INTERNATIONAL Future Actions Dialogue

Sector-based Approach to the Post-2012 Climate Change Policy Architecture

Jake Schmidt
Ned Helme
Jin Lee
Mark Houdashelt

CENTER FOR CLEAN AIR POLICY

August 2006

Center for Clean Air Policy

The Dialogue on Future International Actions to Address Global Climate Change (FAD) Working Papers

The *FAD Working Papers* are intended to help advance the discussions on the design of the future international response to climate change. The concepts developed and opinions expressed in these papers are those of the Center for Clean Air Policy (CCAP), although these views have been informed by extensive interactions with participants in the "FAD." Since October 2002, CCAP has facilitated biannual meetings of the *FAD*, which brings together a group of high-level climate negotiators from developed and developing countries. The process gives participants a chance to informally discuss different approaches to the design of the future international climate regime in a relaxed, off-the-record, non-negotiating setting. Each FAD meeting consists of one day for participants from developing countries—"Developing Country-Only Dialogue—followed by three days of discussions between developing and developed country participants—the "Joint Dialogue". Financial contributions for these efforts were provided by the Australian International Greenhouse Partnerships Office, Environment Canada, Canadian Department of Foreign Affairs and International Trade, European Commission Directorate-General for Environment, Korean Ministry of Foreign Affairs and Trade, German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Japanese Ministry of Economy, Trade and Industry, Mexican Secretaría del Medio Ambiente y Recursos Naturales, Netherlands Ministry of Housing, Spatial Planning and the Environment, New Zealand Climate Change Office, Norwegian Royal Ministry of Foreign Affairs, United Kingdom Department for International Development, United Kingdom Foreign and Commonwealth Office, the United States Environmental Protection Agency, Swedish Ministry of the Environment, Swedish Energy Agency, Swedish Ministry of Industry, Employment, and Communications.

The *FAD Working Papers* do not reflect consensus recommendations of the FAD participants; rather they are CCAP's ideas and papers influenced by the discussions in the FAD. Later in the process CCAP will publish a compendium which will include elements of the *FAD Working Papers* and other options discussed during the FAD meetings. For more information on the FAD, presentations, and other *FAD Working Papers*, see: www.ccap.org/international/future.htm

About the Center for Clean Air Policy

As a recognized world leader in air quality and climate policy since 1985, the Center for Clean Air Policy, an independent non-profit entity, seeks to promote and implement innovative solutions to major environmental and energy problems which balance both environmental and economic interests. The Center's work is guided by the belief that market-based approaches to environmental problems offer the greatest potential to reach common ground between these often conflicting interests. CCAP staffs have participated in the Framework Convention on Climate Change negotiations, helping to shape the Joint Implementation provisions of the Rio Treaty and the Kyoto Protocol Mechanisms. CCAP has also developed a series of papers, the *Airlie Papers,* on domestic carbon trading in the US, the *Leiden Papers,* on international emissions trading, and the *Clean Development Mechanism Papers*, on the design of the CDM. For more information on CCAP, see: www.ccap.org

Acknowledgments

Jake Schmidt (Manager International Program, Senior Policy Analyst), Ned Helme (President), Jin Lee (Policy Associate), and Mark Houdashelt (Policy Analyst) at the Center for Clean Air Policy (CCAP) prepared this paper as an input to CCAP's *Dialogue on Future International Actions to Address Global Climate Change* (the Future Actions Dialogue). Niklas Höhne and Ernst Worrell at Ecofys performed the top-down analytical modeling. The authors would like to thank the valuable input on key elements of this proposal from the participants in the Future Actions Dialogue meeting. The authors would like to acknowledge input and assistance from a number of individuals: Eric Williams (formerly of CCAP) and Frances Sussman provided direction and insights on early thinking on the proposal; Karen Lawson (formerly of CCAP) provided detailed analysis of the cement sector in an earlier version of this paper; research assistance was provided by Matt Ogonowski at CCAP. In addition, the authors have received invaluable input on a variety of aspects of this paper from a number of individuals. Assistance on data included in calculating sector greenhouse gas emissions has been provided by Kevin Baumert, World Resources Institute; Elizabeth Scheehle, US EPA; Deborah Ottinger, US EPA; John-O Niles, Climate, Community and Biodiversity Alliance; and Paulo Moutinho, Instituto de Pesquisa Ambiental da Amazônia. The thinking on the use of benchmarks in this proposal was greatly aided by a presentation from Lynn Price, Lawrence Berkeley National Laboratory, at the October 2005 meeting of the Future Actions Dialogue.

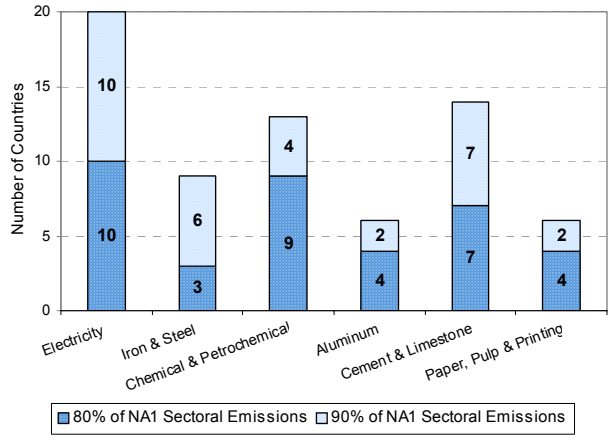
Executive Summary

The primary objective of the United Nations Framework Convention on Climate Change (UNFCCC) is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The Kyoto Protocol was designed to be a first step toward achieving this objective. Negotiations on the structure of the next climate change policy framework are therefore exploring what approaches will be introduced in the post-2012 timeframe, which countries will participate, and what type of structure will apply to each participant.

A number of options have been proposed for the structure of the international response to addressing GHG emissions from industrialized and developing countries. To date, most of the proposals for developing countries have focused on mitigating GHG emissions from the economy as a whole. This paper presents a different approach: the "sector-based" approach focuses on controlling emissions from particular economic sectors in developing countries. It also suggests how such a "sector-based" approach could be used to help establish national targets for industrialized countries as well.

Voluntary "No Lose" Pledge

Key developing countries would pledge to achieve a voluntary sector "no lose" GHG intensity target (e.g., GHG / ton of steel) in the electricity and key industry sectors (e.g. electricity, cement, steel, oil refining, pulp/paper, metals, etc.). The inclusion of the top 10 largest GHG emitting developing countries in each sector would insure coverage of 80-90 percent of developing country GHG emissions in each of the selected sectors (see figure).



Number of participating countries required to cover 80-90% of non-Annex I GHG emissions in particular sectors

Incentivized

Emissions reductions achieved beyond the voluntary pledge would be eligible for sale as emissions reductions credits to developed countries. Emissions reductions to meet the country's pledge would be permanently "retired from the atmosphere" and thus would not be eligible for sale. However, failure to meet the voluntary pledge level would not involve any penalties or any requirement to purchase emissions reduction credits from other countries.

To encourage developing countries to pledge to meet a more aggressive sector "no lose" intensity target, developed countries and international financial institutions would provide a *Technology Finance and Assistance Package*. This program would support specific commitments for the deployment of advanced technologies, development of small and medium-sized enterprises to assist in technology implementation, capacity building, and support for pilot and demonstration projects. It would be designed to leverage increased private sector investment

by writing down the cost and mitigating the risk of advanced technologies to levels that would ensure competitive returns for private sector investors in these technology deployments.

Bottom Up Approach

The final sector "no lose" GHG intensity target made by each of the participating developing countries (e.g., top 10 GHG emitting countries) would result from a negotiation process between developed countries and each individual developing country. The initial building block for this negotiation would be an expert assessment of benchmark energy intensity levels for major processes within each selected industrial sector. This could be carried out by an international entity such as the International Energy Agency or by internationally selected expert institutes such as Lawrence Berkeley National Laboratory (U.S.), Tsinghua University (China), or some other designated organizations. Subsequently, each developing country would conduct its own analysis of the applicability of this benchmark to the development of its own carbon intensity pledge level which would reflect local fuel mix and likely impacts of the carbon intensity target on the competitiveness of its future exports from this sector**.** Developing countries could establish either a single carbon intensity target per sector or two carbon intensity targets per sector, one for new facilities and the other for existing facilities.

How "No Lose" Targets Succeed

While the voluntary nature of the program does not guarantee emissions reductions would be achieved, two key features should ensure success. Firstly, through the establishment of targets that countries feel confident they can achieve because they are based upon accurate, bottom-up assessments, countries are more likely to achieve the desired levels. Secondly, a mix of incentives including the *Technology Finance and Assistance Package* and the receipt of emissions reductions credits in the event a nation exceeds its voluntary pledge provide positive incentives for emissions reductions. Assuming that developing countries act upon their agreed commitments on the *Technology Finance and Assistance Package*, there is certainty that at least the agreed investment in technology or practices (and subsequent emissions reductions) would occur. Further, since countries would only be able to receive emissions reduction credits when they exceed the target, there exists a positive economic incentive to go beyond the target level.

Application to Developed Countries

A benchmarking effort, similar to that of developing countries, would be undertaken for developed countries to determine a consistent level of effort that their industrial sectors should make toward in meeting the national GHG emissions reduction target. The final targets for developed countries would be hard, aggregate, economy-wide targets built upon the initial sectoral analyses. In contrast, final targets for developing countries would be carbon intensity targets that place no limits on growth in a given sector as long as carbon intensity is improved. Thus, absolute GHG emissions in the participating sectors of developing countries could grow, while in developed countries the growth in these sectors' GHG emissions would be limited. In developed countries, these sectors could offset their growth through the purchase of GHG emissions reductions from other sectors or the international market.

New Credit Generation
Countries that reduce their sectoral GHG emissions below the pledged level would be awarded emission reduction credits that could be sold to developed countries and would be fully fungible with international emissions trading mechanisms such as Clean Development Mechanisms (CDM). It is suggested that sectoral performance be assessed twice during each five-year commitment period, once after the first two years of the compliance period and lastly at the completion of the period. This would allow developing countries to sell the credits during the commitment period, rather than being forced to wait until final production numbers for the period are determined. Developing countries also would retain the right to keep the credits or to distribute them to companies within the sector as they see fit.

Finally, countries could elect to allocate their pledge target in the form of caps to companies in the sector and allow them to trade among themselves so that the credits would flow to those companies who exceeded their caps. In order to prevent a country from distributing more emission reduction credits than were actually produced, the country would need to guarantee that any shortfall of allowances would be made up by the government, for example by drawing from Certified Emissions Reductions (CERs) generated from unilateral CDM projects in non-industrial sectors.

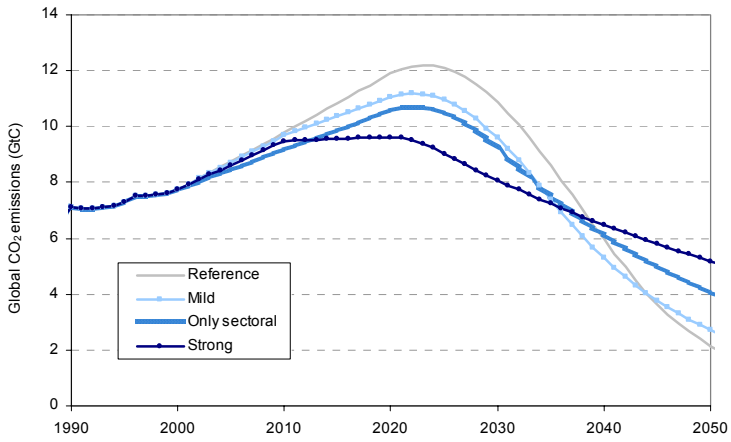
Impact on Industrial Competitiveness
A principle goal of the sector-based approach is to promote the use of best practices in internationally competitive industries worldwide. In practice, it is aimed at achieving a level playing field and at encouraging technological innovation. This approach tackles head-on the conventional wisdom that industrial facilities in developing countries are usually less efficient and more carbon intensive than their counterparts in developed countries. The data on major internationally competitive industrial sectors tells a different story (e.g. the U.S. is the second most carbon intensive cement producer in the world), one that should appropriately be reflected in the targets set in the next round of international negotiations on climate protection for the post-2012 period.

This approach may also offer a useful basis to resolve the continuing arguments in the European Union's Emissions Trading System over the fairness of individual Member State allowance allocations to individual companies as a result of the different implementation of sector targets between countries. By developing consistent benchmarks in major industrial sectors, it could move the allocation process within the European Union toward allocation of allowances based, in part, on such benchmarks.

Global Emissions Implications of the Sector-based Approach
To assess whether the sectoral pledge approach could achieve a level of global emission reductions by 2020 sufficient to preserve the opportunity for stabilization of atmospheric carbon dioxide concentrations at the 450-550 Parts Per Million (ppm) carbon intensity level in this century, a combination of new Annex I country national targets and sectoral targets in the cement, electricity, and steel industries within key GHG emitting developing countries, (and lesser national targets for the United States) was modeled. Four scenarios were evaluated, as follows:

1. Strong Case – GHG emissions reductions to -30 percent below 1990 by 2020 for Annex I countries with the U.S. stabilizing at 1990 levels in 2020 and key developing countries meeting specified sectoral carbon intensity targets by 2020
2. Mild Case – Annex I countries to reduce 15 percent below 1990 GHG emissions levels by 2020 with the U.S. at +10 percent above 1990 levels and developing countries at "business as usual" levels
3. Sectoral Case – All countries meet the same sectoral carbon intensity targets by 2020 with no other reductions required

All three cases made progress toward the 450ppm and 550ppm carbon intensity goals in 2050 with the Strong Case understandably achieving the largest reductions, the Sectoral Case in second place, and the Mild Case achieving the least reductions (see figure). Interestingly, the Mild Case would require three times the level of emissions reductions per year as compared to the Strong Case during years 2020 through 2050 (6.5 percent reduction per year vs. 2.2 percent reduction per year respectively) to reach the 2050 global atmospheric concentration goal. However, the Sectoral Case also would require substantial annual GHG emissions reductions after 2020 – on the order of four percent per year. These results underline the importance of maintaining economy-wide caps for the Annex I countries as opposed to shifting to a global intensity-based sector-based approach.



Global CO_2 emissions required to stabilize atmospheric CO_2 concentrations at 450 ppmv in the sectoral models.

Improvements on the Current International Structure

Under the Kyoto Protocol, the focus tends to be on developing country reductions achieved through the Clean Development Mechanism (CDM). These reductions do not offer a benefit to the atmosphere, as they replace reductions that would otherwise be made by developed countries (Annex I countries).

Under the Sectoral Approach, developing country pledges for GHG emission reductions would constitute new contributions to the reduction of atmospheric concentrations of carbon dioxide - this marks an important departure from the current international architecture for emissions reductions. While there are a number of examples of current unilateral efforts by developing countries to reduce GHGs (e.g. China's tough GHG emissions standards for new cars, Brazil's alcohol fuels programs, etc.), the Sectoral Approach could create explicit recognition and quantification of those efforts as well as of new ones.

In addition, this approach would mean that all GHG emissions generating facilities in a given sector in a participating developing country would be included in the system, unlike in the CDM where only a limited number of facilities in a sector participate. Reductions achieved beyond the country's sectoral pledge would be considered automatically "additional" and available for sale. Host countries would not face uncertainties about emissions additionality. Developing countries not participating in this new approach could still carry out projects in these sectors under the CDM. In fact, the benchmarking process carried out under the Sectoral Approach would assist the CDM Executive Board and its Methodology Panels to evaluate project-specific baselines and additionality for projects in these sectors in those developing countries.

The new Technology Finance and Assistance Package would encourage the development and transfer of new climate-friendly technologies in developing countries, precisely the technological innovation that is required if the world is to achieve stabilization of global carbon concentrations at safe levels. It would build into the international process an explicit negotiation on technology finance between developed countries and key developing countries. Lastly, it would mobilize new public resources to leverage private investment, a portion of existing resources from the World Bank, other international financial institutions, and export credit agencies for the promotion of technological innovation and GHG emissions reduction.

Conclusion

Several factors distinguish the Sectoral Approach:

- Its development out of a multi-country, three and a half year dialogue of senior climate negotiators from Annex I and Annex II countries
- Its reliance, as a starting point for negotiation, on a bottom up expert assessment of benchmark energy intensity levels for major processes within each selected industrial sector
- Key developing countries pledge of a voluntary sector "no lose" GHG intensity target in major industry sectors
- Targets that constitute new contributions to the reduction of GHG emissions by developing countries
- The promotion of the use of best practices in internationally competitive industries worldwide
- Incentives for developing countries to achieve reductions beyond the voluntary pledge

TABLE OF CONTENTS

I. Introduction

The primary objective of the United Nations Framework Convention on Climate Change (UNFCCC) is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The Kyoto Protocol was designed to be a first step toward achieving the UNFCCC's overall aim, but it is much too limited in scale (the reductions in GHG emissions are modest when compared with those needed over the coming decade), in scope (it establishes GHG emissions limits only in specific industrialized countries, known as Annex I countries), and in timeframe (it expires in 2012) to provide atmospheric stabilization of GHG concentrations. Negotiations on the structure of the next climate change policy framework are therefore exploring what approaches will be introduced in the post-2012 timeframe, which countries will participate, and what type of structure will apply to each participant.

Fully addressing post-2012 global climate change at the international level will involve: (1) assessing the GHG emissions budget, which depends on the targeted atmospheric stabilization level, over a defined timeframe (e.g., 2012-2020); (2) distributing the global emissions budget to the various entities (countries, sectors, or companies); and (3) designing the "architectural elements" for meeting the emissions reduction goals that are appropriate for particular groups of countries or companies. The focus of this paper is on the third step and its associated implications for step two.

A number of options have been proposed for the structure of the international response to addressing GHG emissions from industrialized and developing countries. To date, most of the proposals for developing countries have focused on mitigating GHG emissions from the economy as a whole. This paper presents a different approach, instead focusing on the use of "no-lose (non-binding) emissions intensity targets to control emissions from particular economic sectors in developing countries, and suggests how such a "sector-based" approach could be used to help establish national targets for industrialized countries as well.

Sector-based approaches have a number of possible advantages, including:

- *Ease of administration*: targeting emissions in a given sector is generally simpler than doing so economy-wide because, in many sectors, the number of actors is relatively small. This advantage may not apply in sectors that are characterized by a high degree of diversity or a large number of players.
- *Data availability*: in several sectors, emissions inventories or the underlying fuel data are already well-developed, even in developing countries, facilitating the rapid implementation of a reliable sectoral emissions reduction program. Greater data availability also builds confidence, both domestically and internationally, in the emissions monitoring and reporting and thus smoothes international negotiations.
- *Greater equity*: some internationally-competitive sectors in developing countries are equally or more GHG-efficient than those in Annex I countries, so a sector-based approach may be a "fairer" way to reduce global GHG emissions than approaches that differentiate countries by income.
- *Increased technology transfer*: this approach creates a focused environment for global technology transfer and deployment.

- *Targeted emissions reductions*: the emissions sources or sectors with the highest priority for achieving emissions reductions, such as sectors that are energy-intensive or have slow turnover of invested capital, can be specifically targeted.

Sector-based approaches may also have some disadvantages, including:

- *Cost-effectiveness*: more cost-effective emissions reductions may exist outside of a covered sector, but this efficiency loss can be minimized by, for example, allowing emissions trading across sectors (while addressing leakage and free-rider concerns), setting emissions levels or benchmarks within other sectors as well, or using cost-effectiveness criteria to guide the level of emissions reductions established in the targeted sector(s).
- *Limited extent*: focusing on a few selected sectors will ignore emissions from sectors that may present a significant contribution to national emissions. Omitting specific energy-intensive or high-growth sectors may make achieving global GHG stabilization levels more difficult.
- *Leakage*: emissions can potentially "leak" into uncovered sectors, depending on how the sectors are defined and the extent to which related products or activities are also simultaneously covered.

This paper discusses a specific proposal for a sector-based approach to GHG emissions mitigation in the post-2012 framework which is based upon discussions among participants in the Center for Clean Air Policy's *Dialogue on Future International Actions to Address Climate Change*.[1] Section 2 provides an overview of this approach. In Section 3, the most important design features of a sectoral approach for developing countries are considered. The *Technology Finance and Assistance Package* component of the proposal is described in Section 4. Section 5 discusses how the approach applies to industrialized countries, and Section 6 presents some preliminary modeling of the proposed approach. Some implications and final thoughts regarding a sector-based program are presented in Section 7, and Section 8 summarizes the proposed approach.

[1] Other discussions of sectoral approaches and of non-binding emissions targets have been presented by Philibert and Pershing (2001), OECD/IEA (2002), Philibert et al. (2003), Schmidt et al. (2004) and OECD/IEA (2005), among others.

II. Overview of the Proposal

In this sectoral approach, key developing countries pledge to achieve voluntary "no-lose" emissions intensity targets (e.g., GHG / ton of steel) in major energy and heavy industry sectors (e.g. electricity, cement, steel, oil refining, pulp/paper, and metals). In this context, the term "no-lose" means that there is no penalty for not meeting the target, but there are positive incentives for exceeding it. Emissions reductions needed to meet a country's pledge are permanently "retired for the atmosphere," while reductions achieved beyond the voluntary pledge are eligible for sale as emissions reductions credits (ERCs) to industrialized countries (see Figure 1). Failure to meet the voluntary pledge would not incur any penalties or require the purchase of ERCs from other countries.

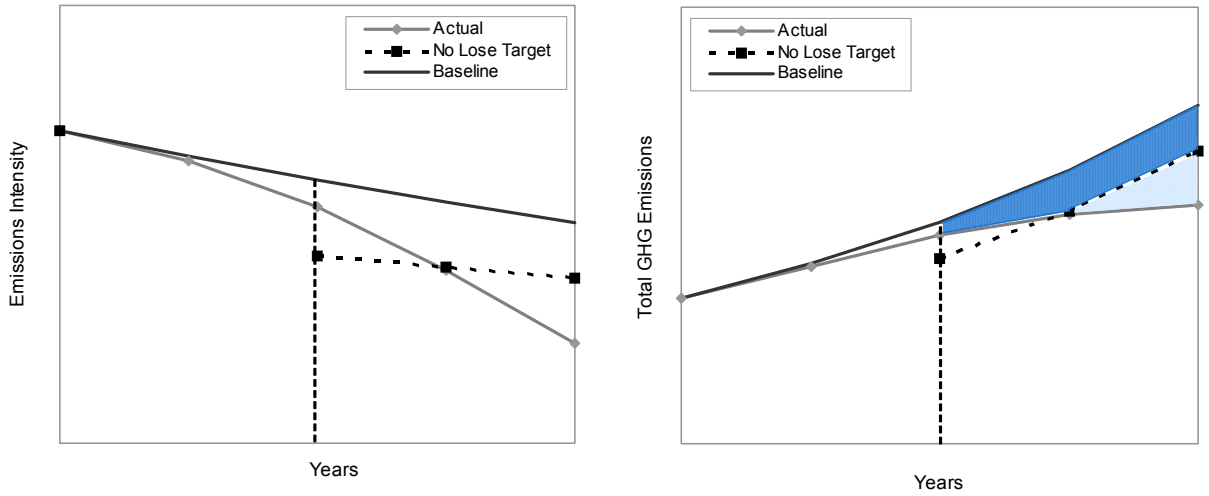


Figure 1. GHG emissions "permanently retired for the atmosphere" and emissions reductions available for sale when exceeding the "no-lose" target.

The left-hand and right-hand panels show the qualitative behavior with time of sectoral emissions intensity and total sectoral GHG emissions, respectively. In both panels, the bold solid line represents the baseline (or business as usual) scenario, and the lighter solid line shows what actually occurs within the sector. The dotted lines show the emissions intensity target (left-hand panel) and the GHG emissions if this target is met (right-hand panel). The vertical dashed line designates the onset of the compliance period. The shaded areas in the right-hand panel represent the emissions that are "permanently retired for the atmosphere" (darker shaded area) and the excess emissions available for sale (lighter shaded area).

The ideal sectoral program would include all major developing countries, but particular emphasis on inclusion of those countries that represent a major portion of each sector's operations and emissions will help minimize concerns about competitiveness and leakage. Participation of the ten highest-emitting developing countries in each sector generally ensures coverage of 80-90% of developing country GHG emissions.

To encourage developing countries to pledge to meet more aggressive sectoral intensity targets, industrialized countries and international financial institutions provide assistance through a *Technology Finance and Assistance Package*. This program supports such activities as deployment of advanced technologies, development of small and medium-sized enterprises to assist in technology implementation, capacity-building activities, and pilot and demonstration

projects. It would be designed to increase private sector investment by mitigating the risk of investing in advanced technologies and helping reduce the costs of these technologies in the future.[2]

The final sectoral GHG intensity pledges made by any participating developing country would result from negotiations between industrialized countries and that developing country. The initial building blocks for these negotiations would be benchmark energy intensity levels for major processes within each selected industrial sector; these benchmarks would be determined by internationally selected experts or institutes. Each developing country would assess the applicability of each benchmark to their domestic facilities and develop its own GHG emissions intensity pledges, taking into account factors such as the local fuel mix and the likely impacts of the intensity target on the competitiveness of its future exports. The level of assistance from the Technology Finance and Assistance Package would also factor into the negotiation process by lowering financial barriers to the achievement of lower energy-intensity levels in the sectors. In the end, a developing country would adopt a single carbon intensity target or perhaps two targets, one for new facilities and the other for existing facilities, in each sector.

For industrialized countries, these energy-intensity benchmarks serve as the starting points for sectoral target negotiations. However, the final targets in industrialized countries are hard, aggregate, economy-wide emissions caps (i.e., similar to those under the Kyoto Protocol) that are built from the sectoral analyses. For developing countries, the final targets are GHG intensity targets that place no limits on the absolute growth in emissions in a given sector as long as GHG intensity improves.

Other sectors in developing countries (e.g., transportation, residential, and commercial) remain eligible to participate in the project-based, policy-based, programmatic, or sectoral CDM (see Schmidt et al., 2006, for a definition and distinction of these approaches), for which the full level of emissions reductions are eligible for sale.

[2] This Technology Finance and Assistance Package would provide greater support to deployment of these advanced technologies than a simple awarding of carbon credits because, in many sectors, revenues from ERCs would be insufficient to provide the initial level of investment and technology transfer required to achieve significant early deployment of these technologies.

III. Designing a Sectoral Program

Several factors must be considered when establishing the structure of a sectoral approach to GHG emissions reductions. In this section, we describe the most important of these and discuss some of the critical features of each.

III.A Which Sectors Participate?

Global GHG emissions in 2000, ignoring land-use change and forestry (LUCF), were estimated to be approximately 32,500 $MMtCO_2e$ (see the Appendix for details). About 47% of these emissions originated in non-Annex I countries. Figure 2 shows how these developing country GHG emissions were distributed among the major economic sectors in 2000 and how sectoral CO_2 emissions are expected to grow in this group of countries. Fuel-combustion CO_2 emissions in developing countries are predicted to grow by 132% between 2000 and 2030, largely due to increased emissions from the electricity and transportation sectors (IEA, 2004b).

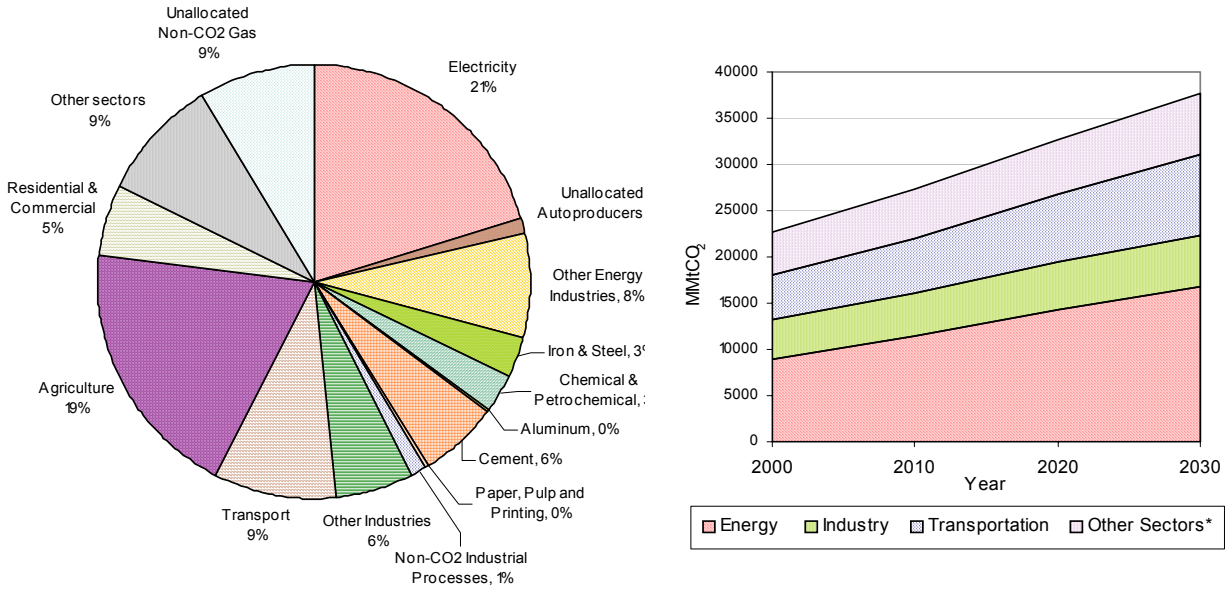


Figure 2. Non-Annex I country GHG emissions (without LUCF).

The left-hand panel shows the GHG emissions share by sector in 2000, and the right-hand panel shows major sector CO_2 emissions projections through 2030 (see the Appendix).

One of the key questions in a sector-based approach is which sectors to include because this influences the structure of such a program. The electricity and major energy-intensive industry sectors – electricity, iron & steel, aluminum, oil refining, cement, lime, and pulp & paper – are well-suited to the "no-lose" sectoral GHG intensity targets defined in this paper because they are each characterized by: (1) a relatively small number of entities; (2) comparatively easy data collection; (3) fairly homogenous products (except in the cases of oil refining and pulp & paper); and (4) participation in international trade (except in the case of electricity). Most importantly, these sectors combined produce significant GHG emissions – approximately 33% of non-Annex I and 15% of global non-LUCF GHG emissions (see Figure 3). An additional factor driving this choice of sectors is a desire to include all sectors which directly compete with one another to

minimize the likelihood that the program may provide indirect incentives for a non-covered competitive product. For example, if the iron and steel sector is subject to an emissions intensity target, while aluminum production is not, this could induce the substitution of aluminum for steel in applications for which either material is an option.

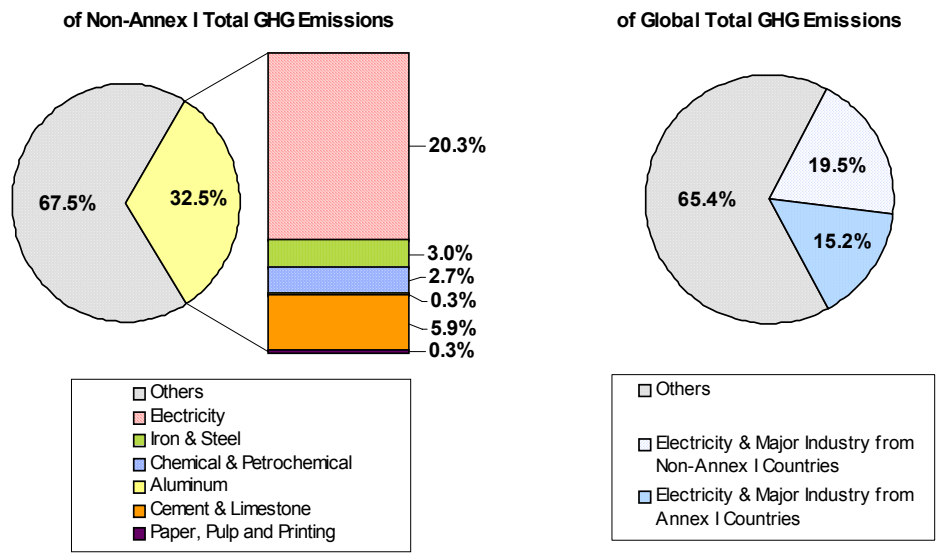


Figure 3. Electricity and major industrial sector GHG emissions in 2000.

Sectoral shares in non-Annex I countries are shown in the left-hand panel, and global shares appear in the right-hand panel (see the Appendix).

Since there is no universally accepted definition of a sector and the existing GHG inventories do not, in all cases, break emissions into appropriate sector categories, we suggest using bottom-up criteria (e.g., combustion facilities above 20 MW) to define each sector; the definitions used in the European Emissions Trading System could serve as a starting point for the establishment of sector boundaries. Further, we propose that only the emissions associated with direct combustion in a particular facility be included in a sector's emissions, since it is clearly preferable to rely on a separate target for the electricity sector, as proposed here, to capture the emissions related to off-site electricity production.

III.B An Industry-based or Country-based Approach?

There are essentially two types of sector-based programs – country-based programs, in which individual countries are responsible for ensuring that the emission levels of the covered sectors meet the emissions-intensity targets, and industry-based or transnational programs, in which targets are established for an entire sector's operations worldwide (Watson et al., 2005). The latter approach seeks to address often-raised concerns about leakage (e.g., firms moving operations from covered to non-covered countries) and competitiveness (e.g., covering one firm but not its competitor).

We suggest that a sectoral approach be country-based for the following reasons:

- A small number of countries are generally responsible for the vast majority of the GHG emissions in each sector, as discussed below, thus addressing concerns about competition by the participation of a small number of countries.
- Countries have much clearer legal authority to ensure that firms operating within their borders comply with program requirements; establishing a new legal institution to enforce sector-wide targets would likely require lengthy and contentious international negotiations. International law has delimited clear precedents for regulating specific industries on a global basis (e.g., international aviation and maritime), but even where global regulation of an industry does occur, the international agency developing the standards still relies upon countries to adopt and enforce them (Cooper et al, 2003; Nieuwpoort and Meijnders, 1998).

III.C Which Countries Participate?

The sector-based program proposed here aims to include all major developing countries, but special emphasis would be placed on encouraging the participation of the countries responsible for the majority of the electricity and key industrial sectors' operations and emissions. Other countries would be free to join the program, but the focus at first would be on those responsible for the majority of the emissions in the sector.

Fortunately, a relatively small number of countries account for a sizeable share of the developing country fraction of GHG emissions in most sectors – covering 80-90% of non-Annex I emissions for the electricity and major industrial sectors requires the participation of ten or fewer countries in each sector and only 20 developing countries overall (see Figure 4 and Table 1).

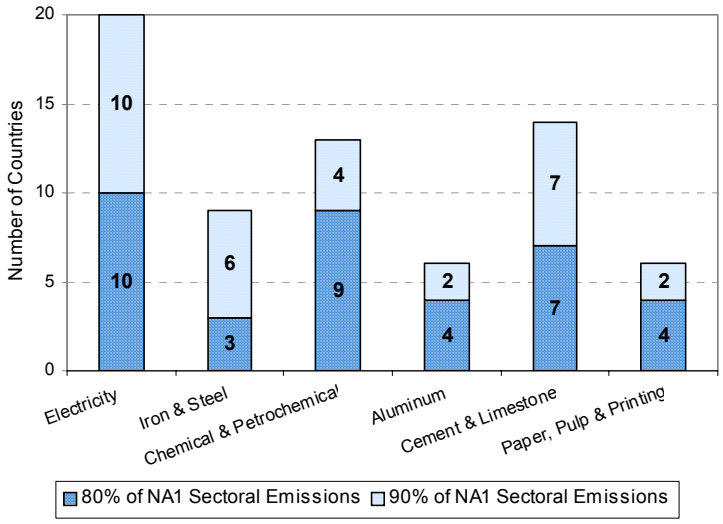


Figure 4. Number of participating countries required to cover 80-90% of non-Annex I GHG emissions in particular sectors in 2000.

The darker shaded regions of each bar show the number of countries responsible for 80% of developing country GHG emissions; the lighter shaded regions show the number of additional countries needed to achieve 90% coverage of developing country GHG emissions (see the Appendix).

Table 1. Top Ten Developing Country GHG Emitters for the Electricity and Major Industrial Sectors

Electricity	Iron & Steel	Chemical & Petrochemical	Aluminum	Cement & Limestone	Paper, Pulp & Printing
China	China	China	China	China	China
India	India	India	Brazil	India	Brazil
South Africa	Brazil	U.A.E.	India	South Korea	South Korea
South Korea	South Africa	South Africa	Venezuela	Brazil	India
Mexico	Mexico	South Korea	Chile	Indonesia	Indonesia
Iran	South Korea	Brazil	Argentina	Mexico	Mexico
Saudi Arabia	Venezuela	Mexico	Bahrain	Thailand	Colombia
Kazakhstan	Indonesia	Iran	Kazakhstan	Pakistan	Thailand
Indonesia	Kazakhstan	Indonesia	South Korea	Egypt	Argentina
Thailand	Iran	Venezuela	Macedonia	Iran	Chile

Source: see the Appendix

In some sectors, a small number of non-Annex I countries also account for a relatively large share of the global GHG emissions, so participation by only a few developing countries can also affect a significant amount of these sectors' worldwide emissions and cover a reasonable amount of overall global emissions. To illustrate this point, Figure 5 shows the percentage of global GHG emissions covered by a program that includes the ten highest-emitting non-Annex I countries for the sectors discussed here.

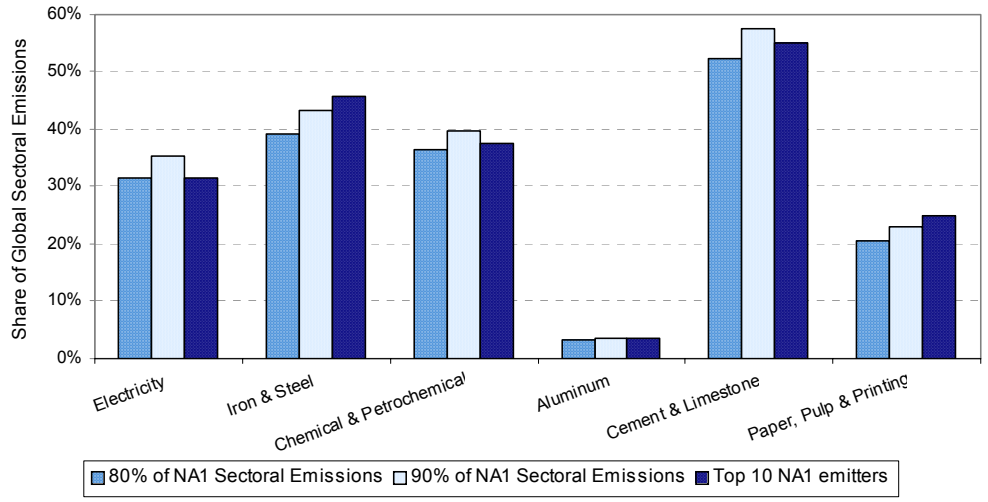


Figure 5. Global shares of developing country sectoral GHG emissions in 2000.

The leftmost and middle bars for each sector show the percentage of global GHG emissions contributed by 80% and 90% of non-Annex I country emissions; the rightmost bar for each sector shows the percentage of global GHG emissions that originate in the ten highest-emitting non-Annex I countries (see the Appendix).

III.D How is the "No-Lose" Target Established?

The final sectoral GHG intensity pledge made by each of the participating developing countries is produced through negotiation with the industrialized countries. Developing countries could

have a single carbon intensity target for each sector or two targets, one for new facilities and the other for existing facilities in the sector.

We envision a three-step process for establishing an aggressive "no-lose" target:

1. Experts assess and define *energy-intensity* benchmarks in each sector to use as a starting point for discussions.
2. Non-annex I countries pledge a carbon-intensity level that they can meet without assistance.
3. Annex I countries negotiate with developing countries on specific financial and other support–through a *Technology Finance and Assistance Package*–to encourage non-Annex I countries to ultimately commit to stricter "no-lose" emissions intensity levels.

Below, we discuss how each of these steps could proceed.

III.D.1 *Establishment of Energy Intensity Benchmarks*

The initial building block for this negotiation will be an expert assessment of benchmark energy intensity (e.g., Joules / ton of steel) levels for major processes within each selected industrial sector. This could be carried out by an international entity such as the International Energy Agency or by internationally selected expert institutes such as Lawrence Berkeley National Laboratory (U.S.), Tsinghua University (China), or some other designated benchmarking organization. Having an independent entity define the benchmark would insure that the process of negotiation begins on a firm technical and economic basis, in much the same way that the "Triptych" analysis served as the starting point for negotiations on burden-sharing within the European Union prior to Kyoto (Phylipsen et al., 1998; Groenenberg et al., 2001). We propose that the benchmarks be established through consideration of the following questions.

Are the benchmarks tailored to energy mix? We propose that the benchmarks be based upon energy intensity because this eliminates differences that are the result of variations in the fuel mix used in a sector or country. These energy intensity benchmarks would later be refined to GHG emissions intensities through negotiations with each country, as described below.

How many benchmarks are developed for each sector? From a purely engineering standpoint, it is often desirable to have a large number of benchmarks to reflect the entire range of production processes in a sector. However, developing and using a large number of benchmarks in an international negotiation process is bound to be cumbersome and present a barrier to effective negotiations. Therefore, the goal is to define a large enough number of benchmarks to reflect the major range of engineering differences between facilities, but not so many as to inhibit the international negotiation process. Therefore, we propose that the independent experts define a limited number of benchmarks, preferably less than five, to represent the major processes in each sector, taking into account considerations such as the availability of raw material substitutes.

What technology type is chosen as a basis of the benchmarks? We suggest that the benchmarks be based upon commercially available technologies, rather than technologies still under development. The independent entity could define separate benchmarks: one representing solely what is feasible from a technological and engineering standpoint and another that also accounts

for the costs of the technologies (e.g., requiring a two year payback or less than $5 per unit of energy). For example, the International Iron and Steel Institute (IISI, 1998) defined two separate benchmarks of these types: "Eco-Tech" and "All-Tech" benchmarks. Considering a range of economic threshold levels might also facilitate discussion of the "no-lose" target and the *Technology Finance and Assistance Package*.

How are existing and new facilities handled in the benchmark process? We propose that separate benchmarks be developed for new and existing facilities in each sector to reflect the differences between the technical availability of emissions reduction technologies, the cost of retrofit technologies versus new facilities, and the degree to which existing facilities have been fully amortized. Alternatively, the differences between new and existing facilities could be handled by allowing more time for existing facilities to meet the benchmark.

How would the benchmarks be updated? Since technology is continually progressing, benchmarks would need to be updated regularly. The frequency of benchmark updating would be sector-dependent and subject to discussion, but it should be driven by the rate of technological progress in each sector. For any particular sector, we suggest that it be no longer than every seven years, the timescale used for updating CDM baselines.

III.D.2 *Development of a Country's Domestic GHG Intensity Pledge*

After the assessment of the energy intensity benchmarks, each developing country would work to define a domestic GHG intensity pledge for each of the covered sectors. These countries would apply the energy-intensity benchmarks, described above, to their domestic facilities and then use the corresponding fuel mix to determine the analogous GHG intensity level for each participating sector. Each country would then pledge to unilaterally meet specific GHG intensity targets for both new and existing facilities, based upon the benchmark assessment, the likely impacts of the carbon intensity target on the competitiveness of its future exports from each sector, and other factors, such as its development objectives (e.g., improving air quality and providing for energy security).

III.D.3 *Negotiation of the Technology Finance and Assistance Package*

The international community would review the benchmark levels and each country's GHG intensity pledges to propose additional activities, facilitated through a *Technology Finance and Assistance Package*, with which it would support these countries in assuming "no-lose" GHG intensity targets that are more aggressive than their original pledges. This process would likely involve a give and take between each participating non-Annex I country and the international community to develop a robust country pledge and an appropriate and sufficient package of incentives. Further details of the *Technology Finance and Assistance Package* are discussed in Section 4.

III.D.4 *Defining the Final "No-Lose" Target*

Based upon a country's initial pledges and the support provided through the *Technology Finance and Assistance Package*, final "no-lose" GHG intensity targets would be established for each developing country in the program. In any sector, separate targets for existing and new facilities

could be defined or a single sector-wide target could be adopted. The latter type of target allows a country to receive credit towards their "no-lose" target by instituting programs that encourage a shift in the sector's operations from low- to high-efficiency facilities. Due to political and other differences among developing countries, we propose that each country be allowed to decide whether separate targets for new and existing facilities or a combined target for the entire sector is a better fit to their national circumstances.

Technological, economic, and political differences among developing countries also make it unlikely that all countries will have the same "no-lose" GHG intensity target for a given sector. However, since the ultimate targets are developed from the same starting point—the independently-defined energy-intensity benchmarks—a degree of comparability and equity is inherent in the target-setting process.

III.E How are Emissions Reduction Credits Generated?

In the proposed approach, the final (negotiated) "no-lose" target becomes the emissions crediting baseline. Emissions reductions beyond the final "no-lose" target are assigned Emissions Reduction Credits (ERCs) that are eligible for sale to Annex I countries. Calculation of the ERCs occurs in the following manner in each participating country:

- The total emissions and output (e.g., tons of cement) for each facility in the program are calculated at the end of the target demonstration period.
- These totals are used to calculate the average carbon emissions intensity for all facilities in the program.
- The total ERCs generated are then calculated by multiplying the difference between this average carbon intensity level and the country's carbon intensity target for the sector by the actual output in the sector.
- The country then decides whether and how to distribute the ERCs or the proceeds of the sale of ERCs to individual entities within the sector, without rewarding "free riders." An alternative would be to award ERCs directly to the covered companies, but this approach would be more complicated to design, requiring international negotiation to determine a policy for deciding which companies to reward, and would be less flexible.

The simplest way to accurately determine the number of ERCs generated from a given sector is to perform an *ex-post* calculation, when both the actual emissions rate and production levels are known (see Hargrave and Helme, 1998, for a discussion of an *ex-ante* system). We propose that a sectoral approach be designed in a manner that generates credits *ex-post*, as described above, every two years during the compliance period. This enables entities (e.g., countries or companies) to participate in carbon-market trading during the same compliance period in which the emissions reductions occur. It also avoids enforcement problems that can occur in *ex-ante* systems when countries are over-allocated ERCs.

IV. The Technology Finance and Assistance Package

In this sectoral approach, industrialized countries, international financial institutions (IFIs), and export credit agencies (ECAs) provide a package of technology finance and assistance incentives to help participating non-Annex I countries establish and meet more aggressive "no-lose" targets through the development and more rapid introduction of advanced technologies. Industrialized countries would offer new commitments of funding, such as that currently developed as follow-on to the G8 Gleneagles summit, which could be used to write down the cost of new, more expensive climate-friendly technologies in key developing countries. Such a process could unfold through both bilateral and multilateral arrangements that are designed to make these new technologies available to firms in developing countries while providing reasonable profits and property rights protections for the industrialized-country entities that provide the technologies. In this sense, the entities in both developed countries (e.g., through return to their shareholders and access to new markets) and developing countries (e.g., through access to new, advanced technologies) will benefit.

IV.A The Financial Scope of the Package

This new finance package would not be designed to fully support these advanced technologies but instead would be designed to leverage private sector investment by combining new financing from industrialized countries with a restructuring of existing financing mechanisms under IFIs and ECAs. The amount of money needed should be based upon a thorough bottom-up analysis of the financial and capacity barriers to meeting more aggressive GHG intensity levels than represented by the country's pledge. Different financing tools (e.g., risk coverage and "soft" loans) would likely be used in each country, depending on the specific characteristics of their financial markets and the structure of each sector involved. In addition, the level of required international financing would likely decrease with time, and ultimately end, because economies of scale will lower the cost of a given technology as it becomes more widely deployed. A good example of this can be seen in Figure 6, which shows the diminishing cost of wind turbines in Germany between 1990 and 2003 that resulted from incentive programs to catalyze the deployment of new technologies. The *Technology Finance and Assistance Package* would have a similar goal—namely to provide near-term incentives to demonstrate and deploy the technologies with the aim of bringing down the cost of these technologies over time.

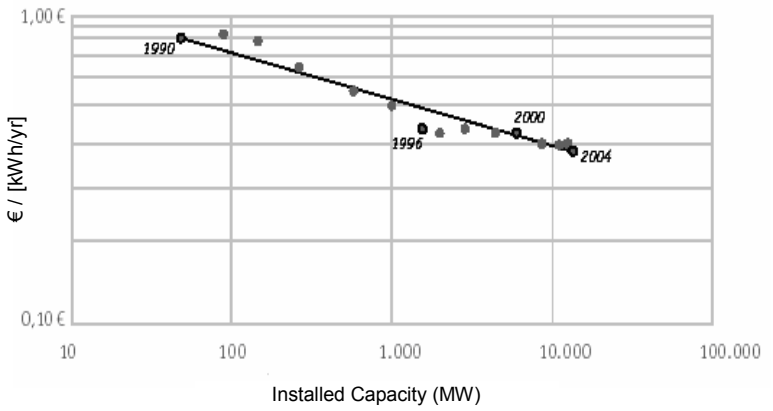


Figure 6. Learning curve for wind energy in Germany.

This curve shows how the cost of wind energy in Germany declined between 1990 and 2004, as the required technology improved and became more fully deployed.

IV.B What activities are supported?

Since the aim of the *Technology Financing and Assistance Package* is to help developing countries meet more aggressive "no-lose" targets, the program will strive to support activities that remove the major barriers to greater penetration and deployment of GHG-reducing technologies in the targeted sectors. In this regard, we propose that the package support but not be limited to the following specific activities:

Demonstration and Pilot Project Grants. For technologies that require further field-testing or have not yet been implemented in a specific developing country, financial and technical support would be provided for select demonstration projects and pilot tests. For example, developed countries could provide financial and technical support for demonstration IGCC-CCS plants in developing countries with significant coal resources (akin to the recent EU-China announcement on supporting such a facility; see *China Daily*, September 6, 2005). The goal would be to finance the incremental cost beyond that of conventional technology, while relying on conventional private and public investment to cover the base cost.

Technology Deployment and Capacity-Building Activities. A direct grant, soft loan, or other special lending provision (e.g., extended payback period, reduced fees, faster transaction processing, lower interest rate or premium, interest rate subsidy) could supplement IFI and ECA financing to cover the additional cost of climate-friendly technologies in targeted sectors and make them competitive with other IFI and ECA projects. For example, estimated concessionary financing of $8-12 billion could expand renewable energy generating capacity in developing countries by 50-70 GW between 2000 and 2010 (Sussman et al., 2004). Since ECA financing makes up a significant amount of private foreign direct investment (FDI), supplemental funding by the *Technology Finance and Assistance Package* could leverage a very large share of private FDI (Sussman et al., 2004). In addition, investment in climate-friendly technologies to developing countries can actually produce more cost-effective emissions reductions than similar levels of investment in these same technologies in industrialized countries (Lefèvre, 2005).

V. How is the approach applied to Annex I Countries?

In a sectoral approach, Annex I countries would adopt national fixed emissions limits (e.g., 30% below 1990 levels) for the entire economy. We suggest that the sectoral benchmarks developed for use in establishing the developing country's "no-lose" targets be used as building blocks for setting the national absolute targets for Annex I countries in a manner similar to the "Triptych" approach, where the level of reductions that can be achieved in individual sectors are combined to produce an economy-wide target for a country (Höhne et al., 2005; den Elzen and Lucas, 2003; Groenenberg, 2002). The benchmarks would thus be applied to the electricity and major industry sectors in the developed countries to determine the assigned amount units (AAUs) for these sectors. Targets for the other sectors (e.g., transportation and residential) could be developed in a different manner and then combined with the AAUs for the electricity and major industry sectors to establish the economy-wide national AAUs. An iteration process may be required to reduce some individual sectoral AAUs to meet the desired overall target for the country (e.g., 15% below 1990 levels).

One of the major concerns in any international agreement is that a "level playing field" exists between the operations in a given industry from country to country. Even in a sectoral approach in which all developing country negotiations start from the same energy intensity benchmarks in a given sector, the final "no-lose" targets adopted by these countries will likely differ to some degree. While this could be interpreted as providing a competitive advantage to some countries, it is also consistent with the principle of common but differentiated responsibility and accounts for national circumstances, such as differing fuel mixes. A level playing field is facilitated by the proposed approach because the same benchmark level—reflecting comparable technology—will be used as the starting point for establishing the targets in industrialized and developing countries. Furthermore, for some industrial sectors, operations in many developing countries are more efficient than those in their industrialized counterparts (see Figure 7).

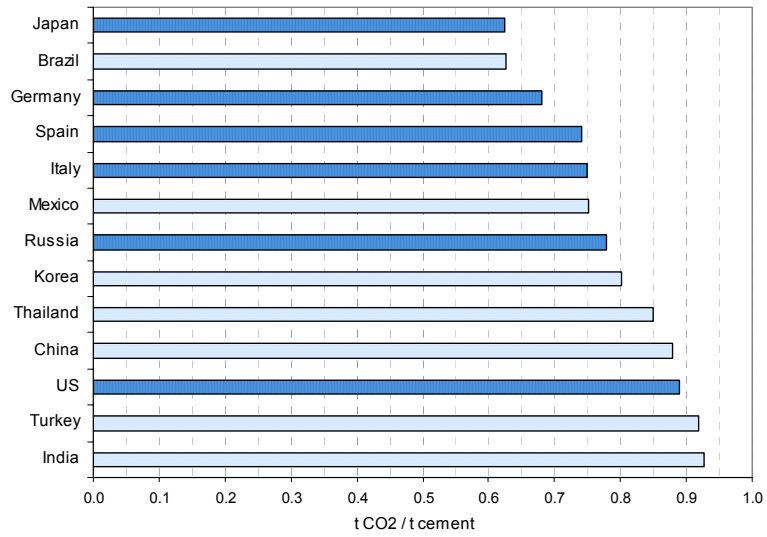


Figure 7. CO_2 emissions intensity of cement production in various countries. Dark and light bars represent emissions intensities in Annex I and non-Annex I countries, respectively. Note that there is no obvious distinction in emissions intensity between these two groups of countries (Hendriks et al., 1999; Price et al., 1999).

Level playing field concerns may also be raised because facilities in Annex I countries have the opportunity to trade to meet their targets—they can purchase allowances to cover any shortfall produced by incomplete implementation of a benchmark. At first glance, this might appear to violate the level playing field principle, but recall that facilities in developing countries face carbon-intensity targets rather than absolute caps, allowing unlimited growth in production, while facilities in Annex I countries face hard emissions caps, so trading is needed there to permit growth in emissions caused by increased production. Overall, a sectoral approach may not produce a completely level playing field in any given sector, but it moves the post-2012 process significantly in that direction by ensuring that a large share of global operations in a given industrial sector are now part of a similar regime, albeit an incentive-based rather than mandatory regime in the major developing countries.

VI. Emissions Implications of a Hypothetical Sector Target

To assess whether the proposed sectoral approach could achieve a level of global emission reductions by 2020 sufficient to preserve the opportunity for stabilization of atmospheric CO_2 concentrations at the 450-550 ppmv level in this century, three future GHG emissions scenarios were modeled (Höhne et al., 2005). The "mild" and "strong" scenarios incorporated a combination of future emissions targets, made up of: 1) absolute economy-wide targets in all Annex I countries except the U.S., 2) a less ambitious national target in the U.S., and 3) no targets ("mild" scenario) or sectoral targets ("strong" scenario) in the cement, electricity, and iron and steel industries in the highest-emitting developing countries. The third scenario consisted of only sectoral targets in all three groups of countries ("sectoral-only"). These scenarios are described more fully in Table 2. The models' outcomes, discussed below, are not intended to be definitive but are instead aimed at understanding the first-order implications of the sectoral approach proposed here.

Table 2. Key Assumptions in Preliminary Top Down Analysis

Scenario	Condition	
"Mild"	*Annex I excl. USA*	-15% below 1990 level in 2020
	USA	+10% above 1990 level in 2020
	Non-Annex I	Reference
"Strong"	*Annex I excl. USA*	-30% below 1990 level in 2020
	USA	+0% at 1990 level in 2020
	Non-Annex I	"Sectoral" for electricity, iron & steel, and cement
"Sectoral-Only"	*All countries*	"Sectoral" for electricity, iron & steel, and cement
"Sectoral"	*Electricity*	Reduction in carbon intensity of electricity production (C/kWh) by 3% per year; growth in production reduced by 0.5% per year due to energy efficiency improvements.
	Iron & Steel	Convergence in tons CO_2/ton steel by 2025 to 0.80 (year 2000 average = 1.53)
	Cement	Convergence in tons CO_2/tons cement by 2020 to 0.60 (year 2000 average = 0.77)

Source: ECOFYS (2005)

VI.A Key Assumptions and Scenarios Analyzed

The modeling incorporated data on CO_2 emissions, energy use and physical production (e.g., tons of steel) for the electricity, iron and steel, and cement sectors in the following major Annex I and non-Annex I countries: EU15, USA, Japan, Canada, Russia, Brazil, China, India, Mexico, South Africa, and South Korea. These countries account for 72% of total global GHG emissions and 79% of the global emissions from the three listed sectors in 2000. In addition, these three sectors are responsible for 91% of the emissions produced by the electricity and major industrial sectors suggested for inclusion in the proposed sectoral approach.

For the selected countries, physical production, energy use and GHG emissions were collected from various international sources, mainly the International Energy Agency, the International Iron and Steel Institute, the US Geological Survey (IEA, 2003b; IEA, 2004a; IISI, 2004; USGS,

2004), and national sources. The resulting emission intensities per product were calculated from the data.

For the scenarios involving sectoral GHG emissions targets, the sectoral emissions intensities were assumed to converge to similar levels by 2020 in the iron and steel and cement sectors and to decline by similar rates in the electricity sector. While the scenarios define fixed limits for Annex I countries (e.g., 15% below 1990 levels), this does not necessarily imply that this level of reduction must occur domestically in those countries. Instead, Annex I countries could meet their national targets by purchasing emissions reductions from developing countries that perform better than their "no-lose" targets or from other sectors in developing countries.

VI.B Preliminary Results

Figure 8 shows how global CO_2 emissions evolve between 1990 and 2020 under the "mild," "strong," and "sectoral-only" scenarios. The emissions reductions in 2020 produced in developing countries by the introduction of the proposed sectoral approach are illustrated in Figure 9. The "sectoral" scenario described in Table 2 reduces GHG emissions (below the reference scenario) in developing countries in 2020 by 11% economy-wide and by 36% overall in the three participating sectors.

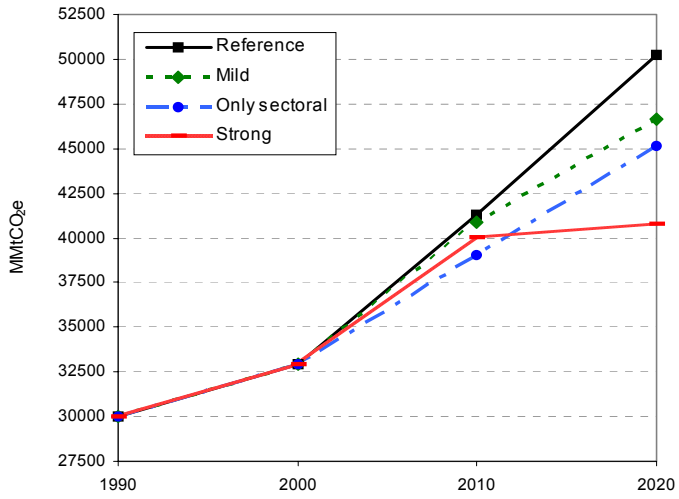


Figure 8. Global GHG emissions under the sectoral scenarios.

The bold line shows the behavior of global GHG emissions between 1990 and 2020 under the reference scenario. The short-dashed, long-dashed, and lighter solid lines show how global GHG emissions are reduced under the "mild", "strong", and "sectoral-only" scenarios, respectively (Höhne et al., 2005). See Table 2 for descriptions of the various scenarios.

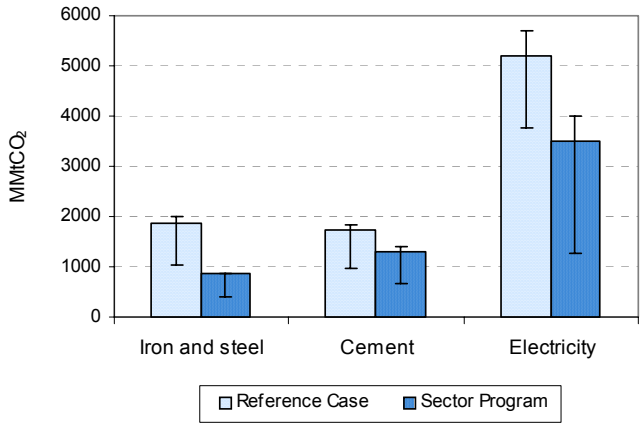


Figure 9. Non-Annex I country model GHG emissions in 2020 in the electricity, cement, and iron and steel sectors.

The left-hand bars for each sector show sectoral GHG emissions for the reference scenario, and the left-hand bars show emissions under the "sectoral" scenario. The models indicate that GHG emissions in 2020 would be reduced by 54%, 25%, and 33% from the reference cases in the iron and steel, cement, and electricity sectors, respectively, by introduction of a sectoral GHG emissions reductions approach in developing countries (see the Appendix; Höhne et al., 2005).

To assess whether these emission levels in 2020 are sufficient to stabilize CO_2 concentrations at a particular level, we assumed that after 2020, total global emissions are reduced as quickly as possible. The inertia to change global emission trends was represented by the simple assumption that the global emission trend after 2020 cannot change more than 0.5 percentage points per year. The MAGICC model (Wigley and Raper, 2001) was used to calculate the resulting CO_2 concentration of the global emission pathways. For details of the methodology, see Höhne and Blok (2006).

All three of the modeled scenarios made sufficient reductions in global GHG emissions to permit stabilization of atmospheric concentrations of CO_2 at the 450-550 ppmv level by the end of the century, if emissions after 2020 are reduced further (see Figure 10). The "strong" scenario understandably achieved the largest reductions, the "sectoral" case was next best, and the "mild" case reduced emissions the least. However, the "mild" scenario requires three times the level of annual emissions reductions of the "strong" case in the years between 2020 and 2050 (6.5% vs. 2.2% per year) to achieve atmospheric stabilization of CO_2 concentrations at 450 ppmv. The "sectoral-only" case also requires significant annual reductions after 2020, on the order of 4% per year, to attain this stabilization level – this result underlines the importance of maintaining economy-wide caps for Annex I countries, rather than shifting to a global, intensity-based sector-only approach toward GHG emissions reductions.

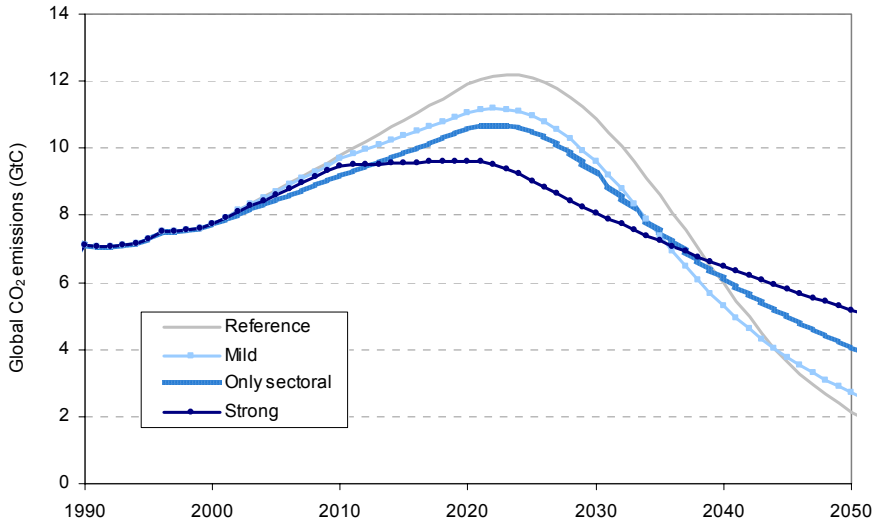


Figure 10. Global CO_2 emissions required to stabilize atmospheric CO_2 concentrations at 450 ppmv in the sectoral models.

From top to bottom in 2020, the lines represent the reference, "mild", "sectoral-only", and "strong" scenarios (see Table 2). For all scenarios, the model assumptions apply through 2020, and the emissions behavior illustrated between 2020 and 2050 is a smooth representation of that required to achieve atmospheric stabilization of CO_2 concentrations at the 450 ppmv level by 2050 (Höhne et al., 2005).

VII. Implications and Next Steps

One of the principal goals of the sectoral approach is to promote the use of best practices in internationally competitive industries around the globe. In practice, it aims to achieve the somewhat proverbial level playing field and encourage technological innovation. This approach also offers a useful basis to resolve the continuing arguments in the European Union's Emissions Trading System over the fairness of individual Member State allowance allocations. By developing consistent benchmarks in major industrial sectors, it could move this process toward a more consistent allocation of allowances.

VII.A Improving on the Kyoto Protocol

The sectoral approach marks an important departure from the current international structure because developing country carbon-intensity targets constitute new contributions to the reduction of atmospheric concentrations of GHGs. Under the Kyoto Protocol, the developing country focus is on reductions achieved through the Clean Development Mechanism (CDM); these replace rather than supplement emissions reductions that would otherwise be made by industrialized countries. A sectoral approach also allows explicit recognition and quantification of developing countries' unilateral efforts to reduce GHG emissions, independent of the CDM, such as China's fuel economy standards for new cars and Brazil's ethanol fuels programs.

In the developing countries which participate in a sectoral program, the pledge process supplants the CDM in the covered sectors. This approach improves upon the CDM because:

- It incorporates all facilities in a given sector in a participating developing country.
- Reductions achieved beyond a country's sectoral target are automatically "additional" and available for sale; host countries no longer face uncertainties about additionality.
- Developing countries not participating in the sectoral program, as well as entities in uncovered sectors of participating developing counties, can still carry out projects under the current or a revised (policy-based or sectoral) version of the CDM.
- The benchmarking process carried out in the proposed sectoral approach can assist the CDM Executive Board and its Methodology Panels to evaluate project-specific baselines and additionality for CDM projects in these sectors.

Most importantly, the proposed *Technology Finance and Assistance Package* encourages the development and transfer of new, climate-friendly technologies in developing countries and promotes precisely the technological innovation required for the world to achieve stabilization of global GHG concentrations at safe levels. It builds into the international process an explicit negotiation on technology finance between industrialized and key developing countries and mobilizes new public resources to leverage private investment and a portion of existing resources from the World Bank, other IFIs, and ECAs to promote technological innovation and GHG reductions.

VII.B Achieving the Same Goals through a Modified Clean Development Mechanism

The goals of the proposal outlined in this paper could instead be achieved through the participation of these same sectors in "Sectoral CDM" (Schmidt et al., 2006; Figueres, 2006), where certified emissions reductions are only generated when a sector's emissions fall below a predetermined intensity level (e.g., a benchmark). The one major difference between Sectoral CDM and the approach proposed here is that Sectoral CDM would not necessarily provide a focused package of technology investments (Schmidt et al., 2006).

VII.C Non-Covered Sectors

A key question for further consideration is whether a sector-based approach could be applied to the other sectors or sub-sectors (e.g., transportation, residential, and commercial sectors). The specific structure proposed for the electricity and major industry sectors is probably not directly applicable to these other sectors, but similar programs could perhaps be developed that reflect their unique characteristics; for example, a motor vehicle emissions intensity target of similar structure (g CO_2 / km), based upon either rate of progress (e.g., 2% decline per year) or ultimate level (e.g., 100 g/km by 2020), could be introduced in the transportation sector (Houdashelt et al., 2006). Alternatively, non-covered sectors may be better suited to some form of the CDM – project-based, sectoral, or programmatic.

Three sectors or sub-sectors seem potentially promising and warrant further consideration:

- Land-use change and forestry (19% of global and 34% of non-Annex I emissions in 2000); ten countries account for over 80% of global emissions (see Appendix);
- Transportation, especially light-duty passenger vehicles (8% of global emissions in 2000, excluding LUCF, and growing rapidly in developing countries); ten countries accounted for more than 90% of passenger vehicle manufacturing in 2004 (International Association of Automobile Manufacturers, 2005), so such an approach could be applied in a limited number of countries and cover the majority of production.
- Appliances – residential appliances and equipment use 30% of the electricity generated in OECD countries (International Energy Agency, 2003a), and some appliances have substantial regional and global markets (Guéret, 2005), implying that collaborative development of appliance energy-efficiency standards in a limited number of locations could have much more widespread impacts.

VII.D Leakage

Philibert and Pershing (2001) discuss how sectoral targets are vulnerable to international and inter-sectoral leakage. However, the approach described here is designed to address each of these. International leakage is minimized by including all major GHG-emitting countries in each covered sector (e.g., the "top ten"). Since the basis for the "no-lose" targets—the energy-intensity benchmarks—are similar in each country, the incentive to shift operations to a country with lower standards is also reduced. Inter-sectoral leakage is reduced to some extent in this proposal through the judicious choice of participating sectors; most of the industries that experience serious competition from other sectors (e.g., steel and aluminum) would be covered. Of course, for any approach that does not cover the entirety of global emissions, as in this

approach, leakage will continue to be a concern. Further consideration of the extent of leakage in a sectoral approach, versus that in other post-2012 proposals, warrants further consideration.

VIII. Summary

We propose that a sectoral approach to GHG emissions reductions should be a key component of the post-2012 climate change mitigation framework. Interest in sector-based approaches for developing countries in the post-2012 regime is garnering considerable attention, as evidenced at the May, 2006, meeting of the Subsidiary Body for Scientific and Technical Advice of the UNFCCC, where a number of interventions (by both industrialized and developing countries) mentioned the sectoral "no-lose" approach as a potentially promising option for developing countries in the post-2012 climate change mitigation framework. In this approach, the ten highest-emitting developing countries in the electricity and other major industrial sectors pledge to meet voluntary, "no-lose" GHG emissions targets in these sectors. In this case, the term "no-lose" implies that participating countries incur no penalties if they fail to meet their targets, while all reductions beyond the target level earn Emissions Reduction Credits that are available for sale to industrialized countries.

The final "no-lose" emissions targets result from negotiations with industrialized countries. The starting points for these negotiations are energy-intensity benchmarks, developed by independent experts, for the electricity and major industrial sectors. From these benchmarks, the participating developing countries determine initial GHG emissions targets that are appropriate for their national circumstances. Industrialized countries then offer incentives for the developing countries to adopt more stringent emissions targets through a Technology Finance and Assistance Package, which helps them to overcome financial and other barriers to technology transfer and deployment.

Preliminary modeling of a hybrid scenario in which Annex I countries adopt economy-wide absolute GHG emissions targets, similar to those in the Kyoto Protocol but influenced by the aforementioned emissions-intensity benchmarks, and high-emitting developing countries adopt "no-lose" sectoral targets indicates that such an approach significantly improves the likelihood that atmospheric concentrations of CO_2 can be stabilized at 450 ppmv by 2050.

References

Cooper, C., Park, D., Schmidt, J., Ulbrich, I. and Winkelman, S. 2003. *Controlling Airport-Related Air Pollution*. Center for Clean Air Policy and the Northeast States for Coordinated Air Use Management, Washington, DC.

European Union, *Presidency Conclusions of the Brussels European Council (22 and 23 March 2005)*. Available at: http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/84335.pdf.

Figueres, Christiana. 2006. *Sector CDM: Opening the CDM to the Yet Unrealized Goal of Sustainable Development*. Forthcoming publication of the International Journal of Sustainable Development Law and Policy.

Guéret, T. 2005. *International Energy Technology Collaboration and Climate Change Mitigation—Case Study 3: Appliance Energy Efficiency*. Organisation for Economic Co-operation and Development/International Energy Agency, Paris.

Groenenberg, H., Phylipsen, D. and Blok, K. 2001. Differentiating Commitments Worldwide: Global Differentiation of GHG Emissions Reductions based on the Triptych Approach—a Preliminary Assessment. *Energy Policy* **29** (2001)1007-1030.

Hargrave, T. and Helme, N. 1998. *Growth Baselines: Reducing Emissions and Increasing Investment in Developing Countries*. Center for Clean Air Policy, Washington, DC.

Hendriks, C.A.,, E Worrell, D. de Jager, K. Blok, and P. Riemer. 1999. *Emission Reduction of Greenhouse Gases from the Cement Industry*. IEA GHG R&D Programme.

Hoehne, N., Worrell, E. and Graus, W. 2005. *Emission Reductions Achieved from a Sectoral Approach*. Presentation at the Center for Clean Air Policy's Dialogue on Future International Actions to Address Global Climate Change, Oslo, April.

International Iron and Steel Institute. [IISI]. 1998. Energy Use in the Steel Industry. Brussels.

International Association of Automobile Manufacturers [OICA]. 2005. World Motor Vehicle Production by Country and Type: OICA correspondents' survey. 6 July. Available at: www.oica.net/htdocs/statistics/tableaux2004/worldproduction_cars2004.pdf

International Energy Agency (IEA). 2003. *CO_2 Emissions from Fuel Combustion, 1970-2001*. Paris, France.

International Energy Agency and World Business Council for Sustainable Development (WBCSD). 2004. *IEA/SMP Transport Model*.

Marland, G., Boden T.A., and Andres, R. J. 2004. *Global, Regional, and National Fossil Fuel CO_2 Emissions*. In: Trends: A Compendium of Data on Global Change. Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, TN.

Nieuwpoort, G. and Meijnders, E.L.M. 1998. The Integration of Economic and Safety Policy for Shipping: The need for self-organization. In: Haralambides, H.E. (ed.) *Quality Shipping, Market Mechanisms for Safer Shipping and Cleaner Oceans*. Rotterdam (1998).

Pacific Northwest Laboratory. 1995. *Energy Efficiency Opportunities in China: Industrial Equipment and Small Cogeneration.* U.S. Department of Energy, Richland, WA.

Phylipsen, G.J.M., Bode, J.W., Blok, K., Merkus, H., and Metz, B. 1998. Triptych sectoral approach to burden differentiation: GHG emissions in the European bubble. Energy Policy 26(12), 929-943.

Price, Lynn, Ernst Worrell and Dian Phylipsen. 1999. *Energy Use and Carbon Dioxide Emissions in Energy-Intensive Industries in Key Developing Countries*. Ernest Orlando Lawrence Berkeley National Laboratory. September.

Schaefer, D. O., Godwin, D. and Harnisch, J. 2006. Estimating Future Emissions and Potential Reductions of HFCs, PFCs, and SF6, *Energy Journal*, in preparation.

Scheehle, E. A. and Kruger, D. 2006. Global anthropogenic methane and nitrous oxide emissions, *Energy Journal***,** in preparation.

Silsbe, Erin, Jake Schmidt, Jin Lee, and Steve Winkelman. 2006. *Programmatic CDM: How it can be implemented?* Forthcoming Clean Development Mechanism Dialogue Working Paper. Center for Clean Air Policy: Washington, DC.

Sussman, F., Helme, N. and Kelly, C. 2004. *Harnessing Financial Flows from Export Credit Agencies*. Center for Clean Air Policy: Washington, DC.

U.S. Environmental Protection Agency. 2005. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003*. U.S. Governmental Printing Office, Washington, DC.

Watson, C., Newman, J., Upton, S., and Hackmann, P. 2005. *Can Transnational Sectoral Agreements Help Reduce Greenhouse Gas Emissions?* Background paper for the OECD Round Table on Sustainable Development, Organisation for Economic Co-operation and Development/International Energy Agency, Paris.

World Resources Institute. 2005. Climate Analysis Indicator Tool version 3.1. Available at: http://cait.wri.org.

World Resources Institute and World Business Council for Sustainable Development. 2004. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard - Revised Edition.* World Resources Institute and World Business Council for Sustainable Development, Washington, DC

Appendix. Sectoral Greenhouse Gas Emissions in 2000

A.1 Methodology

Since no single source compiles all non-Annex I GHG emissions by country and by sector, a set of sources was combined to calculate a "first order" sectoral GHG inventory for each non-Annex I country. Total GHG emissions were calculated by adding: (1) CO_2 emissions from fuel combustion (IEA, 2003); (2) CO_2 emissions from cement manufacturing process (Marland et al., 2004); (3) non-CO_2 emissions (Schaefer et al., 2004; Scheehle & Kruger, 2004; WRI, 2006); and (4) carbon emissions from land use (WRI, 2005). Table A-2 below shows estimated GHG emissions for each country by sector in 2000. Depending on the sources, it was not possible to fully disaggregate data into sectoral distribution and/or countries. Any error in the following data is the sole responsibility of the authors.

A.2 Key Sources

CO_2 emissions from fuel combustion

The International Energy Agency (2003) follows the default methods and emission factors from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories to estimate CO_2 emissions from fuel combustion. Emissions estimates are organized by following categories:

- Public Electricity and Heat Production
- Unallocated Autoproducers
- Other Energy Industries
- Manufacturing Industries and Construction
- Transport
- Other Sectors

CO_2 emissions from cement manufacturing process

Carbon Dioxide Information Analysis Center (CDAIC) of Oak Ridge National Laboratory, U.S. Department of Energy (Marland et al., 2004) estimates global CO_2 emissions from fossil-fuel burning, cement manufacturing, and gas flaring. The author imported emissions estimates from cement production.

Non-CO_2 emissions

Sectoral non-CO_2 emissions data was calculated using emissions estimates of CH_4, N_2O and other fluorinated gases developed by Schaefer, Godwin and Harnisch (2004) and Scheehle and Kruger (2004). Since the original data sets were organized by gas, the author reorganized the data by sector by following categories:

- Energy:
  - CH_4 emissions from coal, natural gas, oil and other stationary and mobile activities
  - N_2O emissions from mobile activities
- Industrial Processes:
  - N_2O emissions from chemical industry
  - High Global Warming Potential (GHWP) gas emissions from industrial processes
- Agriculture:

- N_2O emissions from manure management systems and agricultural soils
- CH_4 emissions from manure management systems, enteric fermentation, and rice cultivation

- Biomass Burning:
  - CH_4 and N_2O emissions from biomass combustions
- Waste:
  - CH_4 emissions from landfills and wastewater handling
  - N_2O emissions from wastewater handling

Because the original data did not include detailed sectoral emissions estimates for some countries, total non-CO_2 emissions estimates were imported from World Resources Institute's Climate Analysis Indicators Tool (CAIT) (2005).

CO_2 Emissions from Land Use Change, and Forestry (LUCF)

Carbon emissions from land use were imported from World Resources Institute's Climate Analysis Indicators Tool (CAIT) (2005).

A.3 Defining and Grouping Sectors

A variety of classification systems are used to organize data on greenhouse gas and economic activities. Below are some of the more prevalent systems.

- *IPCC Common Reporting Format (CRF)* outlines the categories to be used in national greenhouse gas emissions inventory reporting.
- *National Greenhouse Gas Inventories* are used by governments to report national greenhouse gas emissions. These inventories often contain greater disaggregated information than contained in the CRF.
- *North American Industry Classification System (NAICS)* is used by the U.S., Canada, and Mexico to for classifying business establishments.[3]
- *Nomenclature des activités économiques dans les Communautés européennes (NACE)* is used by the European Commission.[4]
- *International Standard Industrial Classification (ISIC)*[5] is a scheme developed by United Nations Statistical Division to classify economic activities.

For greenhouse gas emissions reporting, the most common sector group occurs in the Common Reporting Format (CRF). The CRF categories are: (1) energy, which accounts emissions from fuel combustion; (2) industrial processes; (3) solvent and other product use; (4) agriculture; (5) land-use change and forestry; (6) waste; and (7) other. Another grouping of industries has been proposed as a part of the Triptych proposal for differentiating greenhouse gas targets (Phylipsen et al., 1998). Triptych classifies three groupings of sectors: (1) *energy-intensive industries*, which consists of the iron & steel, chemicals, pulp and paper, non-metallic minerals, non-ferrous metals, and energy-transformation sectors; (2) *power production*; and (3) *domestic*, which consists of the residential, commercial, transportation, light industry, and agriculture sectors (Groenenberg et al., 2001).

[3] For NAICS classifications, see: www.census.gov/epcd/naics02/naico602.txt
[4] For more information on NACE, see: http://europa.eu.int/comm/eurostat/ramon/intro_nace_rev1/en.html
[5] For more information on ISIC, see: http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=2&Lg=1

For the purpose of discussing sector-based GHG mitigation options in this paper, the authors selected key sectors that account for significant portions of total emissions and have potential for implementing sector-based programs. Selected key sectors that were discussed throughout this paper are shown in bold in Table A-1. Other sectors with much smaller GHG emissions were combined as other sectors, and their specific sources are described in Table A-1.

Table A-1. Sectoral Breakdown of Greenhouse Gasses

Energy	**Electricity**	CO_2 from fuel combustion in public electricity, CHP, and heat plants (IEA, 2003)
	Unallocated Autoproducers	CO_2 from fuel combustion in autoproducer electricity, CHP, and heat plants (IEA, 2003)
	Other Energy Industries	CO_2 from fuel combustion from other energy industries (IEA, 2003); Fugitive CH_4 from fuel combustion in coal mining, oil and natural gas, stationary and mobile sources (Schaefer et al., 2004; Scheehle & Kruger, 2004); and N_2O from fuel combustion in stationary and mobile sources (Schaefer et al., 2004; Scheehle & Kruger, 2004)
Industry	**Iron & Steel**	CO_2 from fuel combustion in iron & steel sector (IEA, 2003)
	Chemical & Petrochemical	CO_2 from fuel combustion in chemical & petrochemical sector (IEA, 2003)
	Aluminum	CO_2 from fuel combustion from non-ferrous metals sector (IEA, 2003)
	Cement	CO_2 from fuel combustion from non-metallic minerals sector (IEA, 2003); and CO_2 from cement manufacturing process (Marland et al., 2004)
	Paper, Pulp, & Printing	CO_2 from fuel combustion in paper, pulp, & printing sector (IEA, 2003)
	Non-CO_2 Industrial Processes	N_2O from nitric and adipic acid production (Schaefer et al., 2004; Scheehle & Kruger, 2004); and Other high global warming potential (HGWP) gasses from industrial processes (Schaefer et al., 2004; Scheehle & Kruger, 2004)
	Other Manufacturing Industries	CO_2 from fuel combustion in transport equipment, machinery, mining & quarrying, food & tobacco, wood & wood products, construction, textile & leather, non-specified industry, and non-energy use in industry sectors (IEA, 2003)
Others	**Transportation**	CO_2 from fuel combustion in domestic air transport, road, rail, pipeline transport, national navigation, non-specified transport, and non-energy use in transport sectors (IEA, 2003)
	Agriculture	CO_2 from fuel combustion in agricultural sector (IEA, 2003); N_2O from manure management systems and agricultural soils (Schaefer et al., 2004; Scheehle & Kruger, 2004); and CH_4 from manure management, enteric fermentation, rice cultivation, and other agricultural sources (Schaefer et al., 2004; Scheehle & Kruger, 2004)
	Residential & Commercial	CO_2 from fuel combustion in residential, commercial, and public services (IEA, 2003)
	Other Sectors	CO_2 from fuel combustion in non-specified other sectors and non-energy use in other sectors (IEA, 2003); and CH_4 and N_2O from biomass combustion (Schaefer et al., 2004; Scheehle & Kruger, 2004)
	LUCF	CO_2 from land use change, and forestry (WRI, 2005)
	Unclassified Non-CO_2 Gas	Difference between total non-CO2 emissions from WRI (2005) and the sum of the sectoral non-CO2 gasses from (Schaefer et al., 2004; Scheehle & Kruger, 2004)

A.4 Geographical Coverage

Please note that the following countries have been aggregated into regional groups due to lack of detailed data for individual sectors.

Other Africa

Bhutan, Botswana, Burkina Faso, Central African Republic, Chad, Djibouti, Gambia, Guinea, Guinea Bissau, Liberia, Madagascar, Malawi, Mali, Mauritania, Niger, Rwanda, Sierra Leone, Swaziland, Uganda, Western Sahara, and Zaire.

Other Latin America

Antigua & Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Dominica, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guyana, Martinique, Montserrat, Netherlands Antilles, Puerto Rico, Saint Helena, Saint Lucia, St. Kitts-Nevis, St. Vincent & the Grenadines, Suriname, Turks and Caicos Islands, and U.S. Virgin Islands.

Other Asia

Burundi, Cambodia, Cape Verde, Comoros, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Lao People's Democratic Republic, Macau, Maldives, Mauritius, Mongolia, Nauru, New Caledonia, Niue, Palau, Papua New Guinea, Reunion, Samoa, Sao Tome & Principe, Seychelles, Solomon Islands, Tonga, Vanuatu, and Wake Islands

Table A-2. Sectoral Greenhouse Gas Emissions in 2000 ($MtCO_2$).

Countries	Electricity	Unallocated Autoproducers	Other Energy Industries	Iron & Steel	Chemical & Petrochemical	Non-Ferrous Metals (Aluminum)	Non-Metallic Minerals (Cement)	Paper, Pulp & Printing	Non-CO2 Industrial Processes	Other Manufacturing Industries	Transport	Agriculture	Residential & Commercial	Other sectors	LUCF	Unclassified Non-CO_2 Gas	**TOTAL**	**TOTAL w/o LUCF**
Albania	0.1	0.0	0.0	0.2	0.2	0.1	0.1	0.0	0.0	0.7	1.2	0.3	0.2	0.0	0.8	0.6	**4.5**	**3.7**
Algeria	17.1	0.4	22.4	1.2	2.3	0.0	4.1	0.0	0.9	3.3	7.9	9.3	9.8	19.2	2.8	10.6	**111.2**	**108.4**
Angola	0.5	0.0	0.3	0.0	0.0	0.0	0.2	0.0	0.0	1.6	1.0	0.0	1.1	0.0	17.8	20.8	**43.3**	**25.5**
Argentina	21.7	4.7	28.3	3.7	3.1	1.3	5.6	0.7	1.2	9.9	43.6	78.5	20.6	12.9	55.2	45.1	**336.1**	**281.0**
Armenia	1.6	0.0	1.2	0.0	0.0	0.0	0.1	0.0	0.0	1.3	0.1	0.5	0.1	1.3	0.0	0.5	**6.7**	**6.7**
Australia	164.3	6.1	50.1	9.0	4.6	14.1	8.5	2.0	7.6	16.8	75.3	93.6	10.5	18.4	4.3	5.5	**490.9**	**486.6**
Austria	9.4	3.7	3.7	5.9	1.6	0.2	3.5	1.5	1.5	4.5	18.9	5.5	11.6	4.9	-0.8	1.8	**77.5**	**78.3**
Azerbaijan	14.6	0.1	5.7	0.0	0.8	0.2	0.1	0.0	0.2	4.1	1.5	2.5	4.5	3.7	0.0	3.0	**41.1**	**41.1**
Bahrain	4.3	1.1	3.5	0.0	2.2	1.2	0.0	0.0	0.0	0.0	1.5	0.0	0.2	0.0	0.0	2.6	**16.8**	**16.8**
Bangladesh	8.8	0.0	0.6	0.0	4.4	0.0	3.1	0.0	0.1	4.4	3.0	51.3	3.4	20.7	-9.3	21.2	**111.8**	**121.1**
Belarus	22.0	9.1	8.9	0.2	5.6	0.0	2.7	0.1	0.2	1.9	6.1	17.7	4.3	4.5	5.6	-7.8	**81.1**	**75.4**
Belgium	24.7	2.0	8.6	12.8	8.6	0.4	7.0	0.5	5.7	9.2	24.7	15.6	26.4	2.7	0.0	-2.8	**146.2**	**146.2**
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.9	0.0	0.3	0.0	36.2	5.8	**43.6**	**7.4**
Bolivia	1.1	0.1	2.4	0.0	0.0	0.0	0.5	0.0	0.0	0.8	2.8	11.4	0.8	2.7	83.9	12.6	**119.1**	**35.3**
Bosnia-Herzegovina	8.9	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	2.0	1.8	0.0	0.2	2.4	0.0	1.8	**17.3**	**17.3**
Brazil	18.6	9.9	24.2	25.0	20.0	6.2	33.0	4.3	15.9	25.3	125.7	229.1	21.3	45.6	1373.1	225.0	**2202.2**	**829.1**
Bulgaria	23.1	1.6	6.1	3.2	3.3	0.4	2.5	0.2	1.0	1.5	5.5	18.9	0.9	5.1	-2.0	-12.4	**58.7**	**60.7**
Cameroon	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	1.9	0.0	0.7	0.0	77.2	20.8	**101.2**	**24.0**
Canada	121.7	5.8	109.1	14.8	19.8	2.8	10.6	11.0	15.5	45.0	150.0	70.6	84.1	31.2	64.6	-16.2	**740.3**	**675.8**
Chile	13.0	0.7	4.1	1.9	0.1	1.5	2.6	0.7	0.3	6.4	16.0	8.1	4.1	4.4	15.5	8.1	**87.3**	**71.8**
China	1291.1	36.9	327.2	289.9	156.9	22.5	500.4	23.2	82.3	231.0	230.4	795.9	288.0	274.0	-47.4	186.1	**4688.3**	**4735.7**
Colombia	5.9	1.1	11.9	1.7	2.6	0.0	8.9	1.4	0.5	9.5	18.4	13.6	4.7	10.7	106.2	67.7	**264.9**	**158.7**
Congo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.1	0.0	9.9	4.0	**14.5**	**4.6**
Congo (DR)	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.5	4.1	0.3	6.2	317.5	39.8	**369.7**	**52.2**
Costa Rica	0.1	0.0	0.0	0.0	0.1	0.0	0.6	0.0	0.0	0.7	3.0	0.4	0.3	0.0	9.9	7.2	**22.2**	**12.3**
Côte d'Ivoire	3.3	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.6	1.5	0.2	0.4	0.0	91.2	8.9	**106.7**	**15.5**
Croatia	3.8	0.4	2.4	0.1	1.3	0.0	2.6	0.1	0.2	1.0	4.5	3.5	2.5	0.6	-0.2	2.9	**25.7**	**25.9**
Cuba	11.8	0.4	0.2	0.1	0.0	0.0	0.8	0.0	0.0	13.8	2.0	0.6	1.3	1.3	-9.0	18.4	**41.6**	**50.6**
Cyprus	2.9	0.0	0.1	0.0	0.0	0.0	1.5	0.0	0.0	0.6	1.8	0.0	0.2	0.0	0.1	0.9	**8.0**	**7.9**
Czech Republic	55.2	8.2	9.2	9.0	4.8	0.1	4.7	0.6	1.5	9.0	13.6	8.7	11.1	3.9	-0.1	-0.3	**139.4**	**139.4**
Denmark	22.0	1.4	4.5	0.1	0.3	0.0	3.0	0.2	1.1	2.9	12.0	9.7	4.7	1.6	-0.1	2.0	**65.3**	**65.4**
Dominican Republic	3.4	3.1	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.5	6.6	0.2	3.0	0.0	0.0	10.2	**29.0**	**29.0**
Ecuador	2.3	0.0	1.6	0.0	0.0	0.0	1.4	0.0	0.1	3.3	9.1	9.6	2.1	3.2	58.9	4.8	**96.4**	**37.4**
Egypt	31.7	0.0	16.8	3.0	2.8	0.0	12.0	0.0	0.9	29.4	25.8	12.6	10.1	15.2	3.0	10.5	**173.8**	**170.8**
El Salvador	1.1	0.0	0.1	0.0	0.0	0.0	1.2	0.0	0.0	1.1	2.5	0.0	0.4	0.0	4.1	5.5	**16.1**	**12.0**
Eritrea	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	**0.6**	**0.6**
Estonia	10.3	0.3	0.8	0.0	0.2	0.0	0.5	0.0	0.0	0.5	1.7	1.0	0.4	1.3	2.2	4.3	**23.5**	**21.3**
Ethiopia	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.9	1.8	49.1	0.5	12.2	8.4	-6.0	**67.4**	**58.9**
Finland	18.6	3.5	5.2	4.1	0.9	0.1	1.4	3.4	1.8	2.6	12.2	7.3	4.7	2.0	0.0	0.0	**67.6**	**67.6**
France	31.7	8.8	32.5	15.0	19.7	1.7	18.1	4.2	19.3	29.8	139.1	94.6	88.3	18.2	-0.8	3.4	**523.5**	**524.3**
Gabon	0.3	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.4	0.0	0.1	0.0	3.7	5.4	**10.5**	**6.9**
Georgia	1.0	0.6	0.6	0.1	0.3	0.0	0.2	0.0	0.1	0.4	1.6	1.7	1.4	2.8	0.0	0.9	**11.7**	**11.7**
Germany	279.5	41.7	61.7	38.2	41.3	2.7	34.9	6.9	20.0	29.6	174.2	63.6	156.4	29.5	-6.2	10.7	**984.6**	**990.8**
Ghana	0.5	0.0	0.1	0.0	0.0	0.0	1.0	0.0	0.0	0.7	2.9	0.2	0.4	0.0	27.9	14.0	**47.6**	**19.7**
Gibraltar	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	**0.5**	**0.5**
Greece	43.1	0.7	8.3	0.3	0.7	1.6	11.4	0.4	3.3	3.4	19.3	12.9	8.4	3.7	0.0	3.1	**120.5**	**120.5**
Guatemala	2.4	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	1.4	4.1	0.1	0.9	0.0	56.7	11.3	**77.6**	**20.9**

Countries	Electricity	Unallocated Autoproducers	Other Energy Industries	Iron & Steel	Chemical & Petrochemical	Non-Ferrous Metals (Aluminum)	Non-Metallic Minerals (Cement)	Paper, Pulp and Printing	Non-CO2 Industrial Processes	Other Manufacturing Industries	Transport	Agriculture	Residential & Commercial	Other sectors	LUCF	Unclassified Non-CO_2 Gas	**TOTAL**	**TOTAL w/o LUCF**
Haiti	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	0.0	0.2	0.0	2.0	6.0	**9.4**	**7.4**
Honduras	1.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	1.2	1.8	0.0	0.4	0.0	17.6	8.5	**31.1**	**13.4**
Hungary	21.3	0.4	10.4	2.4	1.9	0.3	3.0	0.2	0.9	1.9	8.9	15.4	13.1	3.8	-3.0	-8.5	**72.3**	**75.3**
Iceland	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.2	0.4	0.6	1.1	0.0	0.1	-0.7	-0.3	**1.9**	**2.6**
India	478.4	29.6	66.2	59.1	49.0	1.7	77.8	2.3	19.0	45.5	125.1	473.0	86.7	131.6	-40.3	167.6	**1771.9**	**1812.3**
Indonesia	56.6	5.1	47.3	6.2	13.5	0.0	23.4	2.0	0.8	24.8	61.9	58.0	47.4	73.4	2565.0	71.0	**3056.2**	**491.2**
Iran, Islamic Rep. of	67.5	3.5	25.9	4.1	14.9	0.0	11.9	0.0	0.3	44.1	71.9	62.6	64.3	17.8	8.1	55.9	**452.7**	**444.6**
Ireland	15.5	0.3	2.1	0.1	1.4	0.8	2.1	0.0	1.7	1.9	10.2	20.4	8.9	2.0	0.0	-1.3	**66.0**	**66.0**
Israel	34.0	0.4	3.1	0.0	1.0	0.0	3.3	0.0	2.5	4.3	11.0	1.6	2.3	16.4	0.1	-1.3	**78.8**	**78.7**
Italy	136.9	0.0	33.2	11.0	18.0	1.4	39.9	4.3	17.4	24.7	113.0	54.4	68.3	14.6	-1.7	-15.1	**520.3**	**522.1**
Jamaica	2.0	3.5	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4	1.9	1.5	0.4	0.0	2.6	2.6	**15.3**	**12.6**
Japan	326.0	87.6	63.5	87.9	41.8	5.2	70.3	15.3	65.2	88.1	253.1	55.3	138.3	10.9	-3.0	-55.0	**1250.4**	**1253.4**
Jordan	4.8	0.4	0.9	0.0	0.0	0.0	1.3	0.0	0.2	2.2	3.5	1.3	2.4	15.9	0.0	-9.0	**23.8**	**23.8**
Kazakhstan	58.4	0.0	13.8	5.4	0.7	0.9	0.6	0.0	0.3	31.9	6.7	13.0	0.2	16.9	0.0	9.5	**158.5**	**158.5**
Kenya	2.4	0.0	0.6	0.0	0.0	0.0	0.7	0.0	0.0	0.8	4.0	0.2	1.1	0.1	11.9	42.5	**64.3**	**52.4**
Korea (DPRK)	12.5	0.0	23.4	0.7	0.0	0.0	3.0	0.0	0.4	109.7	9.2	4.0	0.7	37.9	0.9	9.6	**212.1**	**211.2**
Korea, Rep. of	124.5	27.6	47.5	8.8	23.0	0.5	42.0	3.7	22.5	31.3	87.9	15.4	60.6	12.3	1.2	-7.7	**501.1**	**499.9**
Kuwait	21.8	0.0	16.4	0.0	0.0	0.0	1.0	0.0	0.7	14.8	5.5	0.0	3.0	3.5	0.0	7.0	**73.5**	**73.5**
Kyrgyzstan	1.9	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.0	0.6	0.0	0.0	1.1	0.0	2.3	**7.1**	**7.1**
Latvia	2.5	0.3	0.6	0.3	0.0	0.0	0.2	0.0	0.2	0.5	2.0	1.9	0.6	1.4	4.4	-0.8	**14.0**	**9.7**
Lebanon	5.8	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	2.2	3.9	0.0	1.8	0.0	0.6	2.5	**18.6**	**18.1**
Libya	13.1	0.0	8.1	0.0	3.4	0.0	1.5	0.0	0.0	1.6	10.3	0.0	2.3	0.0	0.7	11.4	**52.5**	**51.7**
Lithuania	3.7	0.1	1.6	0.0	0.9	0.0	0.7	0.1	0.3	0.7	3.1	3.9	0.9	3.6	3.9	-4.8	**18.6**	**14.7**
Luxembourg	0.0	0.1	0.1	0.5	0.0	0.0	0.8	0.0	0.1	0.8	4.7	0.5	1.4	0.1	3.1	-0.1	**12.2**	**9.1**
Macedonia	5.6	0.4	0.0	0.3	0.0	0.2	0.6	0.0	0.0	0.1	1.0	0.1	0.2	0.0	0.0	2.3	**11.0**	**11.0**
Malaysia	28.4	1.7	13.7	0.0	2.2	0.0	5.7	0.0	0.0	25.0	30.9	0.3	3.9	0.0	699.5	45.1	**856.4**	**156.9**
Malta	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.0	0.2	**2.5**	**2.5**
Mexico	110.8	10.3	82.2	14.2	15.3	0.2	23.3	1.7	6.3	17.3	100.3	69.3	24.2	27.1	96.9	-5.3	**593.9**	**497.0**
Moldova, Rep. of	3.8	0.0	2.7	0.0	0.0	0.0	0.1	0.0	0.0	0.5	0.5	0.9	1.3	0.9	0.0	0.0	**10.7**	**10.7**
Morocco	9.3	1.6	0.4	0.0	0.0	0.0	4.0	0.0	0.0	4.8	1.8	0.0	3.4	8.0	2.6	25.0	**60.9**	**58.3**
Mozambique	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.8	0.0	0.1	0.0	9.3	13.5	**24.1**	**14.8**
Myanmar	2.3	0.0	0.8	0.0	0.1	0.0	0.2	0.0	0.0	1.5	3.3	20.0	0.4	10.1	425.7	43.0	**507.7**	**81.9**
Namibia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.2	0.4	0.0	0.2	2.3	8.4	**12.5**	**10.3**
Nepal	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.1	0.8	11.3	0.9	4.0	123.6	13.3	**155.1**	**31.6**
Netherlands	47.2	7.0	19.7	6.2	15.6	0.2	3.5	0.9	16.5	13.4	31.7	25.2	21.5	19.4	0.0	-12.4	**215.6**	**215.6**
New Zealand	4.6	1.3	2.6	1.5	5.0	0.0	0.5	0.0	1.0	3.5	12.8	42.4	1.3	2.7	-0.1	-7.8	**71.1**	**71.2**
Nicaragua	1.4	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.4	1.4	0.0	0.2	0.0	53.7	9.3	**66.8**	**13.0**
Nigeria	5.7	0.0	11.1	0.2	1.0	0.0	1.3	0.0	0.3	6.1	20.8	43.8	4.0	36.8	194.9	27.6	**353.6**	**158.7**
Norway	0.2	0.2	11.4	2.6	2.6	0.3	1.9	0.3	5.0	1.4	11.8	6.7	1.5	4.0	3.2	-3.0	**50.2**	**47.0**
Oman	7.4	0.0	3.3	0.0	0.0	0.0	1.2	0.0	0.0	8.6	2.6	0.0	0.1	1.1	0.0	4.7	**29.1**	**29.1**
Pakistan	32.9	0.0	8.1	1.8	6.4	0.0	14.1	0.0	0.4	9.2	24.9	102.0	11.3	21.0	33.0	50.2	**315.3**	**282.3**
Panama	1.2	0.1	0.2	0.0	0.0	0.0	0.4	0.0	0.0	1.0	2.1	0.0	0.3	0.0	47.5	6.0	**58.8**	**11.2**
Paraguay	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	2.8	0.0	0.2	0.0	20.6	22.5	**46.8**	**26.1**
Peru	2.1	0.9	2.0	3.0	0.0	0.0	1.9	0.0	0.2	4.8	9.1	17.4	3.6	12.8	187.4	11.9	**257.1**	**69.7**
Philippines	21.3	1.3	5.2	1.0	0.7	0.0	9.2	0.5	1.3	3.8	23.2	15.3	8.5	10.8	94.9	30.0	**227.0**	**132.0**
Poland	150.1	9.4	30.0	13.8	12.6	1.6	15.3	1.7	4.5	13.2	25.9	42.1	31.8	20.1	-3.1	6.0	**374.9**	**378.0**
Portugal	19.2	2.0	4.0	0.6	2.2	0.1	10.2	1.0	1.2	3.7	18.2	14.0	3.3	7.0	-1.8	-7.8	**77.0**	**78.8**

Countries	Electricity	Unallocated Autoproducers	Other Energy Industries	Iron & Steel	Chemical & Petrochemical	Non-Ferrous Metals (Aluminum)	Non-Metallic Minerals (Cement)	Paper, Pulp and Printing	Non-CO2 Industrial Processes	Other Manufacturing Industries	Transport	Agriculture	Residential & Commercial	Other sectors	LUCF	Unclassified Non-CO_2 Gas	**TOTAL**	**TOTAL w/o LUCF**
Qatar	10.3	0.0	10.8	0.8	9.2	0.0	0.8	0.0	0.0	0.7	3.0	0.0	0.0	0.0	0.0	4.6	**40.2**	**40.2**
Romania	37.8	3.6	32.1	6.4	6.0	0.0	5.1	0.4	2.4	4.5	9.6	19.7	7.5	6.1	-5.7	-19.4	**116.0**	**121.8**
Russia	509.8	349.6	343.4	90.5	62.2	16.1	31.1	1.9	15.4	30.9	173.2	160.4	160.2	71.9	-1.5	-131.0	**1884.2**	**1885.7**
Saudi Arabia	65.4	0.0	77.5	0.0	4.8	0.0	9.0	0.0	1.5	21.7	30.1	8.2	3.5	78.4	0.0	32.6	**332.6**	**332.6**
Senegal	1.3	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.0	0.6	1.2	7.0	0.3	3.8	3.6	4.1	**22.7**	**19.1**
Serbia & Montenegro	26.6	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	6.4	5.5	0.0	0.1	4.1	0.1	14.2	**57.5**	**57.4**
Singapore	23.7	0.0	10.6	0.0	1.8	0.0	1.6	0.0	3.2	0.6	5.8	0.1	0.0	1.4	0.0	-3.2	**45.7**	**45.7**
Slovak Republic	14.3	0.0	3.6	5.1	0.5	0.0	1.5	0.0	0.4	5.8	4.1	4.3	5.6	1.6	54.3	0.8	**101.9**	**47.7**
Slovenia	5.2	0.2	0.3	0.3	0.4	0.1	1.1	0.5	0.3	1.0	3.9	1.5	2.4	1.2	3.0	0.6	**21.9**	**18.9**
South Africa	174.8	10.5	13.6	17.3	23.2	0.1	7.9	0.2	7.4	15.1	35.7	31.2	7.6	20.8	1.7	-2.7	**364.6**	**362.9**
Spain	84.9	8.8	24.7	7.8	10.7	1.1	36.1	3.3	11.3	15.3	91.8	62.6	23.5	17.4	1.1	-26.4	**374.0**	**372.9**
Sri Lanka	2.9	0.0	0.2	0.0	0.0	0.0	0.5	0.0	0.0	1.1	5.7	0.0	0.4	0.7	29.6	16.8	**57.8**	**28.2**
Sudan	0.9	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	1.0	2.6	0.6	0.4	0.0	30.5	90.2	**126.5**	**96.0**
Sweden	6.1	1.1	4.7	2.9	1.7	0.4	2.6	1.7	1.9	2.8	22.5	8.8	8.0	2.6	-8.6	-0.2	**59.0**	**67.6**
Switzerland	0.1	0.3	1.8	0.2	1.0	0.1	3.8	1.1	0.7	3.5	15.4	5.8	16.5	1.9	-0.1	-0.7	**51.5**	**51.6**
Syria	11.6	1.4	1.9	0.0	0.1	0.0	2.4	0.0	0.0	9.3	3.8	0.0	2.5	21.7	0.1	19.1	**73.9**	**73.8**
Tajikistan	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	1.7	0.0	1.5	**5.9**	**5.9**
Tanzania, United Rep. of	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.8	0.0	0.3	0.0	14.6	56.4	**72.9**	**58.4**
Thailand	48.7	5.4	8.0	1.1	6.5	0.0	22.6	0.8	1.6	17.0	45.7	34.5	4.3	21.1	47.7	31.5	**296.6**	**248.9**
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.7	0.4	0.0	0.2	0.0	8.6	4.3	**14.5**	**5.9**
Trinidad & Tobago	3.7	0.0	2.7	1.2	4.9	0.0	0.6	0.0	0.0	0.5	1.6	0.0	0.2	0.0	0.0	3.4	**18.9**	**18.9**
Tunisia	5.2	0.8	0.2	0.3	0.0	0.0	2.8	0.0	0.0	3.6	4.0	1.0	2.6	0.0	3.9	9.6	**34.1**	**30.2**
Turkey	62.2	12.7	12.1	6.0	4.3	1.5	19.3	0.8	0.9	41.7	35.4	78.5	23.2	20.4	-0.4	34.3	**352.9**	**353.3**
Turkmenistan	8.9	0.0	14.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	1.5	4.6	0.0	19.6	0.0	13.3	**62.2**	**62.2**
Ukraine	88.1	9.9	96.5	38.3	0.0	0.0	2.6	0.0	0.8	59.6	11.8	67.4	82.8	18.3	0.0	-4.5	**471.6**	**471.6**
United Arab Emirates	31.2	0.0	10.0	0.0	24.3	0.0	3.0	0.0	0.4	5.5	5.6	0.0	0.3	0.0	0.0	26.8	**107.1**	**107.1**
United Kingdom	154.8	19.6	64.1	9.0	19.0	1.9	10.3	3.7	15.2	34.8	134.2	52.6	105.3	27.8	-1.7	-21.0	**629.6**	**631.3**
United States	2138.8	314.0	556.7	75.1	179.4	28.7	103.9	50.7	164.0	186.0	1721.2	538.3	596.3	242.4	-403.1	-150.8	**6341.7**	**6744.8**
Uruguay	0.4	0.0	0.4	0.0	0.0	0.0	0.3	0.0	0.2	0.9	2.5	14.6	0.6	1.3	-24.4	3.4	**0.2**	**24.7**
Uzbekistan	35.5	0.1	43.1	0.0	2.6	0.0	1.8	0.0	0.3	16.9	10.4	23.4	40.1	5.3	0.0	-3.1	**176.3**	**176.3**
Venezuela	16.4	1.5	90.7	7.2	11.0	1.5	7.1	0.0	2.6	10.5	33.8	21.1	6.0	12.5	144.2	9.5	**375.5**	**231.4**
Vietnam	8.5	0.8	13.2	0.0	0.0	0.0	6.7	0.0	0.2	10.8	13.3	21.5	5.9	14.1	-48.7	35.2	**81.4**	**130.1**
Yemen	1.3	0.4	0.4	0.0	0.0	0.0	0.7	0.0	0.0	0.5	4.9	0.0	1.7	0.0	0.4	14.3	**24.5**	**24.2**
Zambia	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.6	0.7	0.0	0.1	0.0	235.6	15.8	**253.3**	**17.7**
Zimbabwe	4.5	0.7	0.1	1.4	0.0	0.1	0.8	0.0	0.0	1.2	2.2	1.8	0.9	0.3	47.5	18.8	**80.2**	**32.7**
Other Africa*	4.6	1.0	9.2	0.0	0.0	0.0	0.8	0.0	3.2	1.6	6.5	386.9	0.9	81.9	198.3	-283.6	**410.9**	**212.7**
Other Asia*	1.3	1.1	8.0	0.0	0.0	0.0	0.3	0.0	9.7	1.0	1.5	73.8	0.2	100.0	238.4	-183.9	**251.6**	**13.1**
Other Latin America*	3.3	0.3	4.4	0.0	0.0	0.0	1.2	0.0	1.4	0.0	1.9	69.8	0.0	8.8	56.3	-109.2	**69.0**	**12.7**
Unclassified Countries	0.0	0.0	11.8	0.0	0.0	0.0	0.0	0.0	5.0	1.3	0.0	53.0	0.7	57.7	0.0	31.0	**129.9**	**129.9**
Non-Annex I Total	**3079**	**170**	**1167**	**461**	**416**	**38**	**886**	**41**	**195**	**886**	**1389**	**2944**	**798**	**1353**	**7845**	**1325**	**22992**	**15147**
Annex-I Total	**4659**	**922**	**1630**	**481**	**500**	**84**	**477**	**119**	**406**	**698**	**3376**	**1707**	**1736**	**629**	**-295**	**-435**	**16694**	**16989**
Brunei	2	0	2	0	0	0	0	0	0	0	1	0	0	0	0	3	**8**	**8**
Chinese Taipei	88	24	7	15	19	0	17	2	0	10	33	2	7	1	0	0	**224**	**224**
Iraq	18	0	12	0	2	0	1	0	0	16	29	1	7	6	0	7	**99**	**99**
Non-Parties TOTAL	108	24	22	15	20	0	18	2	0	26	62	4	14	7	0	9	**331**	**331**
WORLD TOTAL	**7846**	**1115**	**2819**	**957**	**936**	**123**	**1382**	**162**	**601**	**1609**	**4827**	**4654**	**2548**	**1989**	**7550**	**900**	**40017**	**32467**

Center for Clean Air Policy
750 First Street, NE • Suite 940
Washington, DC 20002

Tel: 202.408.9260 • Fax: 202.408.8896