Post-2012 climate regime: equitable, effective, sufficient?

Abstract

The likely adoption of a post-2012 climate treaty based on the Kyoto Protocol's architecture would keep the Protocol's inequitable emission rights. Assuming reduction targets of 20% by 2020, this analysis shows that the new "Kyoto II" treaty would grant Annex I parties per-capita emission rights 2.8 times the equitable level. As a consequence, regarding CO2 emissions from fossil fuels alone, developing parties would lose at current prices US$152 billion per year in equitable carbon trading. Equity also implies settling past emissions of those parties that exceeded their equitable share. This analysis estimates that in the period 1995-2007 developed parties incurred in an historical emission debt of US$2.3 trillion at current prices, due to non-LULUCF CO2 emissions alone. During the Kyoto commitment period 2008-2012 the debt will further increase by US$1.1 trillion at current prices. An equitable treaty would be far less complex than Kyoto II: the parties agree on a global emission target that is equitably distributed on per-capita basis; parties exceeding their allocation purchase unused emission rights from other parties. An equitable treaty would be more effective than Kyoto II, as inequity is at the root of the burden-sharing impasse between parties that is crippling the Climate Convention.

Keywords: emission reductions; flexible mechanisms; emission rights; equity; carbon trading; environmental debt

1. Introduction

Greenhouse gas emissions are still out of control, despite the Convention on Climate Change (United Nations, 1992) that entered into force 15 years ago. Stabilizing the already high atmospheric CO2 concentrations today would require reducing anthropogenic emissions from the current 39 billion tonnes per year (own estimate based on Global Carbon Project, 2008) to less than 20 billion, assuming that the rest is absorbed by natural sinks with no further environmental consequences.

The very essence of the Convention and its Kyoto Protocol (United Nations, 1998) is reducing greenhouse gas emissions to safer levels. How to share the burden between parties has been a permanent impasse for achieving any significant progress in emissions reductions. So far binding commitments by developed parties are hardly more than symbolic while developing parties have no commitments.

A perfect compliance of the Kyoto Protocol would reduce annual CO2 emissions by 605 million tonnes at most (own estimate based on UNFCCC Secretariat, 2009). Clearly, the gap between what the Kyoto Protocol will achieve in practice and real reduction needs is enormous.

Performance of the post-2012 climate regime must improve dramatically if greenhouse concentrations are to be timely stabilized. Will the new climate treaty overcome the burden-sharing impasse and deliver?

2. Assumptions, methods and data sources

At the time of this writing (January 2010), it is expected that the new post-2012 climate treaty will most likely use the Kyoto Protocol's architecture where Annex 1 parties commit to reduction targets based on absolute historical emissions at given reference years (e.g. 1990 and 2005). Despite the divide between parties during COP15, with most non-Annex 1 parties pursuing the extension of the Kyoto Protocol, while most Annex 1 parties pursued a new treaty with reduction targets also for major developing parties, the candidate treaties of both positions were built on the Kyoto Protocol's architecture.

This analysis is based on the assumption that the new treaty (Kyoto II) will use the architecture of the Kyoto Protocol, with new reduction targets along the period 2013-2020 for the same Annex 1 that ratified the Protocol plus United States. The new targets would use the same structure of the Kyoto commitments and the European Union's Burden Sharing Agreement (European Parliament, 2000), but aim at levels that match the European Union's policy target –20% by 2020 under 1990 levels– (European Parliament, 2008). In the case of United States, the assumed target is 20% by 2020 under 2005 levels, following the ACES Act passed by the House of Representatives (United States Congress, 2009).

For the sake of simplicity, the analysis considers CO2 emissions only, coming from non-LULUCF sources (i.e. excluding land use, and land-use change and forestry) in the case of developed parties, and from combustion of fossil fuels in the case of developing parties; the difference between non-LULUCF and fuel combustion is essentially emissions from cement production. All comparisons are made in terms of CO2 emitted.

Due to lack of comparable data, most but not all parties to the Climate Convention were considered. The analyses include 95 developing (non-Annex 1) parties and all 40 developed (Annex 1) parties.

The potential of equitable carbon trading for the period 2008-2012 is estimated by projecting CO2 emissions under two scenarios: the Kyoto Protocol, and an alternative regime based on equitable emission rights and equitable reduction obligations. The base of comparison is the absolute level of emission reductions that developed parties must achieve to meet their Kyoto commitments. Under the alternative regime, said reductions are equitably shared by all parties.

Baseline emissions for the period 2008-2012 are calculated under the assumption that they vary at the same rate as the GDP.

For developed parties in the period 2008-2012, domestic reductions below the baseline are estimated at 50% of the excess emissions over the Kyoto target, or 10% of the total emissions for the period, whichever is lower. In the scenario considering the Kyoto Protocol, said domestic reductions are not accounted for developed parties with baseline emissions already below the committed target. In the scenario considering the alternative equitable emission regime, said domestic reductions are accounted for all developed parties.

Similarly, the trading potential for the period 2013-2020 is estimated by projecting emission under the possible Kyoto II treaty, and under the alternative equitable regime. The base of comparison is the absolute level of emission reductions that developed parties must achieve to meet their Kyoto II commitments. Under the alternative regime, said reductions are equitably shared by all parties.

Baseline emissions for the period 2013-2020 were taken from the Reference Scenario of the World Energy Outlook 2008 (IEA, 2008). The IEA projections for developed parties were adjusted as to match the 2007 non-LULUCF emissions from their national communications. The IEA projections for developing parties were adjusted as to match the 2007 statistics from the same Agency.

For developed parties in the period 2013-2020, domestic reductions from the baseline are estimated at 50% of the excess emissions over the Kyoto II target, or 16% of the total emissions for the period, whichever is lower. In the scenario considering the Kyoto II treaty, said domestic reductions are not accounted for developed parties with baseline emissions already below the committed target. In the scenario considering the alternative equitable emission regime, said domestic reductions are accounted for all developed parties.

Historical CO2 emissions of developed parties were taken from their national communications as compiled by the Secretariat of the Climate Convention (UNFCCC, 2009). The figures considered in the analyses exclude emissions from land use, land-use change and forestry (LULUCF).

Historical CO2 emissions of developing parties were obtained from statistics by the International Energy Agency (IEA, 2009). The figures considered correspond to emissions from combustion of fossil fuels under the Reference Approach.

Growth rates of the gross domestic product (GDP) were taken from estimates by the International Monetary Fund (IMF, 2009).

Population figures before 2008 were obtained from the above mentioned statistics by the IEA. Population figures for 2010 and 2015 were taken from forecasts by the United Nations Secretariat (2009).

3. Emission rights and equity in the Kyoto Protocol

The Kyoto Protocol sets reduction commitments for developed (Annex 1) parties relative to their emissions in 1990. The commitment varies from party to party in the range of -10% to 8% (Table 1), and should be achieved in the period 2008-2012. Developing (non-Annex 1) parties have no reduction commitments under the Kyoto Protocol.

[Insert Table 1 here]

It is important to realize that commitments set in the Kyoto Protocol imply in fact emission rights for developed parties, ranging from 92% to 110% of their 1990 emissions. By setting reductions on absolute emissions, the Protocol is implicitly granting inequitable per-capita emission rights, not only between developed parties but especially to most developing parties. Such distribution not only contradicts the Universal Declaration of Human Rights (United Nations, 1948), which proclaims that all human beings are equal in rights, but also the Climate Convention, which states that the parties should protect the climate system on the basis of equity.

Table 1 shows annual per-capita CO2 emission rights for the period 2008-2012, acquired by the developed parties that ratified the Kyoto Protocol. Estonia comes first with 25.6 tonnes per capita, and Monaco last with 2.9 tonnes. Considered together, emission rights of these developed parties are 9.7 tonnes per capita. By comparison, annual emissions of the United States (not a Kyoto party) are 22.6 tonnes per capita, and equitable emission rights (i.e. total emissions of all parties divided by total population of all parties) are only 4.8 tonnes. All the above figures are estimates for the period 2008-2012, and correspond to non-LULUFC CO2 emissions.

Table 2 presents annual per-capita CO2 emissions of 95 of the developing parties that ratified the Protocol. Qatar is by large the highest emitter with 49.1 tonnes per capita. The Democratic Republic of Congo comes last with 0.04 tonnes. Considered together, annual emissions of these 95 developing parties are 2.8 tonnes per capita. All the above figures correspond to CO2 from combustion of fossil fuels, estimated for the period 2008-2012.

[Insert Table 2 here]

4. Equity in the post-2012 treaty

Table 1 shows reduction commitments under 1990 levels that would be established by the possible Kyoto II treaty, in the same format used for the commitments contained in Annex B of the Kyoto Protocol (i.e. a uniform yearly emission target across the commitment period).

Table 1 also presents the annual per-capita CO2 emission rights that developed parties would acquire under Kyoto II. Estonia comes first with 23.8 tonnes per capita, and Turkey last with 0.8 tonnes. Considered together, annual emission rights of these developed parties are 10.7 tonnes per capita, while equitable emission rights are only 4.7 tonnes. All the above figures are estimates for the period 2013-2020, and correspond to non-LULUCF CO2 emissions.

Table 3 presents annual per-capita CO2 emissions of the 95 analysed developing parties for the period 2013-2020. Qatar emits the most with 61.4 tonnes per capita, and the Democratic Republic of Congo the least with 0.4 tonnes. Considered together, annual emissions of these 95 developing parties are 3.3 tonnes per capita. All the above figures correspond to CO2 emissions from combustion of fossil fuels.

[Insert Table 3 here]

5. Carbon trading and equity

What would be the effect of the inequitable emission rights granted by the Kyoto II treaty on carbon trading?

Table 4 shows the estimated amount of reductions developed parties would need to purchase in order to reach the reductions required by Kyoto II in the period 2013-2020. A negative amount of reductions indicates that the party has achieved an emission reduction higher than its commitment, and thus is in position of selling this amount to other developed parties. The amount of reductions for purchase (11.8 billion tonnes) exceeds the amount for sale (6.5 billon). Net purchases (5.3 billion) should come from reductions by certified activities in developing parties. United States would become the largest buyer (4.2 billion tonnes) and Russia the largest seller (3 billion).

[Insert Table 4 here]

Table 5 presents the estimated amount of reductions developed parties would need to purchase under an alternative regime based on equitable emission rights and reductions. Purchases increase to 67.3 billion tonnes, while sales drop to 788 million. Net purchases increase more than twelve-fold to 66.5 billion tonnes, which should come from unused emission rights by developing parties. United States would become the largest buyer (34 billion tonnes), and Turkey the largest seller (732 million).

[Insert Table 5 here]

Table 6 shows the estimated amount of unused emission rights the analysed developing parties could sell under the equitable emission regime. A negative amount of unused rights indicates that the party has emitted more than its equitable share, and thus must purchase this amount from other parties. As expected, there are more unused rights for sale (102 billion tonnes) than reductions for purchase (38.5 billion), which means that developing parties are in position of selling a net amount of 63.5 billion tonnes to developed parties. China would become the largest buyer (21 billion tonnes), and India the largest seller (33.3 billion).

[Insert Table 6 here]

When comparing the net reductions needed by developed parties (66.5 billion) with the net unused rights available from developing parties (63.5 billion), there would be a deficit of 3 billion tonnes of unused rights, which could be easily covered with historical emission credits discussed next.

6. Historical emissions and equity

While the Kyoto Protocol formally grants inequitable emission rights to developed parties, inequity in per-capita emissions has persisted for many years. What are the consequent equitable emission debts and credits?

Emission debts and credits between the parties to the Climate Convention are estimated since its entry in force (March 1994) until 2007, just before the start of the Kyoto Protocol's commitment period. For the sake of simplicity, debts and credits are calculated for CO2 emissions from combustion of fossil fuels alone, for the period 1995-2007.

Table 7 presents the emission debt or credits developed parties have acquired between 1995 and 2007. As expected the debt (117 billion tonnes of CO2) is much higher than credits (963 million). United States has the highest debt (58 billion) and Turkey most credits (930 million). The net debt of developed parties reaches 116 billion tonnes.

[Insert Table 7 here]

Table 8 shows the historical emission credits developing parties are entitled to, originated in the period 1995-2007. A negative amount indicates that the party has in fact emitted more than its equitable share, and thus has incurred in debt. Credits (131 billion tonnes) are much higher than debt (15.7 billion). India is entitled to most credits (40.3 billion) and Korea has the highest debt (3.2 billion). The net credits developing parties are entitled to amount to 116 billion tonnes, which is of course equal to the net debt incurred by developed parties.

[Insert Table 8 here]

Table 7 also shows the emission debt or credits developed parties will acquire during the Kyoto commitment period 2008-2012 due to the inequitable emission rights granted by the Protocol. The debt acquired by the United States (not a Kyoto party), due to emissions over the equitable right between 2008 and 2012, is shown also. A negative amount indicates that the party is expected to emit more than its equitable share, and thus would incur in debt. Debt (53.2 billion tonnes) is substantially higher than credits (323 million). The resulting net debt of developed parties will reach 52.8 billion. United States will acquire the highest debt (28.5 billion tonnes) and Turkey the highest credits (295 million).

Table 9 presents the historical emission credits developing countries will be entitled to during the period 2008-2012, originated in Kyoto's inequitable emission rights. A negative amount indicates that the party is expected to emit more than its equitable share, and thus would incur in debt. Credits (63 billion tonnes) are considerably higher that debt (10.3 billion). The net credits developing parties will be entitled to amount to 52.6 billion tonnes, which almost match the net debt of developed parties (52.8 billion).

[Insert Table 9 here]

How would these historical emission debts and credits fit into an equitable emission regime?

Equitable emission rights for all parties will tend to decrease in the longer term as global emissions are reduced while the population continues to grow. At the same time, per-capita emissions of developing parties will continue rising. Both tendencies will play against the amount of unused emission rights developing parties count on in the longer term.

Historical emission credits could have an important role in compensating the declining amount of unused rights for developing parties. The use of these credits could be spread over a longer period, starting with values lower that the annual average, and yearly increases over the chosen crediting period. Every developing party having credits would decide on a crediting period long enough to prepare itself for major cuts in global emissions, with yearly increases that compensate the expected reduction of unused emission rights.

Table 10 presents an example of developing parties using their historical emission credits along 8 years (2013-2020) with a yearly increase of 5%.

[Insert Table 10 here]

By combining purchases of unused rights as per Table 6 with historical credits along 20013-2020 as per example of Table 10, Bosnia and Herzegovina, Chile, China and Mongolia would reduce their needs of purchasing reductions by 59%, 53%, 65% and 20%, respectively; Argentina would even get in position of selling 192 million tonnes. These very different results just illustrate that the best way of using historical credits varies from party to party. The net amount of unused rights would jump from 63.6 to 232 billion tonnes, while the net demand by developing parties is only 66.5 billion. These figures indicate that an early use of historical credits would not make sense for developing parties as a whole, but just for the few mentioned above.

7. Discussion and conclusions

During a possible Kyoto II treaty for the period 2013-2020, developing parties would lose about 61 billion tonnes in carbon trading due to the inequitable allocation of emission rights to most developed parties. This figure refers only to emissions of CO2 from combustion of fossil fuels. Even assuming today's prices of around US$20 per tonne of CO2, the loss for developing countries in the period 2013-2020 would be around US$1.2 trillion, or US$152 billion per year. A more probable average price of US$35 furthers the loss to US$2.1 trillion, or US$267 billion per year.

According to a recent estimate (European Commission, 2009), developing parties would need US$150 billion per year by 2020 for mitigation and adaptation, 20 to 40% of said amount coming from domestic finance, 40% from international carbon trading and the remainder from international public finance (i.e. developed parties). The latter amount was estimated at US$14-20 billion in 2013, rising to US$33-75 billion in 2020.

In other words, climate financing by developed parties for mitigation and adaptation in developing parties, as suggested by the European Commission, would represent in the best case US$380 billion for the period 2013-2020, or US$47.5 billon per year. These

amounts compare to US$1.2 trillion for the period, or US$152 billion per year, at least that equitable carbon trading would produce considering CO2 emissions from fossil fuel combustion alone.

Equitable carbon trading would provide developing parties with a very significant source of just and immediate financing of their own, that these parties could use according to their national interests and priorities. The above comparison shows that any ad hoc climate funding for mitigation in developing parties loses most of its ground to equitable emission rights.

Trading based on equal emission rights would also drastically increase the efficiency and transparency of the carbon market, especially for developing parties. The well known intricacies and leaks of the Clean Development Mechanism (CDM) under the Kyoto Protocol, most probably carried on to the successor mechanism under the possible Kyoto II treaty, would be replaced by straightforward and transparent trading of unused emission rights from developing parties. Instead of emission reductions from a myriad of certified CDM projects under Kyoto and certified activities under Kyoto II, emission reductions are simply unused emission rights from developing parties that originate from an equal per-capita emission allocated to all parties. Equitable trading would work on the same principle among developed parties or among developing parties.

The principle of equity in per-capita emissions could also be applied to determine the historical emission debt of the parties, for example since the entry in force of the Climate Convention. Regarding CO2 emissions from fossil fuel combustion alone, the net debt of developed parties between 1995 and 2007 amounts to 116 billion tonnes. At current CO2 prices (US$20/tonne), the value of the debt is US$2.3 trillion; a more likely average price of US$35 for the period would make the debt US$4.06 trillion worth.

Another part of the historical debt corresponds to the Kyoto Protocol's era. During the Kyoto commitment period 2008-2012, developing parties will lose 52.8 billion tonnes in carbon trading due to the inequitable emission rights granted by the Protocol to most developed parties. This amount includes losses due to emissions of the United States (not a Kyoto party) over the equitable emission right. The losses refer only to emissions of CO2 from combustion of fossil fuels. Even assuming today's prices of around US$20 per tonne of CO2, the loss for developing countries in the period 2008-2012 would be around US$1.06 trillion, or US$211 billion per year. A more probable average price of US$35 furthers the loss to US$1.85 trillion, or US$370 billion per year.

The above mentioned estimate by the European Commission also considers a fast-start international public finance (i.e. by developed parties) of US$22.5-31.5 billion for the period 2010-2012, to support mitigation and adaptation in developing parties.

This fast-start climate financing by developed parties would represent in the best case US$10.5 billion per year between 2010 and 2012. By comparison, equitable carbon trading would produce at least US$211 billion per year between 2008 and 2012, considering CO2 emissions from combustion of fossil fuels alone.

Credits arising from the historical debt could be used by developing parties to compensate the inevitable loss in the amount of unused emission rights that will occur in the longer term, as global per-capita emissions decline and per-capita emissions of

developing parties raise. Use of these credits in the short term would not make sense for most developing parties.

Transitioning to a climate regime based on equal per-capita emission rights is urgent and crucial. The current impasse between developed and developing parties on how to share the reduction burden has it roots in inequity. Since the impasse is crippling the capacity of the Climate Convention to timely address severe climate change, making the Convention more equitable would substantially enhance its efficiency.

Surprisingly, equity is not an explicit priority issue in the negotiations of the post-2012 regime. Other issues, including climate financing by developing parties, are taking the attention of the negotiators while deepening the impasse. Ironically, a regime based on equitable emission rights would substantially boost transparent emission trading, providing developing parties with a just source of climate financing of their own, much higher than the ad hoc financing being proposed by developed parties.

An equitable climate regime would be far less complex than both the present and the possible post-2012 regimes based on the Kyoto architecture: the parties agree on an annual global emission target that is equitably distributed on per-capita basis among the global population; the resulting equitable per-capita emission right is used to allocate the absolute annual emission right to every party by multiplying said equitable per-capita right by its population. Parties exceeding their absolute emission right purchase unused emission rights directly from other parties, or from an international non-profit intermediary.

Such equitable distribution of emission rights and obligations between parties would make the Kyoto flexibility mechanisms and possible successors largely unnecessary. The Clean Development Mechanism would be replaced by straightforward trading of unused emission rights between developing and developed parties. The other two Kyoto mechanisms would be replaced as well by straightforward trading of rights between developed parties. Ultimately, the separation of trading between developing and developed parties, and trading among developed parties would become redundant, leading to their merger into a global system of trading unused emission rights between all parties.

References

European Commission, 2009. Climate change: Commission sets out global finance blueprint for ambitious action by developing nations (IP/09/1297). European Commission, Brussels.

European Parliament, 2000. European Parliament resolution on the Commission Green Paper on greenhouse gas emissions trading within the European Union (COM(2000) 87 - C5-0193/2000 - 2000/2104(COS)). European Parliament, Brussels.

European Parliament, 2008. European Parliament resolution on the Commission proposal for a decision on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (COM(2008)0017 – C6-0041/2008 – 2008/0014(COD)). European Parliament, Brussels.

Global Carbon Project, 2008. Carbon budget and trends 2007.

International Energy Agency, 2008, World Energy Outlook 2008. IEA, Paris.

International Energy Agency, 2009. CO2 Emissions from Fuel Combustion (2009 Edition). IEA, Paris.

International Monetary Fund, 2009. World Economic Outlook Database (October 2009). IMF, Washington, D.C.

UNFCCC Secretariat, 2009. National Greenhouse Gas Inventory Data for the Period 1990–2007. Advance version. UNFCCC, Bonn.

United Nations, 1948, The Universal Declaration of Human Rights. United Nations, New York.

United Nations, 1992. United Nations Framework Convention on Climate Change. United Nations, New York.

United Nations, 1998. Kyoto Protocol to the United Nations Framework Convention on Climate Change. United Nations, New York

United Nations Secretariat, 2009. World Population Prospects: The 2008 Revision. United Nations, New York.

United States Congress, 2009. A bill to create clean energy jobs, achieve energy independence, reduce global warming pollution and transition to a clean energy economy (as passed by the House of Representatives on June 26, 2009). United States Congress, Washington, D.C.

Note

The views and opinions presented in this article are strictly personal, for which the author assumes full responsibility.

Mhai Selph, January 2010

Table 1

Emission rights and commitments of Annex 1 parties

	Annual emission rights (tonnes CO2 per capita)		**Emission limitation**	**Emission limitation**
	Kyoto (2008-2012)	**Kyoto II** (2013-2020)	**Kyoto Protocol** (2008-2012)	**Kyoto II** (2013-2020)
Austria	6.5	5.9	87.0%	80.9%
Belgium	10.3	9.4	92.5%	86.0%
Denmark	7.8	7.2	79.0%	73.4%
Finland	10.7	9.7	100.0%	92.9%
France	6.4	5.8	100.0%	92.9%
Germany	10.0	9.4	79.0%	73.4%
Greece	9.3	8.6	125.0%	116.2%
Ireland	8.0	6.9	113.0%	105.0%
Italy	6.8	6.3	93.5%	86.9%
Luxembourg	17.9	15.4	72.0%	66.9%
Netherlands	9.0	8.2	94.0%	87.4%
Portugal	5.2	4.8	127.0%	118.0%
Spain	5.8	5.2	115.0%	106.9%
Sweden	6.3	5.7	104.0%	96.7%
United Kingdom	8.4	7.5	87.5%	81.3%
European Union 15	**7.8**	**7.2**	**92.0%**	**85.3%**
Bulgaria	12.1	11.7	92.0%	84.9%
Czech Republic	14.5	13.3	92.0%	84.9%
Estonia	25.6	23.8	92.0%	84.9%
Hungary	8.0	7.5	94.0%	86.7%
Latvia	7.9	7.5	92.0%	84.9%
Lithuania	10.2	9.8	92.0%	84.9%
Poland	11.6	10.8	94.0%	86.7%
Romania	8.4	8.0	92.0%	84.9%
Slovakia	10.5	9.7	92.0%	84.9%
Slovenia	7.4	6.8	92.0%	84.9%
Eurpean Union 25		**7.8**		**85.4%**
Australia	13.9	12.1	108.0%	100.2%
Belarus	9.8	9.4	92.0%	85.3%
Canada	12.6	11.0	94.0%	87.2%
Croatia	5.0	4.7	95.0%	88.1%
Iceland	7.2	6.2	110.0%	102.0%
Japan	8.5	8.0	94.0%	87.2%
Liechtenstein	5.2	4.6	92.0%	85.3%
Monaco	2.9	2.7	92.0%	85.3%
New Zealand	5.9	5.2	100.0%	92.8%
Norway	7.2	6.4	101.0%	93.7%
Russian Federation	17.8	16.9	100.0%	92.8%
Switzerland	5.4	4.9	92.0%	85.3%
Turkey	-	0.8	[92.0%]	48.3%
Ukraine	15.8	15.1	100.0%	92.8%
All above	**9.7**	**9.0**		**88.0%**
United States	[22.6]	15.8	-	87.6%
Annex 1 total		**10.7**		
Equitable emission rights	**4.8**	**4.7**		

Table 2

2008-2012 emissions by non-Annex 1 parties (tonnes CO2 per capita per year)

Albania	1.4	Georgia	1.4	Nigeria	0.4
Algeria	2.8	Ghana	0.5	Oman	14.7
Angola	0.7	Guatemala	0.9	Pakistan	0.8
Argentina	4.5	Haiti	0.3	Panama	2.3
Armenia	1.5	Honduras	1.2	Paraguay	0.6
Azerbaijan	4.1	India	1.3	Peru	1.2
Bahrain	29.2	Indonesia	1.8	Philippines	0.8
Bangladesh	0.3	Iran	6.6	Qatar	49.1
Benin	0.4	Iraq	3.8	Saudi Arabia	14.8
Bolivia	1.4	Israel	10.0	Senegal	0.4
Bosnia & Herzegovina	5.1	Jamaica	5.1	Serbia	5.3
Botswana	2.4	Jordan	3.5	Singapore	11.7
Brazil	2.0	Kazakhstan	13.9	South Africa	8.9
Brunei	15.6	Kenya	0.3	Sri Lanka	0.7
Cambodia	0.3	Korea	10.3	Sudan	0.3
Cameroon	0.3	Korea DPR	2.6	Syria	2.7
Chile	4.7	Kuwait	24.5	Tajikistan	1.1
China PR	5.2	Kyrgyzstan	1.2	Tanzania	0.1
Colombia	1.4	Lebanon	3.2	Thailand	3.5
Congo	0.5	Libya	7.7	Togo	0.1
Congo DR	0.04	Macedonia	4.8	Trinidad and Tobago	24.6
Costa Rica	1.6	Malaysia	6.7	Tunisia	2.2
Côte d'Ivoire	0.3	Malta	6.8	Turkmenistan	11.6
Cuba	2.5	Mexico	4.1	United Arab Emirates	29.6
Cyprus	8.5	Moldova	2.1	Uruguay	2.1
Dominican Rep.	2.2	Mongolia	4.6	Uzbekistan	5.3
Ecuador	2.4	Morocco	1.5	Venezuela	5.7
Egypt	2.2	Mozambique	0.1	Vietnam	1.0
El Salvador	1.0	Myanmar	0.3	Yemen	1.0
Eritrea	0.1	Namibia	1.5	Zambia	0.2
Ethiopia	0.1	Nepal	0.1	Zimbabwe	0.7
Gabon	1.4	Nicaragua	0.8	**All above**	**2.8**

Table 3

2013-2020 emissions by developing parties (tonnes CO2 per capita per year)

Albania	1.7	Georgia	1.7	Nigeria	0.4
Algeria	2.9	Ghana	0.5	Oman	16.1
Angola	0.7	Guatemala	0.9	Pakistan	0.8
Argentina	5.0	Haiti	0.3	Panama	2.7
Armenia	1.6	Honduras	1.2	Paraguay	0.7
Azerbaijan	4.3	India	1.5	Peru	1.4
Bahrain	33.2	Indonesia	2.1	Philippines	0.8
Bangladesh	0.3	Iran	7.4	Qatar	61.4
Benin	0.4	Iraq	4.4	Saudi Arabia	16.4
Bolivia	1.6	Israel	11.4	Senegal	0.4
Bosnia & Herzegovina	6.1	Jamaica	5.6	Serbia	6.1
Botswana	2.9	Jordan	4.0	Singapore	13.1
Brazil	2.4	Kazakhstan	15.7	South Africa	9.7
Brunei	15.3	Kenya	0.3	Sri Lanka	0.8
Cambodia	0.3	Korea	12.2	Sudan	0.3
Cameroon	0.3	Korea DPR	2.7	Syria	3.2
Chile	5.5	Kuwait	27.1	Tajikistan	1.2
China PR	6.6	Kyrgyzstan	1.3	Tanzania	0.1
Colombia	1.7	Lebanon	3.8	Thailand	4.0
Congo	0.4	Libya	8.4	Togo	0.1
Congo DR	0.0	Macedonia	5.6	Trinidad and Tobago	28.8
Costa Rica	1.8	Malaysia	7.3	Tunisia	2.4
Côte d'Ivoire	0.3	Malta	7.0	Turkmenistan	14.1
Cuba	2.8	Mexico	4.4	United Arab Emirates	32.5
Cyprus	8.5	Moldova	2.5	Uruguay	2.5
Dominican Rep.	2.6	Mongolia	6.5	Uzbekistan	6.0
Ecuador	2.6	Morocco	1.6	Venezuela	6.2
Egypt	2.4	Mozambique	0.1	Vietnam	1.1
El Salvador	1.2	Myanmar	0.3	Yemen	1.1
Eritrea	0.1	Namibia	1.4	Zambia	0.2
Ethiopia	0.1	Nepal	0.1	Zimbabwe	0.7
Gabon	1.4	Nicaragua	0.9	**All above**	**3.3**

Table 4

Scenario: Kyoto II, period 2013-2020
Carbon trading potential - Annex 1 parties
(million tonnes CO2)

Austria	114.7
Belgium	63.7
Denmark	66.5
Finland	58.1
France	188.0
Germany	334.3
Greece	89.5
Ireland	38.8
Italy	330.4
Luxembourg	16.8
Netherlands	147.8
Portugal	45.4
Spain	501.2
Sweden	-2.4
United Kingdom	363.2
European Union 15	**2,355.9**
Bulgaria	-168.5
Czech Republic	8.2
Estonia	-121.0
Hungary	-110.5
Latvia	-74.6
Lithuania	-132.8
Poland	-93.3
Romania	-280.2
Slovakia	-56.5
Slovenia	19.1
Eurpean Union 25	**1,345.8**
Australia	881.1
Belarus	-86.4
Canada	1,226.6
Croatia	29.1
Iceland	3.9
Japan	1,136.4
Liechtenstein	0.2
Monaco	0.0
New Zealand	72.5
Norway	64.0
Russian Federation	-2,979.5
Switzerland	29.7
Turkey	1,775.7
Ukraine	-2,404.6
All above	**1,094.4**
United States	4,220.6
Annex 1 total	**5,315.1**
sale	-6,510.3
purchase	11,825.4

Table 5

Scenario: Equitable regime, period 2013-2020
Carbon trading potential - Annex 1 parties
(million tonnes CO2)

Austria	198.3
Belgium	471.1
Denmark	177.1
Finland	275.5
France	744.5
Germany	3,389.2
Greece	441.5
Ireland	125.6
Italy	1,093.8
Luxembourg	62.1
Netherlands	626.4
Portugal	53.8
Spain	676.9
Sweden	69.4
United Kingdom	1,815.5
European Union 15	**10,220.8**
Bulgaria	155.0
Czech Republic	732.0
Estonia	62.1
Hungary	54.8
Latvia	-34.7
Lithuania	-21.7
Poland	1,710.7
Romania	119.3
Slovakia	133.0
Slovenia	53.2
Eurpean Union 25	**13,184.5**
Australia	2,245.7
Belarus	218.4
Canada	3,053.3
Croatia	28.4
Iceland	8.1
Japan	4,416.5
Liechtenstein	0.2
Monaco	-0.5
New Zealand	89.8
Norway	133.7
Russian Federation	8,917.9
Switzerland	41.0
Turkey	-731.1
Ukraine	801.0
All above	**32,407.0**
United States	34,072.0
Annex 1 total	**66,479.0**
sale	-788.0
purchase	67,267.0

Table 6

Scenario: Equitable regime, period 2013-2020
Carbon trading potential - non-Annex 1 parties (million tonnes CO2)

Albania	79.3	Georgia	98.5	Nigeria	6,226.7
Algeria	556.1	Ghana	925.6	Oman	-299.5
Angola	725.6	Guatemala	504.7	Pakistan	6,602.6
Argentina	-93.3	Haiti	395.7	Panama	61.8
Armenia	78.5	Honduras	239.9	Paraguay	228.2
Azerbaijan	27.0	India	33,269.8	Peru	829.3
Bahrain	-205.5	Indonesia	5,103.5	Philippines	3,218.3
Bangladesh	6,232.5	Iran	-1,755.3	Qatar	-752.6
Benin	385.7	Iraq	96.3	Saudi Arabia	-2,791.9
Bolivia	275.9	Israel	-428.2	Senegal	522.2
Bosnia & Herzegovina	-40.5	Jamaica	-21.2	Serbia	-111.0
Botswana	31.5	Jordan	40.0	Singapore	-342.6
Brazil	3,840.4	Kazakhstan	-1,443.2	South Africa	-2,056.3
Brunei	-38.4	Kenya	1,698.8	Sri Lanka	661.3
Cambodia	585.0	Korea	-2,930.5	Sudan	1,720.4
Cameroon	802.4	Korea DPR	388.5	Syria	308.1
Chile	-120.3	Kuwait	-621.4	Tajikistan	223.0
China PR	-20,972.2	Kyrgyzstan	163.4	Tanzania	1,985.3
Colombia	1,223.8	Lebanon	30.6	Thailand	375.3
Congo	148.9	Libya	-218.3	Togo	286.7
Congo DR	3,006.3	Macedonia	-14.6	Trinidad and Tobago	-264.3
Costa Rica	118.0	Malaysia	-644.4	Tunisia	201.0
Côte d'Ivoire	881.2	Malta	-7.8	Turkmenistan	-421.3
Cuba	168.5	Mexico	262.0	United Arab Emirates	-1,183.5
Cyprus	-28.8	Moldova	61.0	Uruguay	61.0
Dominican Rep.	188.1	Mongolia	-42.4	Uzbekistan	-315.5
Ecuador	249.4	Morocco	868.2	Venezuela	-375.4
Egypt	1,736.5	Mozambique	981.9	Vietnam	2,748.2
El Salvador	182.0	Myanmar	1,886.1	Yemen	840.4
Eritrea	228.0	Namibia	64.5	Zambia	560.6
Ethiopia	3,682.2	Nepal	1,221.4	Zimbabwe	461.9
Gabon	44.2	Nicaragua	195.5	**All above**	**63,554.8**
				purchase	-38,540.1
				sale	102,094.9

Table 7

Historical emission debt - Annex 1 parties

	1995-2007	**2008-2012**
	(million tonnes CO2)	
Austria	456.2	170.0
Belgium	997.6	312.8
Denmark	438.0	137.3
Finland	531.8	194.5
France	1,643.6	502.1
Germany	6,783.4	2,153.9
Greece	542.9	315.1
Ireland	311.6	104.9
Italy	2,631.6	828.1
Luxembourg	95.6	46.4
Netherlands	1,497.1	459.7
Portugal	205.9	51.3
Spain	1,644.2	707.1
Sweden	215.4	30.4
United Kingdom	3,964.2	1,226.2
European Union 15	21,959.2	7,239.7
Bulgaria	220.6	116.2
Czech Republic	1,100.9	410.3
Estonia	149.5	49.3
Hungary	215.5	40.0
Latvia	-26.2	-19.0
Lithuania	-6.2	-8.7
Poland	2,081.4	887.6
Romania	149.1	64.2
Slovakia	233.1	75.7
Slovenia	92.0	38.2
Eurpean Union 25	26,168.8	8,893.5
Australia	3,329.7	1,589.5
Belarus	295.3	91.8
Canada	4,992.8	2,189.5
Croatia	15.4	18.6
Iceland	13.1	7.6
Japan	8,923.4	4,408.6
Liechtenstein	1.3	0.3
Monaco	-0.3	-0.3
New Zealand	197.9	75.2
Norway	239.1	113.8
Russian Federation	12,297.4	6,659.4
Switzerland	167.6	38.3
Turkey	-930.0	-294.8
Ukraine	1,929.3	515.6
All above	**57,640.8**	**24,306.4**
United States	58,056.2	28,531.9
Annex 1 total	**115,697.0**	**52,838.2**
sale	-962.7	-322.8
purchase	116,659.7	53,161.1

Table 8

Historical emission credits - non-Annex 1 parties (million tonnes CO2)
Period 1995-2007

Albania	122.3	Georgia	182.6	Nigeria	6,059.9
Algeria	693.4	Ghana	996.9	Oman	-199.0
Angola	674.3	Guatemala	483.9	Pakistan	6,023.4
Argentina	214.8	Haiti	433.5	Panama	85.6
Armenia	115.7	Honduras	260.6	Paraguay	237.4
Azerbaijan	22.8	India	40,286.1	Peru	1,023.2
Bahrain	-162.3	Indonesia	7,166.5	Philippines	3,183.3
Bangladesh	7,021.8	Iran	-892.3	Qatar	-344.8
Benin	369.0	Iraq	130.5	Saudi Arabia	-2,484.5
Bolivia	310.1	Israel	-419.7	Senegal	506.2
Bosnia & Herzegovina	30.2	Jamaica	3.1	Serbia	-158.0
Botswana	38.8	Jordan	60.6	Singapore	-491.7
Brazil	5,183.6	Kazakhstan	-1,215.6	South Africa	-2,487.8
Brunei	-60.2	Kenya	1,564.2	Sri Lanka	862.1
Cambodia	640.1	Korea	-3,246.1	Sudan	1,661.2
Cameroon	806.2	Korea DPR	306.7	Syria	290.2
Chile	52.3	Kuwait	-608.1	Tajikistan	257.3
China PR	16,072.1	Kyrgyzstan	190.3	Tanzania	1,774.7
Colombia	1,436.1	Lebanon	8.3	Thailand	737.5
Congo	160.7	Libya	-271.6	Togo	277.7
Congo DR	2,723.4	Macedonia	-9.7	Trinidad and Tobago	-197.6
Costa Rica	143.7	Malaysia	-517.1	Tunisia	272.9
Côte d'Ivoire	823.4	Malta	-10.9	Turkmenistan	-249.0
Cuba	274.6	Mexico	301.6	United Arab Emirates	-995.8
Cyprus	-44.6	Moldova	103.4	Uruguay	99.6
Dominican Rep.	231.0	Mongolia	6.3	Uzbekistan	-220.7
Ecuador	367.0	Morocco	1,074.5	Venezuela	-379.8
Egypt	1,958.5	Mozambique	954.5	Vietnam	3,391.4
El Salvador	256.1	Myanmar	2,282.9	Yemen	786.2
Eritrea	195.2	Namibia	68.2	Zambia	526.6
Ethiopia	3,475.1	Nepal	1,263.8	Zimbabwe	500.1
Gabon	42.8	Nicaragua	223.1	**All above**	**115,697.0**
				debt	-15,666.9
				credit	131,363.9

Table 9

Historical emission credits - non-Annex 1 parties (million tonnes CO2)
Period 2008-2012

Albania	53.2	Georgia	71.6	Nigeria	3,493.9
Algeria	352.3	Ghana	527.5	Oman	-143.8
Angola	392.6	Guatemala	279.4	Pakistan	3,721.3
Argentina	70.2	Haiti	231.8	Panama	44.7
Armenia	51.2	Honduras	138.4	Paraguay	134.5
Azerbaijan	32.4	India	21,447.1	Peru	531.3
Bahrain	-98.6	Indonesia	3,458.6	Philippines	1,879.4
Bangladesh	3,715.1	Iran	-660.8	Qatar	-334.0
Benin	203.6	Iraq	162.3	Saudi Arabia	-1,307.4
Bolivia	169.1	Israel	-189.1	Senegal	285.3
Bosnia & Herzegovina	-6.3	Jamaica	-3.6	Serbia	-25.1
Botswana	23.4	Jordan	43.7	Singapore	-168.0
Brazil	2,713.0	Kazakhstan	-717.4	South Africa	-1,028.5
Brunei	-21.9	Kenya	922.6	Sri Lanka	420.2
Cambodia	338.1	Korea	-1,342.2	Sudan	968.4
Cameroon	448.6	Korea DPR	268.9	Syria	233.9
Chile	11.7	Kuwait	-301.1	Tajikistan	130.0
China PR	-2,530.5	Kyrgyzstan	100.7	Tanzania	1,048.8
Colombia	777.8	Lebanon	34.4	Thailand	451.6
Congo	81.8	Libya	-96.0	Togo	157.8
Congo DR	1,614.0	Macedonia	-0.1	Trinidad and Tobago	-132.9
Costa Rica	75.2	Malaysia	-270.4	Tunisia	135.2
Côte d'Ivoire	484.9	Malta	-4.0	Turkmenistan	-175.3
Cuba	131.2	Mexico	394.1	United Arab Emirates	-582.5
Cyprus	-16.2	Moldova	47.6	Uruguay	45.8
Dominican Rep.	134.7	Mongolia	2.3	Uzbekistan	-63.5
Ecuador	167.1	Morocco	537.9	Venezuela	-125.0
Egypt	1,081.2	Mozambique	549.5	Vietnam	1,681.5
El Salvador	116.4	Myanmar	1,142.9	Yemen	461.6
Eritrea	122.5	Namibia	36.7	Zambia	303.9
Ethiopia	2,002.6	Nepal	699.5	Zimbabwe	259.0
Gabon	25.2	Nicaragua	116.4	**All above**	**52,646.7**
				debt	-10,344.4
				credit	62,991.1

Table 10

Example of use, historical emission credits - non-Annex 1 parties (million tonnes CO2)
Period 2013-2020 Crediting period: 2013-2020 Annual increase: 5%

Albania	175.4	Georgia	254.2	Nigeria	9,553.9
Algeria	1,045.7	Ghana	1,524.4	Oman	-342.9
Angola	1,066.9	Guatemala	763.2	Pakistan	9,744.6
Argentina	285.0	Haiti	665.3	Panama	130.3
Armenia	166.9	Honduras	399.0	Paraguay	371.9
Azerbaijan	55.2	India	61,733.1	Peru	1,554.5
Bahrain	-260.9	Indonesia	10,625.1	Philippines	5,062.7
Bangladesh	10,736.9	Iran	-1,553.1	Qatar	-678.8
Benin	572.6	Iraq	292.7	Saudi Arabia	-3,791.9
Bolivia	479.2	Israel	-608.8	Senegal	791.6
Bosnia & Herzegovina	23.9	Jamaica	-0.5	Serbia	-183.0
Botswana	62.2	Jordan	104.3	Singapore	-659.7
Brazil	7,896.5	Kazakhstan	-1,933.0	South Africa	-3,516.3
Brunei	-82.1	Kenya	2,486.8	Sri Lanka	1,282.3
Cambodia	978.2	Korea	-4,588.3	Sudan	2,629.6
Cameroon	1,254.8	Korea DPR	575.5	Syria	524.1
Chile	64.0	Kuwait	-909.3	Tajikistan	387.3
China PR	13,541.5	Kyrgyzstan	291.0	Tanzania	2,823.5
Colombia	2,213.9	Lebanon	42.7	Thailand	1,189.2
Congo	242.5	Libya	-367.7	Togo	435.6
Congo DR	4,337.4	Macedonia	-9.8	Trinidad and Tobago	-330.4
Costa Rica	218.9	Malaysia	-787.5	Tunisia	408.2
Côte d'Ivoire	1,308.3	Malta	-14.9	Turkmenistan	-424.3
Cuba	405.8	Mexico	695.7	United Arab Emirates	-1,578.3
Cyprus	-60.8	Moldova	151.0	Uruguay	145.3
Dominican Rep.	365.6	Mongolia	8.6	Uzbekistan	-284.2
Ecuador	534.1	Morocco	1,612.5	Venezuela	-504.9
Egypt	3,039.7	Mozambique	1,504.1	Vietnam	5,073.0
El Salvador	372.4	Myanmar	3,425.8	Yemen	1,247.8
Eritrea	317.8	Namibia	104.8	Zambia	830.6
Ethiopia	5,477.8	Nepal	1,963.3	Zimbabwe	759.1
Gabon	68.0	Nicaragua	339.5	**All above**	**168,343.4**
				debt	-23,471.3
				credit	191,814.7