reductions in emissions.

[8] The Base Year / Period for Poland is 1988 and for Hungary it is the average of 1985-1987. See the UNFCCC guidelines on Reporting and Review, FCCCP/CP/1999/7, February 2000, available on : http://www.unfccc.int/resource/docs/cop5/07.pdf.

[9] The Base Year / Period for Bulgaria is 1988, for Romania is 1989 and for Slovenia is 1986. Same reference as note 9 above.

ANNEX 4. Fund from Share of Proceeds and Climate Investment Fund

	Fund from SoP (M95$)	Climate Investment Fund (M95$)
Kyoto Full-Trade	-	-
KP + Pronk Package	993	-
Re-negotiation + Hard Traget	867	-
Re-negotiation + Soft Target	496	-
Limited Participation + Full-Trade	210	-
Limited Participation + Compl. Payment	-	5554

ANNEX 5. FIGURES FOR SINKS AFTER COP 6 II

	Appendix Z Art. 3.4 forest mt	Art 3.4 Agri. mt	Art 3.3 credits	Sinks through CDM (1%BYE)	Total	Total excl. CDM sinks in FSU and EEE
	(MtC / yr)	(MtC / yr)	(MtC / yr)	(MtC / yr)	(MtC / yr)	(MtC / yr)
Austria	**0.63**			**0.21**	**0.84**	**0.84**
Belgium	**0.03**			**0.37**	**0.40**	**0.40**
Denmark	**0.05**		**0.10**	**0.19**	**0.34**	**0.34**
Finland	**0.16**			**0.20**	**0.36**	**0.36**
France	**0.88**			**1.51**	**2.39**	**2.39**
Germany	**1.24**			**3.30**	**4.54**	**4.54**
Greece	**0.09**			**0.29**	**0.38**	**0.38**
Ireland	**0.05**		**0.91**	**0.15**	**1.11**	**1.11**
Italy	**0.18**		**0.47**	**1.42**	**2.07**	**2.07**
Luxembourg	**0.01**			**0.04**	**0.05**	**0.05**
Netherlands	**0.01**		**0.04**	**0.60**	**0.65**	**0.65**
Portugal	**0.22**			**0.17**	**0.39**	**0.39**
Spain	**0.67**			**0.84**	**1.51**	**1.51**
Sweden	**0.58**			**0.19**	**0.77**	**0.77**
United Kingdom	**0.37**	**0.25**	**0.56**	**2.09**	**3.27**	**3.27**
EU	**5.17**	**0.25**	**2.08**	**11.57**	**19.07**	**19.07**
Australia	**0.00**	**2.18**		**1.31**	**3.49**	**3.49**
Bulgaria	***0.37***			***0.34***	***0.71***	**0.37**
Canada	**12.00**	**4.60**		**1.63**	**18.23**	**18.23**
Czech Republic	***0.32***			***0.52***	***0.84***	**0.32**
Estonia	***0.10***			***0.11***	***0.21***	**0.10**
Hungary	***0.29***			***0.24***	***0.53***	**0.29**
Iceland	**0.00**	**0.05**	**0.02**	**0.01**	**0.08**	**0.08**
Japan	**13.00**			**3.35**	**16.35**	**16.35**
Latvia	***0.18***			***0.10***	***0.28***	**0.18**
Lichtenstein	**0.01**			**0.00**	**0.01**	**0.01**
Lithuania	***0.28***			***0.14***	***0.42***	**0.28**
Monaco	**0.00**			**0.00**	**0.00**	**0.00**
New Zealand	**0.20**		**7.71**	**0.20**	**8.11**	**8.11**
Norway	**0.40**		**0.02**	**0.14**	**0.56**	**0.56**
Poland	***0.82***			***1.25***	***2.07***	**0.82**
Romania	***1.10***			***0.62***	***1.72***	**1.10**
Russian Feder.	***17.63***			***8.28***	***25.91***	**17.63**
Slovakia	***0.51***			***0.20***	***0.71***	**0.51**
Slovenia	***0.36***			***0.05***	***0.41***	**0.36**
Switzerland	**0.50**	**0.01**		**0.14**	**0.65**	**0.65**
Ukraine	***1.11***			***2.50***	***3.61***	**1.11**
(USA)	***(28)***	***(10.4)***		***(16.5)***	**(54.9)**	**(54.9)**
World without US	**54.35**	**7.09**	**9.83**	**32.71**	**103.98**	**89.63**
World with US	**82.35**	**17.49**	**9.83**	**49.21**	**158.88**	**144.53**