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Divider Title: _____

OVERVIEW OF U.S. STRATEGY IN KYOTO NEGOTIATIONS AND BEYOND

The United States entered the negotiations, held December 1-11, 1997 in Kyoto, Japan, with three primary objectives. First, the agreement should include realistic targets and timetables for reducing greenhouse gas emissions among the world's major industrial nations. Second, the agreement should include an array of flexible, market-based approaches for reducing emissions. Third, the agreement should include meaningful participation of key developing countries. At the close of the Kyoto Conference, the Parties to the United Nations Framework Convention on Climate Change agreed to a Protocol to harness the forces of the global marketplace to reduce greenhouse gas emissions that reflected the first two of our objectives, and made an important down payment on the third objective.

The United States will continue its efforts to promote meaningful participation of key developing countries in bilateral and multilateral venues. In addition, the Administration will work with the other parties to the Protocol to develop rules for some of the important provisions in the agreement, including those related to international emissions trading, the Clean Development Mechanism, and carbon sinks. The Administration is working hard to make Kyoto a reality, to ensure that its critical flexibility mechanisms get up and running, and that its coverage becomes global. The following discussion details the Administration's three negotiating objectives, and their economic importance.

**Statement of
Stuart E. Eizenstat
Under Secretary of State
for Economic, Business and Agricultural Affairs
before the
Senate Foreign Relations Committee
February 11, 1998**

Thank you, Mr. Chairman.

At the outset, let me thank those members of Congress, in this chamber and in the House of Representatives, who participated with us in the Kyoto Conference and who lent their advice and support to our efforts there. In particular I wish to thank Senators Hagel, Baucus, Chafee, Enzi, Kerry and Lieberman for taking the time to be present. I must also thank Senator Byrd, who could not be with us in Kyoto, for his interest and leadership. Rarely has there been an environmental issue more important or complex than global warming, and rarely has there been a greater need for the Executive Branch and the Congress to work closely together.

It is with great pleasure that I appear here today to explain the Administration's position on global warming. To this end, I will divide my testimony into four parts: (1) a short discussion of the science - the driving force for all the efforts we have taken to date to mitigate a significant and growing global environmental problem; (2) a discussion of the results of the recent Kyoto Conference and key features of the Kyoto Protocol; (3) an effort to correct misperceptions; and (4) a brief review of the President's Climate Change Technology Initiative. I hope to leave you with a clear understanding of why we believe that it is necessary to act, of how we intend to proceed internationally, and of what the President plans to do here at home.

achieved the first two – realistic targets and timetables for reducing greenhouse gas emissions among the world's major industrial nations, which fully protect the unique role of our military in its global reach; and flexible market-based mechanisms for achieving those targets. The third, meaningful participation of developing countries, will be the focus of our work in the coming months and years, but with the Kyoto Protocol we have made an important down payment.

Elements of the Kyoto Protocol and Related Decisions

Our first objective – realistic targets and timetables among developed countries – had to be a credible step in reducing the dangerous buildup of greenhouse gases, yet measured enough to safeguard U.S. prosperity at home and competitiveness abroad. In the end, we secured the key elements of the President's proposal on targets and timetables, often over the initial objections of the European Union and other developed countries. The agreement and related decisions include:

- The U.S. concept of a multi-year time frame for emissions reductions rather than a fixed, single-year target. The multi-year time frame will allow the United States, other nations and our industries greater flexibility in meeting our targets. Averaging over five years, instead of requiring countries to meet a specific target each year, can lower costs, especially given an uncertain future. The averaging can smooth out the effects of short-term events such as fluctuations in the business cycle and energy demand, or hard winters and hot summers that would increase energy use and emissions.
- The U.S. specific time frame of 2008-2012, rather than earlier periods preferred by the European Union and others, giving us more time to phase in change gradually and deploy new technologies cost-effectively, and thereby to cushion the effects on our businesses and workers.
- Differentiated targets for the key industrial powers ranging from 6% to 8% below baseline levels (1990 and 1995) of greenhouse gas emissions, with the United States agreeing to a 7% reduction.

When changes in the accounting rules for certain gases and offsets for activities that absorb carbon dioxide are factored in, the level of effort required of the United States is quite close to the President's original proposal to return emissions to 1990 levels by 2008-2012, representing at most a 3 percent real reduction below that proposal, and perhaps less.

- An innovative proposal shaped in part by the United States, allowing certain activities, such as planting trees, that absorb carbon dioxide – called “sinks” – to be offset against emissions targets. This will both promote cost-effective solutions to climate change and encourage good forestry practices. As a major forestry nation this will be of special benefit to the United States.
- As proposed by the United States, the Kyoto Protocol covers all six significant greenhouse gases even though the E.U. and Japan proposed and fought until the last moment to cover only three. This was an important environmental victory – also supported by many in our own industry – because gases that other countries wanted to omit and leave uncovered (including substitutes for the now banned chloro-fluorocarbons that endanger the ozone layer) are among the fastest growing and longest lasting greenhouse gases.

Flexible Market Mechanisms

(59) Our second broad Presidential objective was to make sure that countries can use flexible market mechanisms to reach their targets rather than the mandatory “policies and measures,” such as carbon taxes, favored by the E.U. and many other developed countries.

The Kyoto Protocol enshrines a centerpiece of this U.S. market-based approach – the opportunity for companies and countries to trade emissions permits. In this way, companies or countries can purchase less expensive emissions permits from companies or countries that have more permits than they need (because they have met their targets with room to spare). This is not only economically sensible, but environmentally sound. By finding the least expensive way to reduce emissions, we will be providing a strong

incentive for achieving the maximum level of emissions reductions at the least cost. The United States has had a very positive experience with permit trading in the acid rain program, reducing costs by 50 percent from what was expected, yet fully serving our environmental goals.

This was a new concept for developed and developing countries alike – some of whom fought it vigorously. But we have it firmly enshrined in the Kyoto Protocol and it is a critical way of ensuring cost-effective solutions. Its inclusion was a major victory for us.

We went even further by achieving a conceptual understanding with several countries, including Australia, Canada, Japan, New Zealand, Russia and Ukraine, to trade emissions rights with each other. This 'umbrella group' could further reduce compliance costs.

Ensuring that we can meet our target reductions cost-effectively will depend significantly on access to the flexibility mechanisms we fought hard to include in the Kyoto Protocol. Let me be very clear: The commitment we made in Kyoto would not have been made -- could not have been made -- were it not for the flexibility mechanisms that were also agreed there. Until we are satisfied with the rules and procedures yet to be established, the promise of Kyoto will never be realized.

Meaningful Participation of Developing Countries

(60) Our third objective was to secure meaningful participation of key developing countries, a concern that the Senate obviously shares, as evidenced by last summer's Byrd-Hagel Resolution. Global warming is, after all, a global problem which requires a global solution – not only from the developed world but also from key developing countries.

Per capita emission rates are low in the developing world and will remain so for some time, and over 70 percent of today's atmospheric concentrations of greenhouse gases attributable to human activities are the result of emissions by the industrialized world. At the same time, it is also true that by around 2015 China will be the largest overall emitter of greenhouse gases, and by 2025 the developing world will emit more greenhouse gases in total than the developed world. So from an

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Realistic Targets and Timetables

The United States was committed to achieving realistic targets and timetables among developed countries that would represent a credible step in slowing the accumulation of greenhouse gases in the atmosphere, yet be measured enough to ensure continued economic prosperity. The specific limits adopted in the Protocol vary across countries, although those for the countries with the wealthiest economies are similar (see Table 1).

Table 1. Selected Annex I Countries' Emissions Targets

Country	Emissions Target over 2008-2012 ¹⁰
European Union	1990 minus 8%
United States	1990 minus 7% ¹¹
Japan	1990 minus 6%
Canada	1990 minus 6%
Russian Federation	1990 stabilization
Annex I Average	1990 minus 5.2%

Source: Kyoto Protocol, Annex B

Flexibility and Market Mechanisms

¹⁰ The 1990 base year actually refers to the 1990 levels for carbon dioxide, methane, and nitrous oxide and the choice of 1990 or 1995 levels for the three categories of synthetic greenhouse gases (Kyoto Protocol, Articles 3.1, 3.8). For some countries, their calculated "1990" target may thus be a hybrid of 1990 and 1995 emissions.

¹¹ The U.S. target of 1990 minus 7% does not represent an effort level 7% below the "1990 target" in the President's October 1997 proposal because of differences in the emissions accounting framework used in the President's October proposal and the framework actually adopted in the Kyoto Protocol. The United States' Kyoto target represents an effort level no more than 3% greater than the President's October proposal. Two changes in the calculation of emissions account for this difference. First, the Protocol allows countries to use 1995 emissions for the three categories of synthetic gases instead of 1990 levels. For the United States, emissions of these gases were about 13 MMTCE higher in 1995 than in 1990 (Climate Action Report 1997). The change to 1995 emissions for these gases implies that the Kyoto target is roughly equal to 1990 emissions minus 6%. Further, the Kyoto Protocol does not include carbon sinks in the calculation of the 1990 baseline, although certain carbon sinks will count towards meeting our 2008-2012 commitments. The omission of sinks from the Kyoto baseline changes the Kyoto target by about 50 MMTCE, or about 3% in comparison with the President's proposal (derived from Joyce 1995). Further, if U.S. forestry activities covered by the Protocol result in net carbon sequestration, the target will be still easier to attain.

Distr.

LIMITED

FCCC/CP/1997/L.7/Add.1

10 December 1997

Subject to technical revision

Original: ENGLISH

CONFERENCE OF THE PARTIES

Third session

Kyoto, 1-10 December 1997

Agenda item 5

**KYOTO PROTOCOL TO THE
UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE**

The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the

Conference of the Parties to the Convention at its first session,



Consumption of halocarbons and sulphur hexafluoride

Other

Solvent and other product use

Agriculture

Enteric fermentation

Manure management

Rice cultivation

Agricultural soils

Prescribed burning of savannas

Field burning of agricultural residues

Other

Waste

Solid waste disposal on land

Wastewater handling

Waste incineration

Other

Annex B

Party Quantified emission limitation or reduction commitment

(percentage of base year or period)

Australia 108

Austria 92

Belgium 92

Bulgaria* 92

61



Canada 94

Croatia* 95

Czech Republic* 92

Denmark 92

Estonia* 92

European Community 92

Finland 92

France 92

Germany 92

Greece 92

Hungary* 94

Iceland 110

Ireland 92

Italy 92

Japan 94

Latvia* 92

Liechtenstein 92

Lithuania* 92

Luxembourg 92

Monaco 92

Netherlands 92

New Zealand 100

Norway 101

Poland* 94

Portugal 92

Romania* 92

Russian Federation* 100

Slovakia* 92

Slovenia* 92

Spain 92

Sweden 92

Switzerland 92

Ukraine* 100

United Kingdom of Great Britain and Northern Ireland 92

United States of America 93

* Countries that are undergoing the process of transition to a market economy.

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Conference of the Parties to the Convention at its first session,

...tion or phasing out of market imperfections, fiscal incentives, tax and duty
...sidies in all greenhouse gas emitting sectors that run counter to the objective of the
...apply market instruments;

...ment of appropriate reforms in relevant sectors aimed at promoting policies and measures
...reduce emissions of greenhouse gases not controlled by the Montreal Protocol;

...ures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal
...ol in the transport sector;

...Limitation and/or reduction of methane through recovery and use in waste management, as well as
...the production, transport and distribution of energy;

(b) Cooperate with other such Parties to enhance the individual and combined effectiveness of their policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(i), of the Convention. To this end, these Parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, consider ways to facilitate such cooperation, taking into account all relevant information.

2. The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

3. The Parties included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9 of the Convention, taking into account Article 3 of the Convention. The Conference of the Parties serving as the meeting of the Parties to this Protocol may take further action, as appropriate, to promote the implementation of the provisions of this paragraph.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol, if it decides that it would be beneficial to coordinate any of the policies and measures in

paragraph 1(a) above, taking into account different national circumstances and potential effects, shall consider ways and means to elaborate the coordination of such policies and measures.

Article 3

(2)

1. The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

(63)

missions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions minus removals in 1990 from land use change for the purposes of calculating their assigned amount.

8. Any Party included in Annex I may use 1995 as its base year for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, for the purposes of the calculation referred to in paragraph 7 above. (63)

9. Commitments for subsequent periods for Parties included in Annex I shall be established in amendments to Annex B to this Protocol, which shall be adopted in accordance with the provisions of Article 20, paragraph 7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall initiate the consideration of such commitments at least seven years before the end of the first commitment period mentioned in paragraph 7 above.

10. Any emission reduction units, or any part of an assigned amount, which a Party acquires from another Party in accordance with the provisions of Article 6 and of Article 16 bis shall be added to the assigned amount for that Party.

11. Any emission reduction units, or any part of an assigned amount, which a Party transfers to another Party in accordance with the provisions of Article 6 and of Article 16 bis shall be subtracted from the assigned amount for that Party.

12. Any certified emission reductions which a Party acquires from another Party in accordance with the provisions of Article 12 shall be added to the assigned amount for that Party.

13. If the emissions of a Party included in Annex I during a commitment period are less than its assigned amount under this Article, this difference shall, on request of that Party, be added to the assigned amount for that Party for subsequent commitment periods.

14. Each Party included in Annex I shall strive to implement the commitments mentioned in paragraph 1 above in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. In line with relevant decisions of the Conference of the Parties on the implementation of those paragraphs, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of response measures on Parties referred to in those paragraphs. Among the issues to be considered shall be the establishment of funding, insurance and transfer of technology.

Article 4

1. Any Parties included in Annex I that have agreed to jointly fulfil their commitments under Article 3 shall be deemed to have met those commitments provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of Article 3. The respective emission level allocated to each of the Parties to the agreement shall be set out in that agreement.

2. The Parties to any such agreement shall notify the secretariat of the terms of the

agreement on the date of deposit of their instruments of ratification, acceptance, approval or accession. The secretariat shall in turn inform the Parties and signatories to the Convention of the terms of the

PRESIDENT CLINTON'S CLIMATE CHANGE PROPOSAL

October 22, 1997

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Global climate change is the premier environmental challenge and opportunity of the 21st century, and the risks it poses justify sensible preventive steps. Addressing this issue is one of the United States' greatest imperatives, for this and future generations. Recognizing the solid foundation of climate science, President Clinton is committed to strong and sensible action to reduce greenhouse gas emissions -- including realistic and binding emissions targets.

Key elements of President Clinton's climate change proposal include:

- **Binding Targets to Reach 1990 Emissions Levels by 2008-2012 and Reductions Below 1990 Levels in the 5-Year Period That Follows.** A critical component of the President's comprehensive framework is a realistic, achievable, and binding target of reducing greenhouse emissions to 1990 levels by 2008-2012 and reductions below 1990 levels in the 5-year period that follows.
- **\$5 Billion Program of Tax Cuts and R&D for New Technologies.** To spur energy efficiency and the development of new technologies, the President proposes a major new package of tax cuts and R&D spending amounting to \$5 billion over five years.
- **Industry-by-Industry Consultations and Early Credit.** The Administration challenges key industries to prepare plans over the next 9 months on how they can best reduce emissions. To provide an incentive for near-term actions to cut emissions, the President is committed to ensuring appropriate rewards for firms that act early.
- **Developing Countries Must Participate.** Climate change is a global problem, and requires a global solution. That's why the United States has spear-headed joint implementation projects, and the President has committed that the United States will not adopt binding obligations without developing country participation.
- **Broad-Based Domestic and International Emissions Trading System Begins After A Decade of Experience Has Accumulated.** The President is committed to a market-based emissions trading system, both domestically and internationally, that will harness the power of the market to reduce emissions to 1990 levels by 2008-2012. The trading system would begin after a decade's worth of experience with tax incentives, R&D, early credit, electricity restructuring, Federal efforts, and other measures.

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BINDING TARGETS: The U.S. binding target is realistic: It seeks to return U.S. emissions to 1990 levels in the period 2008-2012 and reduce them further thereafter. We reject the European proposal for more stringent early reductions, as well as the "do-nothing" approach of some interests. The target is achievable: By providing incentives for early action to reduce emissions, attacking domestic energy inefficiencies, and putting in place a market-based emissions trading system, we can reach 1990 levels in the proposed time frame with minimal economic costs. And it is meaningful: Achieving 1990 levels in the period 2008-2012 would amount to almost a 30 percent reduction off a business-as-usual path, an important first step on the road toward stabilizing greenhouse gas concentrations in the atmosphere.

The Kyoto Protocol on Climate Change Fact Sheet

BACKGROUND

- At a conference held December 1-11, 1997 in Kyoto, Japan, the Parties to the UN Framework Convention on Climate Change agreed to an historic Protocol to reduce greenhouse gas emissions by harnessing the forces of the global marketplace to protect the environment.
- The Kyoto Protocol in key respects -- including emissions targets and timetables for industrialized nations and market-based measures for meeting those targets -- reflects proposals advanced by the United States. The Protocol makes a down payment on the meaningful participation of developing countries, but more needs to be done in this area. Securing meaningful developing country participation remains a core U.S. goal.

EMISSIONS TARGETS

- A central feature of the Kyoto Protocol is a set of binding emissions targets for developed nations. The specific limits vary from country to country, though those for the key industrial powers of the European Union, Japan, and the United States are similar -- 8% below 1990 emissions levels for the EU, 7% for the U.S., 6% for Japan.
- The framework for these emissions targets is based largely on U.S. proposals:
 - ▶ **Emissions targets are to be reached over a five-year budget period as proposed by the U.S., rather than by a single year.** Allowing emissions to be averaged across a budget period increases flexibility by helping to smooth out short-term fluctuations in economic performance or weather, either of which could spike emissions in a particular year.
 - ▶ **The first budget period will be the U.S. proposal of 2008-2012.** The Parties rejected proposals favored by others, including budget periods beginning as early as 2003, that were neither realistic nor achievable. Having a full decade before the start of the binding period will allow more time for U.S. companies to make the transition to greater energy efficiency and/or lower carbon technologies.
 - ▶ **The emissions targets include all six major greenhouse gases.** The EU and Japan initially favored counting only three gases -- carbon dioxide, methane, and nitrous oxide. Ensuring the inclusion of the additional gases (synthetic substitutes for ozone-depleting CFCs) that are highly potent and long-lasting in the atmosphere provides more comprehensive environmental protection and lends more certainty concerning the treatment of the additional gases.

- ▶ **Activities that absorb carbon, such as planting trees, will be offset against emissions targets.** The treatment of these so-called "sinks" was another controversial issue at Kyoto. Many countries wanted sinks to be excluded. The United States insisted that they be included in the interest of encouraging activities like afforestation and reforestation. Accounting for the role of forests is critical to a comprehensive and environmentally responsible approach to climate change. It also provides the private sector with low-cost opportunities to reduce emissions.

Is the target the United States agreed to actually 7% lower than what the President proposed in October?

No. The 7% target represents no more than a 3% real reduction below the President's initial proposal of reducing greenhouse gases to 1990 levels by 2008-2012. The remaining 4 percentage points result from certain changes in the way gases and sinks are calculated and do not reflect any increase in effort as compared to the President's original proposal.

- ▶ **Changing the baseline for the three synthetic greenhouse gases from 1990 to 1995 accounts for about 1% of the 7% reduction.** Use of these three gases has grown since 1990, so that permitting a 1995 baseline allows for a higher overall baseline than the Administration assumed last October when the President announced his goal of reaching 1990 levels by 2008-2012. Making reductions to meet a higher baseline is of course easier than making reductions to meet a lower baseline. Had the United States maintained the same level of effort assumed by the President in October, and no other factors had changed, the shift to a 1995 baseline for the three synthetic gases would, alone, have transformed the President's goal of 1990 levels into a goal equivalent to 1% below 1990 levels.
- ▶ **Altering the accounting method for carbon-absorbing activities, such as planting trees, accounts for about 3% of the 7% reduction.** The President's original goal assumed that carbon-absorbing activities would be counted, both in the 1990 base year and in the 2008-2012 budget period. Under the method agreed in Kyoto, carbon-absorbing activities in the 1990 base year are not counted (yielding a higher baseline), although certain carbon-absorbing activities will count against emission reduction commitments in the budget period. This decision with respect to the accounting method makes the U.S. target somewhat less stringent. Specifically, had the U.S. maintained the same level of effort assumed by the President in October, and no other factors had changed, the shift in the accounting method for carbon-absorbing activities would, alone, have transformed the President's goal of 1990 levels into a goal equivalent to at least 3% below 1990 levels.

INTERNATIONAL EMISSIONS TRADING

- The United States prevailed in securing acceptance of emissions trading among nations with emissions targets. This free market approach, pioneered in the U.S., will allow countries to seek out the most cost-effective emissions reductions.

CLIMATE CHANGE DIVISION
Office of Policy, Planning & Evaluation
U.S. Environmental Protection Agency
401 M Street SW, Washington, D.C. 20460

To: Joe Aldy, Margot Anderson, Bill Breed
Organization: USDA

Fax: 395-6870, 690-4915, 586-2062

From: Bill Hohenstein
Organization: Climate Change Division
Phone: 202 260-7019
Fax: 202 260-6405

Date: June 17, 1998

Pages including cover sheet: ~~12~~ 9

Attached are the following

1. The worksheet used to develop forest sink estimates for the US - used in kyoto Protocol negotiations.
2. A citaion for the USDA Forest Service pub. Where the stock numbers came from.
3. A one page description on why the US was able to take a larger numeical cut due to the treatment of sinks.

Preliminary draft. For discussion purposes only. Do not cite or distribute. February 17, 1998

Land Use Change and Forests -- Sinks

Under Article 3.3 of the Kyoto agreement, sinks are greenhouse gases removed from the atmosphere that

"[result] from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, measured as verifiable changes in stocks in each commitment period."

The treatment of forests and land use change in the Kyoto Protocol achieved two goals of the United States. The framework contained in the Kyoto Protocol:

- will not penalize the US for carbon sequestration that occurred in the base year, 1990
- will allow the US to receive credit for forest planting and regeneration that sequesters carbon.

Each year, the U.S. sequesters more carbon in our forests than we emit from those same land use activities. However, the U.S. sequestered about 55 MMTCe *more* in 1990 than we are projected to sequester in 2010. The Kyoto language will recognize our positive land use-related sequestration, and not penalize us for the fact that it won't be as large as it was in 1990. (67a)

In the 2008-2012 budget period, the U.S. will receive credit in our emissions calculation for the carbon sequestration from afforestation (planting trees in previously unforested areas) and reforestation activities, and the carbon emissions from deforestation will be subtracted from those credits. The inclusion of afforestation and reforestation will allow the US to take advantage of low cost carbon sequestration projects domestically, in other Annex I countries, and through the Clean Development Mechanism.

We will have the opportunity in Buenos Aires to amend the list of activities and apply these amendments to our commitments in the first budget period if we wish. The US will work with key environmental and business constituencies to develop a strategy to ensure that verifiable carbon sequestration projects and actions receive credit under the Kyoto Protocol. We will continue to work on these elements as we move forward with developing and implementing other key provisions of the agreement, including the rules for international trading and the Clean Development Mechanism.

DRAFT

11/25/97 09:17 202 720 5437

USDA SECRETARY

001/003

November 25, 1997

TO: Bill Hohenstein, EPA, 260-6405
 Abe Haspel, DOE, 586-3047
 Jonathan Pershing, DOS, 647-0191

FROM: Carol Whitman

SUBJECT: Sink Numbers for 1990 and 2010

USDA reviewed the sink numbers for above and below ground forest carbon. In the years 1990 and 2010, forest sink numbers are:

	1990	2010	Total
		MMT	
Above ground Carbon	125	104	282
Below ground Carbon	157	123	227

Emissions for 1990 and 2010, without aboveground forest sinks and total forest sinks would then be:

	1990	2010
		MMT
Total Emissions	1583	1946
- Sinks (Aboveground)	1458	1837†
- All Sinks	1301	1719†

† Adjusted for 1993 CCAP.

cc: C. Rawls

11/25/97 09:17 0202 720 3437

USDA SECRETARY

002/003

NOV-24-97 MON 18:35 USDA-FS, NEFES

FAX NO. 2158754095

P.03

YEAR	Soil Carbon A	Forest Floor B	TOTAL A+B	PERIOD	FLUX
1952	14385	2128	16513	1952-1962	150
1962	15711	2279	17990	1962-1970	152
1970	16840	2394	19234	1970-1977	281
1977	18422	2583	21005	1977-1987	200
1987	20009	2778	22787	1987-1992	177
1992	20785	2882	23667	1992-2000	127
2000	21475	2959	24435	2000-2010	111
2010	22557	3109	25666	2010-2020	123
2020	23838	3256	26894	2020-2030	124
2030	24757	3383	28150	2030-2040	125
2040	25978	3521	29500		

Net Flux
1990
2000
2010

Trees and
UnderstoryLandfills and
Harvested
ProductsSub-total Trees
products

108 98
81 98
78 69

27
20 31
20 35

128 126
149 109
108 104

Soil and Forest Floor

Total

177 157
138 111
147 123

Total

311 282
229 220
323 227

122

1. estimate
2. 2000 + projections
smoothed

For flux

11/25/87 08:17 23202 720 5437

NOV-24-97 MON 16:34 USDA-FS, NEFES

USDA SECRETARY

FAX NO. 2159754095

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CALCULATIONS OF THE CARBON FLUX IN US FORESTS

Carbon Inventory in Forests (MMTCE)

Data source: Birdsey and Heath

YEAR	UNDERSTORY A	TREES B	TOTAL A+B	PERIOD	FLUX
1962		419	9890	9878 1952-1962	77
1962		451	10298	19749 1962-1970 1952-1970	81
1970		480	10953	11433 1970-1977	114
1977		521	11943	12484 1977-1987	128
1987		558	13008	13687 1987-1992 (77-92)	161
1992		579	13467	14057 1992-2000 1987-1992-2000	84
2000		580	14078	14858 2000-2010	78
2010		604	14849	15453 2010-2020	69
2020		628	15407	16035 2020-2030	62
2030		646	15819	16408 2030-2040	41
2040		689	16188	16857	

Carbon Inventory for Landfills and Wood Products (MMTCE)

YEAR	A Wood in Use	B Landfills	A+B TOTAL	PERIOD	FLUX
1990	1272	1236	2508	1990-1990	27
1990	1407	1374	2781	1990-2000	27
2000	1520	1533	3059	2000-2010	31
2010	1682	1734	3398	2010-2020	36
2020	1804	1954	3758	2020-2030	37
2030	1948	2185	4133	2030-2040	38
2040	2097	2428	4523		

Carbon Inventory for Soil Carbon and Forest Floor

I
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RUNNING AVERAGE
AGREES w/ 2nd PAGE

USDA Forest Service
General Technical Report RM-271

September 1995

Productivity of America's Forests and Climate Change

Editor:

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Rocky Mountain Forest and Range Experiment Station¹

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¹Headquarters is in Fort Collins. In cooperation with Colorado State University.

Table 4.2.—(continued).

Ecosystem		1992	1995	1998	2001	2004	2007	2010	2013	2016	2019	2022
Southeast	Annual Dead Flux		45	47	59	61	42	31	30	31	31	
	Annual Live Flux		19	19	25	27	21	13	10	9	9	
	TOTAL FLUX		64	66	84	88	63	43	40	40	40	
	Soils	1,602	1,810	2,039	2,314	2,514	2,518	2,532	2,566	2,590	2,625	2,671
	Forest Floor	130	147	166	190	209	210	198	195	192	191	195
	Understory	71	80	91	103	111	111	108	112	116	118	120
	Trees	1,299	1,469	1,664	1,895	2,079	2,086	2,059	2,005	1,904	1,830	1,776
	TOTAL STORAGE	3,102	3,507	3,960	4,503	4,912	4,924	4,897	4,878	4,802	4,764	4,762
	Annual Dead Flux		26	36	30	15	1	2	3	3	4	
	Annual Live Flux		21	30	26	13	(2)	(4)	(7)	(8)	(6)	
South Central	TOTAL FLUX		48	66	56	28	(1)	(3)	(5)	(6)	(2)	
	Soils	1,894	2,274	2,550	2,868	3,153	3,292	3,341	3,414	3,482	3,552	3,620
	Forest Floor	143	173	192	218	240	251	249	261	276	281	276
	Understory	99	118	133	148	164	170	158	162	169	172	177
	Trees	1,626	1,906	2,111	2,369	2,651	2,825	2,903	3,110	3,204	3,175	3,071
	TOTAL STORAGE	3,762	4,470	4,985	5,602	6,208	6,539	6,651	6,947	7,131	7,180	7,145
	Annual Dead Flux		39	43	38	31	15	7	8	8	7	
	Annual Live Flux		29	33	34	32	19	15	16	4	(6)	
	TOTAL FLUX		68	75	72	62	34	23	24	12	1	
	Soils	3,623	3,507	3,510	3,708	3,898	3,891	3,983	4,242	4,514	4,788	5,071
Rocky Mtns.	Forest Floor	650	641	645	679	711	723	747	794	845	896	946
	Understory	66	63	62	64	67	65	80	84	87	92	95
	Trees	2,571	2,469	2,463	2,606	2,735	2,713	2,737	2,931	3,129	3,329	3,528
	TOTAL STORAGE	6,911	6,679	6,680	7,057	7,410	7,393	7,547	8,051	8,574	9,105	9,639
	Annual Dead Flux		(7)	16	27	15	9	23	31	32	33	
	Annual Live Flux		(6)	9	16	7	1	13	20	20	20	
	TOTAL FLUX		(13)	25	43	22	11	37	51	53	53	
	Soils	3,168	3,077	2,976	2,936	2,872	2,859	2,880	3,059	3,250	3,456	3,654
	Forest Floor	650	630	607	600	583	578	587	622	658	698	737
	Understory	129	125	121	119	117	117	111	116	122	128	135
Pacific Coast	Trees	2,135	2,074	2,011	1,979	1,953	1,943	2,075	2,222	2,373	2,533	2,671
	TOTAL STORAGE	6,083	5,907	5,714	5,634	5,526	5,498	5,653	6,019	6,403	6,815	7,198
	Annual Dead Flux		(13)	(11)	(7)	(7)	1	14	22	24	24	
	Annual Live Flux		(7)	(7)	(4)	(3)	(9)	15	15	16	16	
	TOTAL FLUX		(20)	(18)	(11)	(9)	10	29	38	40	40	
	Soils	14,368	15,711	16,840	18,422	20,009	20,785	21,475	22,557	23,638	24,757	25,878
	Forest Floor	2,126	2,279	2,394	2,585	2,778	2,882	2,960	3,109	3,256	3,393	3,521
	Understory	419	451	480	521	558	570	580	604	628	649	669
	Trees	9,560	10,298	10,953	11,943	13,009	13,487	14,079	14,849	15,407	15,849	16,188
	TOTAL STORAGE	26,473	28,738	30,666	33,471	36,353	37,724	39,094	41,119	42,930	44,647	46,257
TOTAL	Annual Dead Flux		152	201	209	177	127	111	123	124	125	
	Annual Live Flux		81	114	126	106	84	78	69	52	41	
	TOTAL FLUX		233	316	335	284	211	189	192	176	166	

¹ Assumptions about forest land area used in projecting carbon storage and flux: (1) area of other forest land, reserved lands, and National Forest timberland are unchanged after 1992. (2) volume on reserved lands assumed to grow at the same rate as volume on similar unreserved lands. (3) area for private lands and other public lands are equal to projections from the 1993 RPA Assessment update. (4) for National Forest lands, harvest and growth rate projections are from National Forest plans and from previous RPA projections.

² Dead flux refers to average annual change in carbon in soils and the forest floor for the preceding and following periods. A positive flux indicates increasing carbon storage in dead organic matter.

³ Live flux refers to average annual change in carbon in understory and trees for the preceding and following periods. A positive flux indicates increasing carbon storage in live organic matter.

Table 4.3.—Summary of historical estimates and projections of carbon storage and flux (in million metric tons) by ownership group

Owner	Ecosystem component	1952	1962	1970	1977	1987	1992	2000	2010	2020	2030	2040
National Forest	Soils	5,183	5,458	5,482	5,439	4,824	4,585	4,621	5,031	5,472	5,949	6,440
	Forest Floor	837	882	882	875	784	760	771	842	917	997	1,080
	Understory	101	108	109	109	99	99	101	112	123	135	145
	Trees	2,294	2,482	2,512	2,540	2,456	2,458	2,554	2,826	3,110	3,408	3,714
	TOTAL STORAGE	8,415	8,930	8,985	8,963	8,163	7,902	8,047	8,811	9,622	10,489	11,379
	Annual Dead Flux ²		19	(2)	(44)	(65)	(17)	29	50	54	57	
	Annual Live Flux ³		13	4	(4)	(6)	8	21	29	30	31	
	TOTAL FLUX		32	2	(48)	(71)	(9)	51	79	84	88	
Other Public	Soils	1,954	2,177	2,359	2,510	2,380	2,311	2,595	2,912	3,212	3,510	3,811
	Forest Floor	302	332	357	378	369	350	392	439	485	530	578
	Understory	36	39	42	44	48	46	51	56	63	68	74
	Trees	818	914	993	1,066	1,178	1,145	1,263	1,391	1,523	1,662	1,810
	TOTAL STORAGE	3,110	3,462	3,751	3,998	3,975	3,852	4,301	4,798	5,283	5,770	6,273
	Annual Dead Flux		26	25	2	(15)	18	38	36	34	35	
	Annual Live Flux		10	10	11	5	7	14	14	14	15	
	TOTAL FLUX		36	35	13	(10)	(25)	53	49	49	50	
Forest Industry	Soils	1,997	2,220	2,419	2,561	2,579	2,559	2,536	2,523	2,543	2,584	2,626
	Forest Floor	306	318	333	341	342	338	297	296	309	314	314
	Understory	62	68	70	75	76	73	88	87	87	86	87
	Trees	1,208	1,324	1,392	1,470	1,501	1,473	1,464	1,587	1,733	1,822	1,855
	TOTAL STORAGE	3,573	3,930	4,214	4,447	4,498	4,443	4,385	4,493	4,672	4,806	4,882
	Annual Dead Flux		25	24	10	0	(7)	(4)	1	4	4	
	Annual Live Flux		11	10	7	0	(2)	7	13	12	6	
	TOTAL FLUX		36	34	17	0	(9)	3	14	16	11	
Other Private	Soils	5,480	6,296	6,998	7,751	9,254	10,040	10,253	10,575	10,843	11,083	11,306
	Forest Floor	663	756	828	906	1,081	1,196	1,237	1,258	1,256	1,247	1,228
	Understory	165	186	210	232	265	281	265	273	275	277	279
	Trees	3,840	4,338	4,815	5,308	6,090	6,609	6,885	7,056	6,971	6,797	6,559
	TOTAL STORAGE	10,148	11,576	12,851	14,197	16,691	18,126	18,640	19,162	19,345	19,404	19,372
	Annual Dead Flux		94	107	148	172	89	33	30	25	22	
	Annual Live Flux		57	68	78	90	61	24	5	(13)	(20)	
	TOTAL FLUX		150	175	226	262	150	58	35	12	1	
TOTAL	Soils	14,614	16,151	17,258	18,261	19,037	19,495	20,005	21,041	22,070	23,126	24,183
	Forest Floor	2,108	2,288	2,400	2,500	2,576	2,644	2,697	2,835	2,967	3,088	3,200
	Understory	364	401	431	460	488	499	505	528	548	566	585
	Trees	8,160	9,058	9,712	10,384	11,225	11,685	12,166	12,860	13,337	13,689	13,938
	TOTAL STORAGE	25,246	27,898	29,801	31,605	33,327	34,323	35,373	37,264	38,922	40,469	41,906
	Annual Dead Flux		163	155	115	92	84	97	117	117	117	
	Annual Live Flux		90	92	92	89	74	67	61	43	32	
	TOTAL FLUX		253	247	207	181	157	163	177	160	149	

¹Assumptions about forest land area used in projecting carbon storage and flux: (1) area of National Forest timberland are unchanged after 1992. (2) area for private lands and other public lands are equal to projections from the 1993 RPA Assessment update. (3) for National Forest lands, harvest and growth rate projections are from National Forest plans and from previous RPA projections.

²Dead flux refers to average annual change in carbon in soils and the forest floor for the preceding and following periods. A positive flux indicates increasing carbon storage in dead organic matter.

³Live flux refers to average annual change in carbon in understory and trees for the preceding and following periods. A positive flux indicates increasing carbon storage in live organic matter.

One mitigation option favored for increasing carbon sinks is an increase in reforestation of marginal cropland and pasture. Several scenarios investigated in previous studies show the possibility of medium- to long-term gains in carbon storage, on the order of 5-10 million metric tons per year for a relatively low-cost program treating about 20 million acres of timberland that would also produce an economic return on investment (table 4.6). A more ambitious program treating all biologically suitable land in the U.S. could achieve substantially higher gains, on the order of those attainable under a major climate shift.

A moderate tree planting scenario affecting only the South Central region, and a separate recycling scenario, were run using the new base projections (table 4.7). Small gains were estimated from tree planting, appearing by 2030 when the trees were sufficiently grown to make some difference. Increased recycling produced a more immediate and larger gain; however, this analysis included only the effects on forest carbon storage, which may be partly increased or offset by changes in the carbon held in product pools.

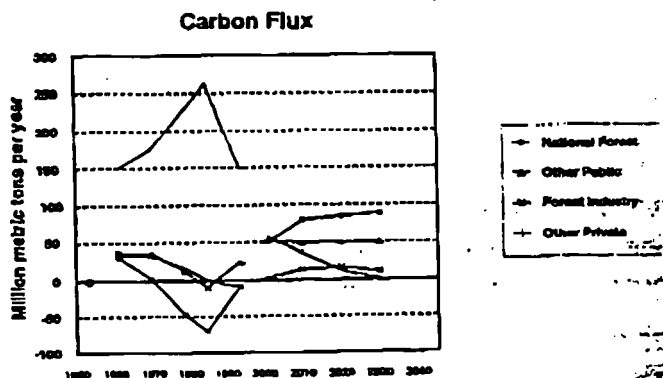
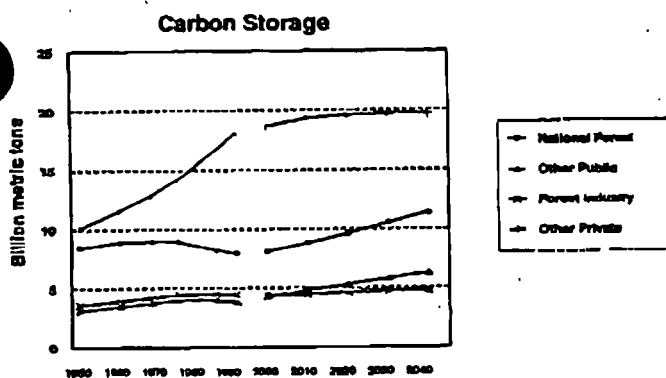


Figure 4.5.—Carbon storage and flux by owner, U.S. timberland, 1952-2040. A positive flux indicates increasing carbon storage in forest ecosystems.

Table 4.4.—Cumulative disposition of carbon harvested from private timberland in the conterminous U.S., 1980-2040.¹

Year/Period	Wood in use	Landfill	Used for energy	Emitted
—million metric tons—				
Storage:				
1980	1,272	1,236	3,642	3,129
1990	1,407	1,374	4,129	3,598
2000	1,520	1,533	4,647	4,109
2010	1,662	1,734	5,269	4,683
2020	1,804	1,954	5,942	5,314
2030	1,948	2,185	6,656	5,911
2040	2,097	2,426	7,416	6,719
—million metric tons per year—				
Flux: ²				
1990	12	15	50	49
2000	13	18	57	54
2010	14	21	65	60
2020	14	23	69	65
2030	15	24	74	70

¹Includes carbon removed from timberland after 1990.

²Calculated as average annual change over the preceding and following periods.

Table 4.5.—Comparison of carbon storage and flux for base run and climate change scenarios, trees only, private timberland in the conterminous U.S., 1990-2040.

Year/Period	Change in productivity			
	Base Run	Minimum	Average	Maximum
—million metric tons—				
Storage:				
1990	7,838	7,838	7,838	7,838
2000	8,266	8,232	8,313	8,351
2010	8,554	8,501	8,728	8,876
2020	8,610	8,584	8,998	9,312
2030	8,516	8,533	9,202	9,732
2040	8,303	8,398	9,375	10,193
—million metric tons per year—				
Flux: ¹				
1990-2000	43	39	48	51
2000-2010	29	27	42	53
2010-2020	6	8	27	44
2020-2030	(9)	(5)	20	42
2030-2040	(21)	(14)	17	46

¹Positive flux indicates net transfer of carbon from atmosphere to trees.

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The ultimate economic cost to the United States and other countries of meeting the Kyoto Protocol targets depends critically on whether emissions reductions are pursued in a cost-effective manner. For this reason, the United States insisted that the Protocol include flexible, market-based provisions designed to permit our environmental objectives to be accomplished at least cost. The mechanisms would do this by establishing an international market value for emissions reductions. This will create incentives for the reductions to be made, and in a manner that does not waste resources or impose avoidable costs on our people or industries.

The nature of the climate change problem suggests that flexibility and market mechanisms can substantially lower costs of achieving given levels of environmental protection. Indeed, 2,600 economists from academia, industry, and government stated in a letter signed last year advocating action on climate change that:

“Economic studies have found that there are many potential policies to reduce greenhouse gas emissions for which the total benefits outweigh the total costs.... The most efficient approach to slowing climate change is through market-based policies” (Economists’ Statement on Climate Change 1997).

The market mechanisms used to lower costs can be characterized in terms of three categories of flexibility: (1) “when” flexibility; (2) “what” flexibility; and (3) “where” flexibility, which may be the most important of all. Such methods have long been championed by economists interested in increasing the efficiency of environmental protection, as well as by those environmentalists interested in maximizing the environmental benefits of a given investment.

“When Flexibility” (Timing)

The freedom to delay or accelerate reductions within an agreed upon time frame -- while ensuring the credibility of emissions reductions -- can lower costs.

The Kyoto Protocol incorporates this principle of “when flexibility” in four ways:

- First, the period over which the initial emissions reductions occur begins and ends in a more realistic time frame than what had been proposed by many other countries. By adopting a gradual and credible path of reductions in the early years, adjustment costs can be greatly reduced while attaining the same ultimate environmental goals. (70)
- Second, under the Kyoto Protocol, the emissions target is not stated in terms of a specific year, but rather in terms of an average over a five-year period (2008-2012) (Kyoto Protocol, Article 3.1). Averaging over five years, instead of requiring countries to meet a specific target each year, can lower costs, especially given an uncertain future. Averaging can smooth (72) (71)

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

*Endorsed by Over 2500 Economists
including eight Nobel Laureates*

68

I. The review conducted by a distinguished international panel of scientists under the auspices of the Intergovernmental Panel on Climate Change has determined that "the balance of evidence suggests a discernible human influence on global climate." As economists, we believe that global climate change carries with it significant environmental, economic, social, and geopolitical risks, and that preventive steps are justified.

II. Economic studies have found that there are many potential policies to reduce greenhouse-gas emissions for which the total benefits outweigh the total costs. For the United States in particular, sound economic analysis shows that there are policy options that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run.

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III. The most efficient approach to slowing climate change is through market-based policies. In order for the world to achieve its climatic objectives at minimum cost, a cooperative approach among nations is required—such as an international emissions trading agreement. The United States and other nations can most efficiently implement their climate policies through market mechanisms, such as carbon taxes or the auction of emissions permits. The revenues generated from such policies can effectively be used to reduce the deficit or to lower existing taxes.

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**Statement of
Stuart E. Eizenstat
Under Secretary of State
for Economic, Business and Agricultural Affairs
before the
Senate Foreign Relations Committee
February 11, 1998**

Thank you, Mr. Chairman.

At the outset, let me thank those members of Congress, in this chamber and in the House of Representatives, who participated with us in the Kyoto Conference and who lent their advice and support to our efforts there. In particular I wish to thank Senators Hagel, Baucus, Chafee, Enzi, Kerry and Lieberman for taking the time to be present. I must also thank Senator Byrd, who could not be with us in Kyoto, for his interest and leadership. Rarely has there been an environmental issue more important or complex than global warming, and rarely has there been a greater need for the Executive Branch and the Congress to work closely together.

It is with great pleasure that I appear here today to explain the Administration's position on global warming. To this end, I will divide my testimony into four parts: (1) a short discussion of the science - the driving force for all the efforts we have taken to date to mitigate a significant and growing global environmental problem; (2) a discussion of the results of the recent Kyoto Conference and key features of the Kyoto Protocol; (3) an effort to correct misperceptions; and (4) a brief review of the President's Climate Change Technology Initiative. I hope to leave you with a clear understanding of why we believe that it is necessary to act, of how we intend to proceed internationally, and of what the President plans to do here at home.

achieved the first two – realistic targets and timetables for reducing greenhouse gas emissions among the world's major industrial nations, which fully protect the unique role of our military in its global reach; and flexible market-based mechanisms for achieving those targets. The third, meaningful participation of developing countries, will be the focus of our work in the coming months and years, but with the Kyoto Protocol we have made an important down payment.

Elements of the Kyoto Protocol and Related Decisions

Our first objective – realistic targets and timetables among developed countries – had to be a credible step in reducing the dangerous buildup of greenhouse gases, yet measured enough to safeguard U.S. prosperity at home and competitiveness abroad. In the end, we secured the key elements of the President's proposal on targets and timetables, often over the initial objections of the European Union and other developed countries. The agreement and related decisions include:

- The U.S. concept of a multi-year time frame for emissions reductions rather than a fixed, single-year target. The multi-year time frame will allow the United States, other nations and our industries greater flexibility in meeting our targets. Averaging over five years, instead of requiring countries to meet a specific target each year, can lower costs, especially given an uncertain future. (72)
The averaging can smooth out the effects of short-term events such as fluctuations in the business cycle and energy demand, or hard winters and hot summers that would increase energy use and emissions. (71)
- The U.S. specific time frame of 2008-2012, rather than earlier periods preferred by the European Union and others, giving us more time to phase in change gradually and deploy new technologies cost-effectively, and thereby to cushion the effects on our businesses and workers. (70)
- Differentiated targets for the key industrial powers ranging from 6% to 8% below baseline levels (1990 and 1995) of greenhouse gas emissions, with the United States agreeing to a 7% reduction.

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Third session

Kyoto, 1-10 December 1997

Agenda item 5

**KYOTO PROTOCOL TO THE
UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE**

The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the

Conference of the Parties to the Convention at its first session,

...ion or phasing out of market imperfections, fiscal incentives, tax and duty
...sidies in all greenhouse gas emitting sectors that run counter to the objective of the
...apply market instruments;

...ment of appropriate reforms in relevant sectors aimed at promoting policies and measures
...reduce emissions of greenhouse gases not controlled by the Montreal Protocol;

...ures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal
...in the transport sector;

...limitation and/or reduction of methane through recovery and use in waste management, as well as
...the production, transport and distribution of energy;

(b) Cooperate with other such Parties to enhance the individual and combined effectiveness of their policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(i), of the Convention. To this end, these Parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, consider ways to facilitate such cooperation, taking into account all relevant information.

2. The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

3. The Parties included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9 of the Convention, taking into account Article 3 of the Convention. The Conference of the Parties serving as the meeting of the Parties to this Protocol may take further action, as appropriate, to promote the implementation of the provisions of this paragraph.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol, if it decides that it would be beneficial to coordinate any of the policies and measures in

paragraph 1(a) above, taking into account different national circumstances and potential effects, shall consider ways and means to elaborate the coordination of such policies and measures.

Article 3

1. The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

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out the effects of short-term events such as fluctuations in the business cycle and energy demand, or hard winters and hot summers that would increase energy use and emissions.

- Third, there is allowance for “banking” emission reductions within the 2008-2012 commitment period (Kyoto Protocol, Article 3.13), for use in a subsequent commitment period, although the emission targets of the subsequent periods have not yet been specified. (72)
- Fourth, Clean Development Mechanism (CDM)¹² credits achieved between 2000 and 2007 can be banked for use in the first or subsequent commitment periods (Kyoto Protocol, Articles 12.10, 3.13). (73)

“What Flexibility” (Gases and Sinks)

“What flexibility” relates to the form the emissions reductions take and is available across two dimensions. The first is the inclusion in the agreement of all six types of greenhouse gases (Kyoto Protocol, Annex A). Emissions of different kinds of gases, not just carbon dioxide, contribute to the greenhouse effect. Reductions in emissions of one gas can be used to substitute for increases in emissions of another by an amount that has equivalent environmental effects using IPCC conversion factors for all greenhouse gases, based on their global warming potentials (see Table 2). The Kyoto Protocol stipulates that countries with binding targets are to reduce their *total* greenhouse gas emissions by certain percentages (Kyoto Protocol, Article 3.1), but does not require specific reductions for specific gases. For instance, the global warming potential per unit mass of sulfur hexafluoride is more than 24,000 times greater over 100 years than CO₂, suggesting that it might be cheaper to achieve the same environmental benefit by eliminating one ton of SF₆ rather than 24,000 tons of CO₂. (74)

The second dimension of “what flexibility” is the treatment of sinks, i.e., land use activities that promote the removal of carbon from the atmosphere through the growth of plants. Certain kinds of sinks, in particular afforestation and reforestation net of deforestation, will be used to attain the target by offsetting emissions. Promoting afforestation and reforestation may reduce atmospheric concentrations of CO₂ at much lower costs than reducing emissions of greenhouse gases resulting from industrial activity. In addition, other carbon sinks, such as agricultural soils, could be added to the list of sink activities in the future (Kyoto Protocol, Article 3.4). (75)

¹² For a discussion of the Clean Development Mechanism see p. 25. (76)

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**KYOTO PROTOCOL TO THE
UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE**

The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the

Conference of the Parties to the Convention at its first session,

- ...uction or phasing out of market imperfections, fiscal incentives, tax and duty
...ubsidies in all greenhouse gas emitting sectors that run counter to the objective of the
...apply market instruments;
- ...gement of appropriate reforms in relevant sectors aimed at promoting policies and measures
...or reduce emissions of greenhouse gases not controlled by the Montreal Protocol;
- ...asures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal
...ool in the transport sector;
- (b) Limitation and/or reduction of methane through recovery and use in waste management, as well as
in the production, transport and distribution of energy;
- (b) Cooperate with other such Parties to enhance the individual and combined effectiveness of their
policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(i), of the
Convention. To this end, these Parties shall take steps to share their experience and exchange information
on such policies and measures, including developing ways of improving their comparability, transparency
and effectiveness. The Conference of the Parties serving as the meeting of the Parties to this Protocol
shall, at its first session or as soon as practicable thereafter, consider ways to facilitate such cooperation,
taking into account all relevant information.

2. The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

3. The Parties included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9 of the Convention, taking into account Article 3 of the Convention. The Conference of the Parties serving as the meeting of the Parties to this Protocol may take further action, as appropriate, to promote the implementation of the provisions of this paragraph.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol, if it decides that it would be beneficial to coordinate any of the policies and measures in

paragraph 1(a) above, taking into account different national circumstances and potential effects, shall consider ways and means to elaborate the coordination of such policies and measures.

Article 3

2

1. The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

2. Each Party included in Annex I shall, by 2005, have made demonstrable progress in achieving its commitments under this Protocol.

3. The net changes in greenhouse gas emissions from sources and removals by sinks resulting from direct human-induced land use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, measured as verifiable changes in stocks in each commitment period shall be used to meet the commitments in this Article of each Party included in Annex I. The greenhouse gas emissions from sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner and reviewed in accordance with Articles 7 and 8.

4. Prior to the first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol, each Party included in Annex I shall provide for consideration by the Subsidiary Body for Scientific and Technological Advice data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how and which additional human-induced activities related to changes in greenhouse gas emissions and removals in the agricultural soil and land use change and forestry categories, shall be added to, or subtracted from, the assigned amount for Parties included in Annex I, taking into account uncertainties, transparency in reporting, verifiability, the methodological work of the Intergovernmental Panel on Climate Change, the advice provided by the Subsidiary Body for Scientific and Technological Advice in accordance with Article 5 and the decisions of the Conference of the Parties. Such a decision shall apply in the second and subsequent commitment periods. A Party may choose to apply such a decision on these additional human-induced activities for its first commitment period, provided that these activities have taken place since 1990.

5. The Parties included in Annex I undergoing the process of transition to a market economy whose base year or period was established pursuant to decision 9/CP.2 of the Conference of the Parties at its second session, shall use that base year or period for the implementation of their commitments under this Article. Any other Party included in

Annex I undergoing the process of transition to a market economy which has not yet submitted its first national communication under Article 12 of the Convention may also notify the Conference of the Parties serving as the meeting of the Parties to this Protocol that it intends to use a historical base year or period other than 1990 for the implementation of its commitments under this Article. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall decide on the acceptance of such notification.

6. Taking into account Article 4, paragraph 6, of the Convention, in the implementation of their commitments under this Protocol other than those in this Article, a certain degree of

flexibility shall be allowed by the Conference of the Parties serving as the meeting of the Parties to this Protocol to the Parties included in Annex I undergoing the process of transition to a market economy.

7. In the first quantified emission limitation and reduction commitment period, from

2. 2008 to 2012, the assigned amount for each Party included in Annex I shall be equal to the percentage inscribed for it in Annex B of its aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A in 1990, or the base year or period determined in accordance with paragraph 5 above, multiplied by five. Those Parties included in Annex I for whom land use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990

missions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions minus removals in 1990 from land use change for the purposes of calculating their assigned amount.

8. Any Party included in Annex I may use 1995 as its base year for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, for the purposes of the calculation referred to in paragraph 7 above.

9. Commitments for subsequent periods for Parties included in Annex I shall be established in amendments to Annex B to this Protocol, which shall be adopted in accordance with the provisions of Article 20, paragraph 7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall initiate the consideration of such commitments at least seven years before the end of the first commitment period mentioned in paragraph 7 above.

10. Any emission reduction units, or any part of an assigned amount, which a Party acquires from another Party in accordance with the provisions of Article 6 and of Article 16 bis shall be added to the assigned amount for that Party.

11. Any emission reduction units, or any part of an assigned amount, which a Party transfers to another Party in accordance with the provisions of Article 6 and of Article 16 bis shall be subtracted from the assigned amount for that Party.

12. Any certified emission reductions which a Party acquires from another Party in accordance with the provisions of Article 12 shall be added to the assigned amount for that Party.

13. If the emissions of a Party included in Annex I during a commitment period are less than its assigned amount under this Article, this difference shall, on request of that Party, be added to the assigned amount for that Party for subsequent commitment periods.

14. Each Party included in Annex I shall strive to implement the commitments mentioned in paragraph 1 above in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. In line with relevant decisions of the Conference of the Parties on the implementation of those paragraphs, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of response measures on Parties referred to in those paragraphs. Among the issues to be considered shall be the establishment of funding, insurance and transfer of technology.

Article 4

1. Any Parties included in Annex I that have agreed to jointly fulfil their commitments under Article 3 shall be deemed to have met those commitments provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of Article 3. The respective emission level allocated to each of the Parties to the agreement shall be set out in that agreement.

2. The Parties to any such agreement shall notify the secretariat of the terms of the agreement on the date of deposit of their instruments of ratification, acceptance, approval or accession. The secretariat shall in turn inform the Parties and signatories to the Convention of the terms of the

2. In the context of the implementation of Article 4, paragraph 1, of the Convention, in accordance with the provisions of Article 4, paragraph 3, and Article 11 of the Convention, and through the operating entity or entities of the financial mechanism of the Convention, the developed country Parties and other developed Parties included in Annex II to the Convention shall:

(a) Provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in advancing the implementation of existing commitments under Article 4, paragraph 1(a), of the Convention that are covered in

Article 10, subparagraph (a); and

(b) Also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of advancing the implementation of existing commitments in Article 4, paragraph 1, of the Convention that are covered by Article 10 and that are agreed between a developing country Party and the international entity or entities referred to in Article 11 of the Convention, in accordance with that Article.

The implementation of these existing commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among developed country Parties. The guidance to the financial mechanism of the Convention in relevant decisions of the Conference of the Parties, including those agreed before the adoption of this Protocol, shall apply *mutatis mutandis* to the provisions of this paragraph.

3. The developed country Parties and other developed Parties in Annex II to the

Convention may also provide, and developing country Parties avail themselves of, financial resources for the implementation of Article 10, through bilateral, regional and other multilateral channels.

Article 12

1. A clean development mechanism is hereby defined.

2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

3. Under the clean development mechanism:

(a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and

(b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.

5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

- (a) Voluntary participation approved by each Party involved;
- (b) Real, measurable, and long-term benefits related to the mitigation of climate change; and
- (c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

9. Participation under the clean development mechanism, including in activities mentioned in paragraph (a) above and acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

Article 13

1. The Conference of the Parties, the supreme body of the Convention, shall serve as the meeting of the Parties to this Protocol.

2. Parties to the Convention that are not Parties to this Protocol may participate as

observers in the proceedings of any session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, decisions under this Protocol shall be taken only by those that are Parties to it.

3. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, any member of the Bureau of the Conference of the Parties representing a Party to the Convention but, at that time, not a Party to this Protocol, shall be substituted by an additional member to be elected by and from amongst the Parties to this Protocol.

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**KYOTO PROTOCOL TO THE
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The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the

Conference of the Parties to the Convention at its first session,

their instruments of ratification, acceptance, approval or accession.

2. For the purposes of this Article, "the total carbon dioxide emissions for 1990 of the Parties included in Annex I" means the amount communicated on or before the date of adoption of this Protocol by the Parties included in Annex I in their first national communications submitted in accordance with Article 12 of the Convention.

3. For each State or regional economic integration organization that ratifies, accepts or approves this Protocol or accedes thereto after the conditions set out in paragraph 1 above for the entry into force have been fulfilled, this Protocol shall enter into force on the ninetieth day following the date of deposit of its instrument of ratification, acceptance, approval or accession.

4. For the purposes of this Article, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by States members of the organization.

Article 25

No reservations may be made to this Protocol.

Article 26

1. At any time after three years from the date on which this Protocol has entered into force for a Party, that Party may withdraw from this Protocol by giving written notification to the Depositary.

2. Any such withdrawal shall take effect upon expiry of one year from the date of receipt by the Depositary of the notification of withdrawal, or on such later date as may be specified in the notification of withdrawal.

3. Any Party that withdraws from the Convention shall be considered as also having withdrawn from this Protocol.

Article 27

The original of this Protocol, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the

United Nations.

Done at Kyoto this tenth day of December one thousand nine hundred and ninety-seven.

Annex A

Greenhouse gases

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Carbon dioxide (CO₂)

Methane (CH₄)

Nitrous oxide (N₂O)

Hydrofluorocarbons (HFCs)

Perfluorocarbons (PFCs)

Sulphur hexafluoride (SF₆)

Sectors/source categories

Energy

Fuel combustion

Energy industries

Manufacturing industries and construction

Transport

Other sectors

Other

Fugitive emissions from fuels

Solid fuels

Oil and natural gas

Other

Industrial processes

Mineral products

Chemical industry

Metal production

Other production

Production of halocarbons and sulphur hexafluoride

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Being guided by Article 3 of the Convention,

*Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the
Conference of the Parties to the Convention at its first session,*

technologies;

(v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and apply market instruments;

(vi) Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol;

(vii) Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector;

(viii) Limitation and/or reduction of methane through recovery and use in waste management, as well as in the production, transport and distribution of energy;

(b) Cooperate with other such Parties to enhance the individual and combined effectiveness of their policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(i), of the Convention. To this end, these Parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, consider ways to facilitate such cooperation, taking into account all relevant information.

2. The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

3. The Parties included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9 of the Convention, taking into account Article 3 of the Convention. The Conference of the Parties serving as the meeting of the Parties to this Protocol may take further action, as appropriate, to promote the implementation of the provisions of this paragraph.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol, if it decides that it would be beneficial to coordinate any of the policies and measures in

paragraph 1(a) above, taking into account different national circumstances and potential effects, shall consider ways and means to elaborate the coordination of such policies and measures.

Article 3

1. The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

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*Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the
Conference of the Parties to the Convention at its first session,*

technologies;

(v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and apply market instruments;

(vi) Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol;

(vii) Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector;

(viii) Limitation and/or reduction of methane through recovery and use in waste management, as well as in the production, transport and distribution of energy;

(b) Cooperate with other such Parties to enhance the individual and combined effectiveness of their policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(i), of the Convention. To this end, these Parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, consider ways to facilitate such cooperation, taking into account all relevant information.

2. The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

3. The Parties included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9 of the Convention, taking into account Article 3 of the Convention. The Conference of the Parties serving as the meeting of the Parties to this Protocol may take further action, as appropriate, to promote the implementation of the provisions of this paragraph.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol, if it decides that it would be beneficial to coordinate any of the policies and measures in

paragraph 1(a) above, taking into account different national circumstances and potential effects, shall consider ways and means to elaborate the coordination of such policies and measures.

Article 3

1. The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

2. Each Party included in Annex I shall, by 2005, have made demonstrable progress in achieving its commitments under this Protocol.

3. The net changes in greenhouse gas emissions from sources and removals by sinks resulting from direct human-induced land use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, measured as verifiable changes in stocks in each commitment period shall be used to meet the commitments in this Article of each Party included in Annex I. The greenhouse gas emissions from sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner and reviewed in accordance with Articles 7 and 8. (76)

4. Prior to the first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol, each Party included in Annex I shall provide for consideration by the Subsidiary Body for Scientific and Technological Advice data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how and which additional human-induced activities related to changes in greenhouse gas emissions and removals in the agricultural soil and land use change and forestry categories, shall be added to, or subtracted from, the assigned amount for Parties included in Annex I, taking into account uncertainties, transparency in reporting, verifiability, the methodological work of the Intergovernmental Panel on Climate Change, the advice provided by the Subsidiary Body for Scientific and Technological Advice in accordance with Article 5 and the decisions of the Conference of the Parties. Such a decision shall apply in the second and subsequent commitment periods. A Party may choose to apply such a decision on these additional human-induced activities for its first commitment period, provided that these activities have taken place since 1990. (77)

5. The Parties included in Annex I undergoing the process of transition to a market economy whose base year or period was established pursuant to decision 9/CP.2 of the Conference of the Parties at its second session, shall use that base year or period for the implementation of their commitments under this Article. Any other Party included in

Annex I undergoing the process of transition to a market economy which has not yet submitted its first national communication under Article 12 of the Convention may also notify the Conference of the Parties serving as the meeting of the Parties to this Protocol that it intends to use a historical base year or period other than 1990 for the implementation of its commitments under this Article. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall decide on the acceptance of such notification.

6. Taking into account Article 4, paragraph 6, of the Convention, in the implementation of their commitments under this Protocol other than those in this Article, a certain degree of

flexibility shall be allowed by the Conference of the Parties serving as the meeting of the Parties to this Protocol to the Parties included in Annex I undergoing the process of transition to a market economy.

7. In the first quantified emission limitation and reduction commitment period, from

2008 to 2012, the assigned amount for each Party included in Annex I shall be equal to the percentage inscribed for it in Annex B of its aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A in 1990, or the base year or period determined in accordance with paragraph 5 above, multiplied by five. Those Parties included in Annex I for whom land use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990

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Divider Title: _____

Table 2. Global Warming Potentials of Greenhouse Gases Included in the Kyoto Protocol

Chemical/Species	Chemical Formula	Global Warming Potential (100 year time horizon; carbon equivalence) per unit mass
Carbon Dioxide	CO ₂	0.27
Methane	CH ₄	6
Nitrous Oxide	N ₂ O	85
HFC-23	CHF ₃	3,191
HFC-32	CH ₂ F ₂	177
HFC-41	CH ₃ F	41
HFC-43-10mee	C ₅ H ₂ F ₁₀	355
HFC-125	C ₂ HF ₅	764
HFC-134	C ₂ H ₂ F ₄	273
HFC-134a	CH ₂ FCF ₃	355
HFC-152a	C ₂ H ₄ F ₂	38
HFC-143	C ₂ H ₃ F ₃	82
HFC-143a	C ₂ H ₃ F ₃	1,036
HFC-227ea	C ₃ HF ₇	791
HFC-236fa	C ₃ H ₂ F ₆	1,718
HFC-245ca	C ₃ H ₃ F ₅	153
Sulfur hexafluoride	SF ₆	6,518
Perfluoromethane	CF ₄	1,773
Perfluoroethane	C ₂ F ₆	2,509
Perfluoropropane	C ₃ F ₈	1,909
Perfluorobutane	C ₄ F ₁₀	1,909
Perfluorocyclobutane	c-C ₄ F ₈	2,373
Perfluoropentane	C ₅ F ₁₂	2,045
Perfluorohexane	C ₆ F ₁₄	2,018

Source: Houghton et al. 1996, p. 22 and adjusted based on carbon content of CO₂.

● Climate Change 1995

The Science of Climate Change

**Edited by J.T. Houghton,
L.G. Meira Filho, B.A. Callander, N. Harris,
A. Kattenberg and K. Maskell**

Production Editor: J.A. Lakeman

●

Contribution of WGI to the Second Assessment Report
of the Intergovernmental Panel on Climate Change

Published for the Intergovernmental Panel on Climate Change



CAMBRIDGE
UNIVERSITY PRESS

Technical Summary

Prepared by the lead authors taking into account comments arising from extensive review by individual experts, governments and non-governmental organisations

This summary, part of the background material on which the Summary for Policymakers is based, has been accepted by the IPCC but not approved in detail. Acceptance by the IPCC signifies the Panel's view that the summary presents a comprehensive, objective and balanced view of the subject matter.

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Table 4: Global Warming Potential referenced to the updated decay response for the Bern carbon cycle model and future CO₂ atmospheric concentrations held constant at current levels.

Species	Chemical Formula	Lifetime (years)	Global Warming Potential (Time Horizon)		
			20 years	100 years	500 years
CO ₂	CO ₂	variable [§]	1	1	1
Methane*	CH ₄	12±3	56	21	6.5
Nitrous oxide	N ₂ O	120	280	310	170
HFC-23	CHF ₃	264	9,100	11,700	9,800
HFC-32	CH ₂ F ₂	5.6	2,100	650	200
HFC-41	CH ₃ F	3.7	490	150	45
HFC-43-10mee	C ₅ H ₂ F ₁₀	17.1	3,000	1,300	400
HFC-125	C ₂ HF ₅	32.6	4,600	2,800	920
HFC-134	C ₂ H ₂ F ₄	10.6	2,900	1,000	310
HFC-134a	CH ₂ FCF ₃	14.6	3,400	1,300	420
HFC-152a	C ₂ H ₄ F ₂	1.5	460	140	42
HFC-143	C ₂ H ₃ F ₃	3.8	1,000	300	94
HFC-143a	C ₂ H ₃ F ₃	48.3	5,000	3,800	1,400
HFC-227ea	C ₃ HF ₇	36.5	4,300	2,900	950
HFC-236fa	C ₃ H ₂ F ₆	209	5,100	6,300	4,700
HFC-245ca	C ₃ H ₃ F ₅	6.6	1,800	560	170
Sulphur hexafluoride	SF ₆	3,200	16,300	23,900	34,900
Perfluoromethane	CF ₄	50,000	4,400	6,500	10,000
Perfluoroethane	C ₂ F ₆	10,000	6,200	9,200	14,000
Perfluoropropane	C ₃ F ₈	2,600	4,800	7,000	10,100
Perfluorobutane	C ₄ F ₁₀	2,600	4,800	7,000	10,100
Perfluorocyclobutane	c-C ₄ F ₈	3,200	6,000	8,700	12,700
Perfluoropentane	C ₅ F ₁₂	4,100	5,100	7,500	11,000
Perfluorohexane	C ₆ F ₁₄	3,200	5,000	7,400	10,700
Ozone-depleting substances [†]	e.g., CFCs and HCFCs				

[§] Derived from the Bern carbon cycle model.

* The GWP for methane includes indirect effects of tropospheric ozone production and stratospheric water vapour production, as in IPCC (1994). The updated adjustment time for methane is discussed in Section B.2.

† The Global Warming Potentials for ozone-depleting substances (including all CFCs, HCFCs and halons, whose direct GWPs have been given in previous reports) are a sum of a direct (positive) component and an indirect (negative) component which depends strongly upon the effectiveness of each substance for ozone destruction. Generally, the halons are likely to have negative net GWPs, while those of the CFCs are likely to be positive over both 20- and 100-year time horizons (see Chapter 2, Table 2.8).

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“Where Flexibility” (International)

Greenhouse gas emissions have the same environmental consequences regardless of where in the world they occur. Therefore, the least-cost approach to controlling climate change is to reduce emissions wherever such reductions are cheapest. The Kyoto Protocol includes three important cost-saving provisions of this nature.

- First, it provides for countries that take on binding targets -- at present the industrial countries -- to trade greenhouse gas emissions allowances with each other (Kyoto Protocol, Article 17, formerly known as Article 16bis). This market in emissions allowances could ensure that emissions reductions occur where they are least expensive within the industrial countries. In particular, U.S. companies could purchase emissions reductions in other participating countries when doing so would reduce their costs -- thus lowering costs without diminishing the level of environmental protection. It is worth noting that regardless of where the reductions take place, countries and their people will bear the cost of ensuring reductions sufficient to meet their specific Kyoto targets, while everyone will enjoy the environmental benefits. (78)
- Second, the agreement provides for joint implementation by Annex I countries (Kyoto Protocol, Article 6). Thus if some industrial countries do not develop programs to trade allowances internationally, U.S. firms could nonetheless implement projects in those countries for which they could receive emissions reduction credits in the United States. (79)
- Third, the agreement allows industrial countries or firms in those countries, through the Clean Development Mechanism, to invest in “clean development” projects in the developing world and use these projects' certified emissions reductions toward meeting their targets (Kyoto Protocol, Article 12). Investment in these kinds of projects would promote sustainable development in developing countries. Many such clean development projects may be quite inexpensive, measured in terms of the cost per ton of emissions avoided, as has been illustrated by the U.S. joint implementation pilot program. The low cost implies that both developing countries and industrial countries could benefit through these clean development efforts. (80)

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Third session

Kyoto, 1-10 December 1997

Agenda item 5

**KYOTO PROTOCOL TO THE
UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE**

The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

*Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the
Conference of the Parties to the Convention at its first session,*

bodies of this Protocol, decisions under this Protocol shall be taken **only** by the **Parties** to this Protocol.

3. When the subsidiary bodies established by Articles 9 and 10 of the Convention exercise their functions with regard to matters concerning this Protocol, any member of the **Bureaux** of those subsidiary bodies representing a Party to the Convention but, at that time, not a party to this Protocol, shall be substituted by an additional member to be elected by and from amongst the **Parties** to this Protocol.

Article 16

The Conference of the Parties serving as the meeting of the **Parties** to this Protocol shall, as soon as practicable, consider the application to this Protocol of, and modify as appropriate, the multilateral consultative process referred to in Article 13 of the Convention, in the light of any relevant decisions that may be taken by the Conference of the Parties. Any multilateral consultative process that may be applied to this Protocol shall operate without prejudice to the procedures and mechanisms established in accordance with Article 17.

Article 16 bis

The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading. The Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under Article 3 of this Protocol. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article.

Article 17

The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, approve appropriate and effective procedures and mechanisms to determine and to address cases of non-compliance with the provisions of this Protocol, including through the development of an indicative list of consequences, taking into account the cause, type, degree and frequency of non-compliance. Any procedures and mechanisms under this Article entailing binding consequences shall be adopted by means of an amendment to this Protocol.

Article 18

The provisions of Article 14 of the Convention on settlement of disputes shall apply *mutatis mutandis* to this Protocol.

Article 19

1. Any Party may propose amendments to this Protocol.
2. Amendments to this Protocol shall be adopted at an ordinary session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. The text of any proposed amendment to this

upon by the Conference of the Parties at its third session. Based on the work of, *inter alia*, the Intergovernmental Panel on Climate Change and advice provided by the Subsidiary Body for Scientific and Technological Advice, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall regularly review and, as appropriate, revise the global warming potential of each such greenhouse gas, taking fully into account any relevant decisions by the Conference of the Parties. Any revision to a global warming potential shall apply only to those commitments under Article 3 in respect of any commitment period adopted subsequent to that revision.

Article 6

79

1. For the purpose of meeting its commitments under Article 3, any Party included in

Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:

- (a) Any such project has the approval of the Parties involved;
- (b) Any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur;
- (c) It does not acquire any emission reduction units if it is not in compliance with its obligations under Articles 5 and 7; and
- (d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3.

2. The Conference of the Parties serving as the meeting of the Parties to this Protocol may, at its first session or as soon as practicable thereafter, further elaborate guidelines for the implementation of this Article, including for verification and reporting.

3. A Party included in Annex I may authorize legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this Article of emission reduction units.

4. If a question of implementation by a Party included in Annex I of the requirements referred to in this paragraph is identified in accordance with the relevant provisions of

Article 8, transfers and acquisitions of emission reduction units may continue to be made after the question has been identified, provided that any such units may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

Article 7

1. Each Party included in Annex I shall incorporate in its annual inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, submitted in accordance with the relevant decisions of the Conference of the Parties, the necessary supplementary information for the purposes of ensuring compliance with Article 3, to be determined in accordance with paragraph 4 below.

2. In the context of the implementation of Article 4, paragraph 1, of the Convention, in accordance with the provisions of Article 4, paragraph 3, and Article 11 of the Convention, and through the operating entity or entities of the financial mechanism of the Convention, the developed country Parties and other developed Parties included in Annex II to the Convention shall:

(a) Provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in advancing the implementation of existing commitments under Article 4, paragraph 1(a), of the Convention that are covered in

Article 10, subparagraph (a); and

(b) Also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of advancing the implementation of existing commitments in Article 4, paragraph 1, of the Convention that are covered by Article 10 and that are agreed between a developing country Party and the international entity or entities referred to in Article 11 of the Convention, in accordance with that Article.

The implementation of these existing commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among developed country Parties. The guidance to the financial mechanism of the Convention in relevant decisions of the Conference of the Parties, including those agreed before the adoption of this Protocol, shall apply *mutatis mutandis* to the provisions of this paragraph.

3. The developed country Parties and other developed Parties in Annex II to the

Convention may also provide, and developing country Parties avail themselves of, financial resources for the implementation of Article 10, through bilateral, regional and other multilateral channels.

Article 12

80

1. A clean development mechanism is hereby defined.

2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

3. Under the clean development mechanism:

(a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and

(b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.

5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

- (a) Voluntary participation approved by each Party involved;
- (b) Real, measurable, and long-term benefits related to the mitigation of climate change; and
- (c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

9. Participation under the clean development mechanism, including in activities mentioned in paragraph 3(a) above and acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

Article 13

1. The Conference of the Parties, the supreme body of the Convention, shall serve as the meeting of the Parties to this Protocol.

2. Parties to the Convention that are not Parties to this Protocol may participate as observers in the proceedings of any session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, decisions under this Protocol shall be taken only by those that are Parties to it.

3. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, any member of the Bureau of the Conference of the Parties representing a Party to the Convention but, at that time, not a Party to this Protocol, shall be substituted by an additional member to be elected by and from amongst the Parties to this Protocol.

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Opportunities for Cost-Savings through International Trade in Emissions Allowances

One of the primary principles of classical and neoclassical economics is that trade can make the participating parties better off. In the case of reducing greenhouse gas emissions, trade in emissions allowances could reduce the costs of firms and/or countries with higher abatement costs because they can choose to pay low-cost abaters to further reduce their emissions. Similarly, countries with lower abatement costs are better off by participating in international emissions markets because of the net income they can earn by selling emissions allowances abroad. This is no different than high-cost producers of any good wanting to buy at lower world market prices from willing exporters. If a firm finds it relatively costly to "produce" an emissions reduction, it may find it economically advantageous to purchase emissions from low-cost "producers". An international market for emissions also would create incentives for high-cost producers to innovate and find ways to become low-cost producers, and thus sellers of emissions. A wide range of both formal and anecdotal evidence shows that the flexibility mechanisms, particularly trade in emissions, would allow the world to achieve global emissions reductions at substantially reduced cost. Given the magnitude of the reductions necessary, an effective trading system would be needed to achieve our environmental goals while minimizing the cost and disruption to our people and firms.

The benefits of achieving emissions reductions targets through international trading have been evaluated by numerous economists in the energy modeling community. Barrett (1992), for example, found that stabilizing emissions country-by-country could cost the European Union (E.U.) 50 times as much as stabilizing emissions for the E.U. as a whole. OECD's GREEN model shows that the costs of abatement vary among regions of the globe by a factor of 20 (Burniaux et al. 1992). GREEN also indicates that even with each region reaching a 1990 emissions target at the least cost, allowing trade among regions would lower worldwide compliance costs by another factor of two.

The Stanford Energy Modeling Forum (EMF) conducts exercises with a set of energy-economic models to assess hypothetical energy policy scenarios. In the EMF-14 exercise, six models assessed two emissions pathways over the next 100+ years to achieve a 550 ppm carbon dioxide concentration target. For these two emissions pathways, the models calculated the economic costs of reducing emissions with and without international trading. While the magnitude of the cost-savings varied across models, the finding that trading reduces costs among the group of trading partners was very robust. In the six models included in the EMF exercise, international trading reduced the cost of meeting the global emissions targets by nearly 60% (Weyant 1997).

(B)

Facsimile cover sheet**London
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From: Gail Moody

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Number of pages: 22
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Message:

Matt,

I hope this is the paper you wanted. Please let me know.

Thanks



Reaching a CO₂-emission limitation agreement for the Community : implications for equity and cost-effectiveness

Scott Barrett

London Business School and
Centre for Social and Economic Research on the Global Environment

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in *European Economy*, Special Edition No 1,
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Directorate-General for Economic and Financial Affairs,
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Summary

On 29 October 1990, a joint Council of the Community's Energy and Environment Ministers declared that the European Community and Member States were willing to take actions aimed at stabilizing total CO₂ emissions at the 1990 level by 2000 for the Community as a whole. Even before this Community-wide target had been agreed, a number of Member States announced unilateral CO₂ emission reduction targets. However, these targets vary widely, and some countries have steadfastly refused to set their own targets. What is more, none of the proposed unilateral targets is legally binding; they can be changed at the discretion of the proposers. Hence, it is not obvious how the Community-wide target would be achieved. Reaching agreement on how the Community target is to be achieved will likely prove contentious. This paper reveals areas where agreement will prove hardest to reach, and indicates how these problems might be overcome.

The main conclusions of the paper are as follows :

- 1. Using data developed for the Commission, estimates of the cost of abating emissions are shown to vary among countries within the EC (excluding Luxembourg and Ireland, for which no data were available). Belgium, Italy, the Netherlands and Spain stand out as high-cost countries. Denmark and Portugal stand out as low-cost countries. France, Germany, Greece and the United Kingdom fall between these extremes. However, it must be emphasized that while the cost data used in this analysis are based on research, much uncertainty surrounds both the absolute levels of costs and comparability of levels across countries.*
- 2. The minimum total cost of stabilizing Community emissions at the 1988 level by 2010 is estimated to be ECU 1.4 billion in 2010 (total costs over the period 1988–2010 could not be calculated). This cost-effective policy imposes weak obligations on the high-cost countries and large obligations on the low-cost countries. Relative to 1988, Belgium would be required to stabilize emissions; Denmark, France, Germany and the United Kingdom would be required to reduce emissions from 10–24 %; and Greece, Italy, the Netherlands, Portugal and Spain would be allowed to increase emissions between 13 and 43 %.*
- 3. The target of stabilizing Community emissions at the 1988 level could be achieved by a carbon tax of about ECU 20 per tonne of CO₂. This corresponds to a carbon tax of about USD 75 per tonne of carbon, and is quite large compared with estimates available in the literature, given the total reduction in emissions.*
- 4. If each and every EC country were required to stabilize emissions at the 1988 level by 2010, the total cost of abatement in 2010 would be about ECU 70 billion, or almost 50 times that of the cost-effective solution. National stabilization targets would in fact reduce total emissions 4 % relative to 1988 simply because the baseline implies that emissions for several countries will fall even if abatement at a positive marginal cost is not undertaken. Nevertheless, this comparison indicates the advantages of the cost-effective allocation.*
- 5. An alternative proposal which required that Denmark, Germany and the Netherlands reduce their emissions 5 % relative to 1988; that Belgium, France, Italy and the United Kingdom stabilize their emissions at the 1988 level; and that allowed Greece, Portugal and Spain to increase their emissions by 15 % from the 1988 level would still prove about 35 times more costly than the cost-effective solution (although for reasons outlined above total abatement is 2 % greater under the alternative proposal). Hence, even non-uniform emission targets may prove very costly.*
- 6. While the cost-effective allocation reduces costs for the Community as a whole, the distribution of costs is uneven. The largest costs would be borne by France, Germany and the United Kingdom, but substantial costs would also be borne by Denmark, Greece and Portugal.*
- 7. Agreement on equitable burden sharing is likely to prove contentious. Denmark, for example, would bear the highest cost per capita, but would still be allowed to emit more CO₂ per capita than the average. Greece would bear a high cost relative to GDP, but would be allowed to emit more CO₂ per unit of GDP than any other country.*
- 8. Assuming that the Community target maximizes net benefits for the Community as a whole (holding emissions for the rest of the world unchanged), and that marginal benefits of abatement are proportional to GDP and constant for all considered abatement levels, the cost-effective policy would leave Denmark, Greece and Portugal worse off. Hence, these countries would*

prefer that negotiations failed. Compensating payments would have to be made to these countries to ensure their willingness to agree to the cost-effective allocation. If marginal benefits are instead assumed to be proportional to agricultural output, Greece would be a net gainer from the cost-effective policy, while the United Kingdom would be made worse off. Since much uncertainty surrounds benefit estimates, these results indicate that it is not obvious which countries would gain, and which would lose, if the cost-effective policy were implemented without side payments. This cautionary conclusion is reinforced by the uncertainty surrounding cost estimates.

9. The countries that are net losers might demand a compensating payment that left the other countries better off even after making the payment than if negotiations failed. However, the net gainers might do better still by reaching an agreement independently of countries demanding compensation. An agreement limiting Community CO₂ emissions must not only make every individual country better off with the agreement than without it, but every coalition of countries better off with the agreement than without it. Determination of the transfers required to reach such an agreement will prove difficult, and the magnitude of such transfers will not be unique. However, an agreement making every party and coalition of parties better off should be negotiable.

1. Introduction

On 29 October 1990, a joint Council of the Community's Energy and Environment Ministers declared that the European Community and Member States were willing to take actions aimed at stabilizing total CO₂ emissions at the 1990 level by 2000 for the Community as a whole. Even before this Community-wide target had been agreed, a number of Member States announced unilateral CO₂ emission reduction targets. However, these targets vary widely, and some countries have steadfastly refused to set their own targets. What is more, none of the proposed unilateral targets is legally binding; they can be changed at the discretion of the proposers. Hence, it is not obvious how the Community-wide target would be achieved. Reaching agreement on how the Community target is to be achieved will likely prove contentious. This paper reveals areas where agreement will prove hardest to reach, and indicates how these problems might be overcome.

Why seek a Community agreement at all, if individual countries have already announced unilateral policies? There are many reasons, but perhaps the most important is the desire on the part of these same countries to make their own actions more effective, either by lowering the costs of reducing emissions, or by increasing the associated benefits. Costs can be lowered if the other EC countries undertake greater abatement than they otherwise would. The reason is that marginal abatement costs are almost certain to be smaller for countries that undertake little or no abatement. The total costs of reducing CO₂ emissions could be reduced, perhaps substantially, if the burden were shared more widely. Similarly, benefits can be increased if abatement by one country is made contingent on abatement by others. Abatement by one country benefits all countries. Hence, the country that bears the costs of abatement receives only a fraction

of the total benefit. However, if one country's abatement is tied to that of others, then more abatement is achieved in total and hence every country receives a greater benefit.

The desire to reduce costs is likely to lead countries to want to achieve Community-wide abatement at minimum total cost, and hence to choose abatement obligations or a carbon tax policy which equalizes marginal costs across the Community. The desire to increase benefits is likely to lead countries to choose a total level of abatement at which each country's marginal cost equals the marginal benefit for the Community as a whole. This level maximizes net benefits for the Community.

Interest in a Community-wide agreement can therefore be seen as a natural response by countries to exploit the potential for an increase in net benefits. However, securing agreement faces two difficulties. The first is that agreement will only succeed if it makes every party better off. The second is that even if individual country obligations can be agreed, there will exist incentives for countries to break ranks and free-ride on the abatement by other countries. This last problem is less worrisome for a Community directive than for an international agreement because Community directives can potentially be enforced by the European Court. For this reason, this paper is solely concerned with the problem of winning (and not sustaining) agreement.¹

If the EC countries were identical, agreement would be easy to reach; each country would want others to undertake exactly the same abatement. However, the EC countries differ substantially both with respect to their costs and benefits of abatement. Under a cost-effective abatement

¹ For a discussion of the free-rider problem in international agreements, see Barrett (1990).

policy, countries with low marginal abatement costs would be required to undertake more abatement (in percentage terms) than other countries, but these low-cost countries are not necessarily the countries that would benefit most from the abatement. Equating marginal costs for each country to marginal benefits for the Community as a whole may leave some countries worse off with the agreement. To get these countries to accede to the agreement may require that the countries that benefit most from the abatement compensate those that bear the greatest costs.

The problem of reaching agreement will be further complicated by the possibility that countries will seek to form coalitions that may undermine full cooperation. If the agreement ensures that each country does better with the agreement than without it, there is still the possibility that a group of countries might do better still by pulling out of the agreement altogether. The search for an effective division of the gains to full cooperation must recognize these group incentives as well as the individual incentives.

The analysis presented in this paper develops estimates of costs and benefits and employs game-theoretic techniques to examine the problem of reaching agreement on achieving the Community-wide CO₂ abatement target. The analysis should not be taken to indicate exactly how a directive intending to achieve the Community-wide target should be drafted, but rather to indicate areas where negotiators need to focus their attention. One limitation of this paper is that no data were available for Luxembourg and Ireland.

Perhaps the first difficulty facing negotiators will be establishing a common set of data — for the baseline from which an abatement target or carbon tax is to be calculated, and for abatement costs and benefits. Without a common set of data, agreement will prove difficult to reach because individual countries will face incentives to misrepresent values for these data. This paper employs estimates for these data to illustrate their importance in negotiations. The estimates used in this paper should not be interpreted as representing true values. However, in using these estimates it will become immediately apparent how important it is to agree on values for these data.

The main body of the paper is in two sections. The first presents estimates of the 'baseline' level of emissions assumed to be used in negotiations, and of the costs of abatement for individual countries. It then calculates the cost-effective allocation of abatement responsibility within the Community, and demonstrates that alternative allocations could prove to be many times more costly overall.

The next section considers how the burden of achieving the cost-effective allocation might be borne by different

countries. It begins by comparing the allocations implied by the cost-effectiveness analysis with stated national targets. It then indicates how a consideration of benefits can prove important to negotiations. In particular, it is shown that some countries might be made worse off with the cost-effective allocation, even while the Community as a whole is made better off, unless compensation is made. The paper then considers the problem of coalition formation, and ends by indicating how linked issues can serve the same function as side payments in achieving agreement.

2. Analysis of costs

To determine the costs of attaining a stabilization target, one must know (i) emissions in the absence of policies intended to meet the target, and (ii) the cost of achieving the emission reductions needed to meet the target.

If emissions for the Community as a whole were to remain constant or fall in the absence of any policy to meet the target, then the cost of meeting the target would be zero; the constraint implied by the target would be non-binding. If the constraint were binding, then costs will be positive. Presumably, the constraint is binding; otherwise the Community target would not be helpful. However, determining the magnitude of emissions that would need to be abated in order to meet the Community target is a difficult task, as discussed below.

2.1. Determining the 'baseline' emission level

Emissions in the absence of Community policy on emission abatement will depend on a number of factors, including growth in economic activity, prices of fossil fuels and other energy sources, technical change, and other Community policies affecting energy markets. None of these factors is easy to predict.

The task of predicting future emissions is complicated by the fact that some countries may have implemented policies that resulted in reduced emission levels had a Community-wide agreement not been reached. In other words, some countries may have wanted to take unilateral action to abate emissions. By definition, these policies are never observed, even *ex post*. To be sure, some countries have already proposed unilateral targets. But there is no reason to believe that these targets would have been implemented in the absence of a Community-wide agreement. In fact, we shall see later that

a comparison of costs and benefits may lead these countries to reduce their targets substantially unless a wider agreement to abate CO₂ emissions can be reached.

Assuming that the Community-wide agreement goes farther than all unilateral actions taken together, failure to observe policies in the absence of Community-wide agreement poses no problem for cost-effectiveness analysis, as discussed later in this section. However, it does pose a problem for an analysis of equity. Presumably, countries that had an interest in undertaking substantial unilateral action in the absence of a Community agreement should bear a bigger share of the burden of meeting the Community target, all else being equal. Hence, identifying the benchmark for analysis of burden-sharing is a particularly important task.

In the analysis of cost-effectiveness, I shall rely on the estimates of baseline emissions provided by Coherence (1991). These estimates assume that countries will undertake unilateral policies that reduce emissions at a marginal cost up to zero, but that no abatement policies involving a positive marginal cost are undertaken unilaterally. The game-theoretic analysis of bargaining will, however, depart from these estimates by trying to say something about the benchmark where countries would undertake policies involving positive marginal costs even in the absence of a Community-wide agreement.

Even the estimates that rule out unilateral abatement policies will be controversial and certainly subject to uncertainty. One of the primary tasks for negotiation will be to agree on a common prediction of future emissions in the absence of a Community agreement.

The estimates provided by Coherence (1991) are shown in Table 1. Emissions for the Community as a whole (excluding Luxembourg and Ireland) are expected to increase 5 % from 1988 to 2010. However, growth in emissions varies widely among countries. Emissions in the UK are expected to fall 10 %, even without any policies involving positive marginal costs. Emissions in Portugal are expected to increase 82 %.

For comparison, estimates prepared by the Commission (Directorate-General XVII, 1990; see also, Scherp, 1990) indicate that emissions will rise 14 % over the period 1990–2010 for the Community as a whole. While some of the Commission's estimates come close to those prepared by Coherence, others diverge sharply. For example, the Commission estimates indicate that the United Kingdom's emissions will rise 12 % and Denmark's emissions will rise 20 % between 1990 and 2010.

Table 1

Actual and projected emissions

	CO ₂ emissions 1988 2010 ¹ (million t)		Percent change
Belgium	109	110	1
Denmark	61	60	-1
France	374	370	-1
Germany	718	677	-6
Greece	84	127	52
Italy	399	489	23
The Netherlands	146	165	13
Portugal	28	51	82
Spain	196	265	35
United Kingdom	561	505	-10
Total	2 676	2 820	5

¹ Projected.
Source: Coherence (1991).

The difference in these estimates lies partly in the assumption made by Coherence that energy use is economically efficient.¹ Where energy use is not economically efficient — where, for example, energy users pay a price for energy that does not reflect the full cost of supply, and hence face an insufficient incentive to conserve energy — then it is in the private interests of all countries to adopt an energy policy that removes barriers to efficient energy conservation. To remove any incentive for strategic behaviour, it is likely that an agreement on CO₂ abatement will seek to establish a benchmark that ensures that the cost of abating the first unit of emission is zero. Otherwise countries that failed to exploit all opportunities for efficient energy conservation would be rewarded. Hence, even if the estimates prepared by the Commission better represented future emission levels, the Coherence estimates may prove more relevant to negotiations.

¹ The difference may also be due to different assumptions regarding economic growth, energy prices, etc. The exact contribution of all these different assumptions to the difference in forecasts of future emissions is difficult to determine.

Marginal CO₂ reduction cost estimates

The purpose of this note is to provide a theoretical background to marginal unitary CO₂ reduction cost estimates associated to CO₂ reduction policies and presented in the synthesis report of the 'Cost-effectiveness analysis of CO₂ reduction options'.¹

Introduction

- Marginal abatement costs indicate how the cost of reducing successive units of CO₂ emission rise with the level of abatement undertaken. They can be estimated with reference to cost-effective CO₂ reduction policies resulting from the aforementioned study. The corresponding marginal costs are neither so-called short-run nor long-run marginal costs but marginal costs associated to a transient period (2000-2010) during which different CO₂ reduction targets have to be met (stabilization by the year 2000, reductions afterwards). This situation makes the computation of marginal cost more difficult and requires the use of standard present value computations. This makes useful conceptual considerations on the definition and computation of marginal abatement costs from the results of a dynamic cost-effectiveness analysis. They are discussed in the following.

Definitions

- Marginal costs refer to incremental quantities. They can be defined, without any reference to time, as the cost incurred for a short-term increase of production (short-run marginal cost) or as the cost incurred for a persistent increase of production (long-run marginal cost). Marginal costs are usually defined for efficiently operated systems. In these cases, and under certain conditions, short-run and long-run marginal costs are equal.
- Marginal costs of CO₂ reduction policies (e.g. the marginal cost of moving from a 15% reduction policy to a 16% reduction policy in 2010), do not nicely fit within these definitions. CO₂ reduction policies are defined with respect to a target year; still they correspond to long-term strategies as it is expected that they will lead to energy systems capable of maintaining the achieved emission levels through time. Long-term marginal costs would then seem to be the natural concept to apply (persistent decrease of emissions). They would however represent the costs of reduction policies from 2010 on. This is probably too far in the future and too dependent on very uncertain data to be of interest. Short-run marginal cost is not of interest either as the study concentrates on strategies that extend from 1995 to 2010.

- For our purpose, marginal costs need to be defined for a transient period (2000 to 2010). This requires some conceptual considerations. They are briefly described in the following.

Marginal CO₂ reduction cost

- As indicated above, long-run and short-run marginal costs are usually defined with reference to optimized or efficiently operated systems. This condition is met in the study we refer to. Marginal costs have been defined for the different countries with reference to cost-effective reduction policies. A cost-effective policy determines a path of CO₂ reduction through time.
- Paths of CO₂ reduction can then be ranked with respect to these cost-effective policies: the path of CO₂ emission reduction associated to a 15% reduction target is less costly than the path associated to a 16% reduction target. One can therefore define the marginal cost of moving from a policy aiming at reducing CO₂ by 15% to a policy with a 16% reduction target from 2005 on. This marginal cost is the present value of all costs incurred between 1990 to 2010 when moving from the first to the second policy.
- The obtained marginal cost is very similar to the standard concept of long-run marginal cost. It differs however from it in two respects. First, it is expressed as a present value over a period and not as a cost per unit of production. Second, it refers to an evolving stream of CO₂ reduction while the standard concept of long-run marginal cost would refer to a steady stream of CO₂ reduction.
- These two differences can be easily dealt with through standard present value computations. Indeed, present values of costs over a certain period can be converted into costs per unit of production by dividing them by present values of production (here reduction). Although this latter concept can sometimes cause surprise, it is very common and has been used. Moreover, the present value of production (here reduction) does not require an assumption of constant production (here reduction).

- The following approach was therefore followed:

incremental costs were computed when moving from one policy to the next one (e.g. from a 5% reduction policy to a 10% reduction policy). These incremental costs are expressed as present values over the period 1980-2010;

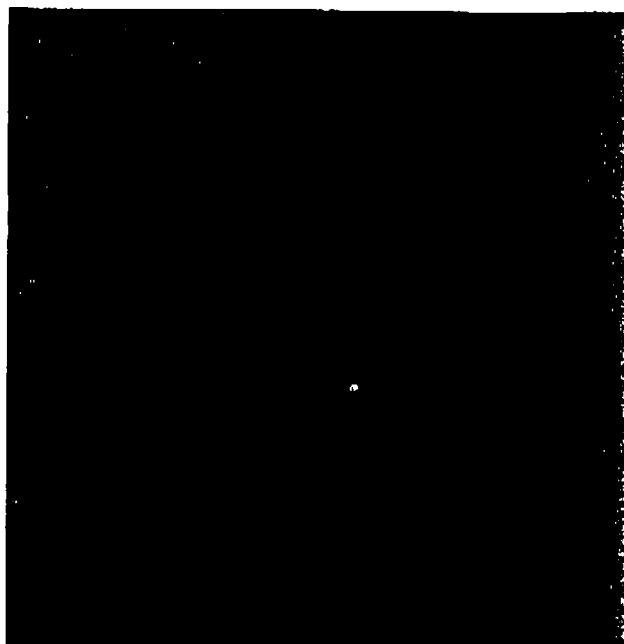
incremental reductions were computed when moving from one policy to the next one. These incremental reductions are also expressed as present values over the same period;

¹ 'Cost-effectiveness analysis of CO₂ reduction options'. Synthesis report. Coherence ex. report for the Commission of the European Communities. Directorate-General for Science, Research and Development.

marginal costs were obtained by dividing the incremental cost by the corresponding incremental reduction;

the obtained value satisfies the property that if paid for all incremental reduction between 1995 and 2010, it would lead to a cost equal to the incremental cost.

Marginal cost curves can be drawn from the obtained marginal abatement costs as illustrated in the following figures for two EC countries, Belgium and the United Kingdom.



2.2. Estimating abatement costs

How much would it cost to abate emissions beyond this baseline? We know that the cost of abating the first tonne of CO₂ is close to zero. The reason is that by definition all policies that abate emissions at zero cost have already been taken. The real difficulty is determining how the cost of abating successive units of emission rise with the level of abatement undertaken.

Data on abatement costs have been developed by Coherence (1991), as explained in the box above. The data are presented as engineering estimates of the marginal cost of meeting CO₂ reduction targets in 2010 relative to 1988 emissions. Cost functions should relate marginal costs to the extent of abatement undertaken in the current year, and not relative to some arbitrary base year. The marginal cost of stabilizing emissions in 2010 at the 1988 level depends not only on the cost of abating emissions in 2010, but also on the extent of abatement needed to stabilize emissions at the 1988 level. To estimate the cost functions, I have therefore related marginal cost to the reduction in emissions in the same year, 2010. The data are shown in Table 2.

While one could base the analysis on these data assuming that the cost functions are piece-wise linear, it seems more reasonable to assume that the cost functions are smooth and pass near these observations. Estimating smooth (continuously differentiable) cost functions will also make comparisons across countries easier and simplify the analysis of costs. Finally, estimated cost functions will allow extrapolation beyond the limits of the data shown in Table 2.

One would expect that marginal costs would depend on percentage abatement rather than on the level of abatement (Barrett, 1991b). To take an example, 1988 emissions are 25 times greater in Germany than in Portugal. A 100 % reduction in Portugal's emissions is therefore equivalent to a 4 % reduction in Germany's. The German reduction could be achieved relatively easily by fuel-switching in electric power generation. However, the equivalent reduction in Portugal's emissions would require banning the use of fossil fuels, not only in electric power generation but also in transportation and for industrial and domestic uses. The marginal cost to Portugal of reducing its emissions 100 % would clearly be huge. However, the marginal cost to Portugal of reducing its emissions by just 4 % would not differ markedly from the marginal cost to Germany of achieving

the same percentage reduction. Both could be achieved by modest fuel-switching.

However, even then marginal costs would probably not be identical. Germany consumes substantial quantities of coal, oil and gas, and hence can substitute within this group of fuels. Germany also consumes substantial amounts of nuclear power, and hence can substitute out of the fossil fuels.

Table 2

Marginal cost estimates for 2010 emission reduction

	2010 emission reduction (million t)	Reduction as percentage of 2010 emissions	Marginal cost (ECU/t CO ₂)
Belgium	1.02	0.009	15
	6.42	0.058	15
	11.87	0.108	39
	16.12	0.147	290
Denmark	0.51	0.009	0
	6.51	0.109	6
	12.51	0.209	11
	18.51	0.309	32
France	33.00	0.089	19
	71.00	0.192	43
Germany	31.10	0.046	15
	67.00	0.099	18
	102.90	0.152	43
	138.80	0.205	63
	174.70	0.258	138
Greece	43.40	0.342	23
	47.60	0.375	56
	51.80	0.408	224
Italy	90.00	0.184	22
	109.00	0.223	112
	129.00	0.264	413
	133.00	0.272	1 544
The Netherlands	18.40	0.112	27
	25.70	0.156	136
	27.90	0.169	1 063
Portugal	9.28	0.182	12
Spain	75.10	0.283	18
	84.60	0.319	143
	94.10	0.355	1 556
United Kingdom	6.66	0.013	12
	56.20	0.111	35
	112.32	0.222	63

Source: The data in columns (1) and (3) are from Coherence (1991). The data in column (2) were obtained dividing the data in column (1) by projected emission in 2010 for each country (Table 1).

Portugal's energy consumption relies very heavily on oil: it consumes no natural gas and does not have nuclear power facilities. Hence substitution possibilities are more limited in Portugal, and we would therefore expect that the marginal cost of any given percentage abatement would be higher in Portugal than in Germany, all else being equal.

The data indicate that marginal costs increase with percentage abatement at an increasing rate. Taking Germany as an example, the difference in the marginal cost of abating emissions by 5 % and 10 % is very small. However, increasing abatement from 20 % to 25 % involves a substantial increase in marginal costs. A similar pattern can be seen for the other countries, although the range of observations is obviously small in many cases (Portugal being an extreme example). The particular functional form chosen is

$$\ln(1 - \text{percent reduction}) = \alpha MC \quad (1)$$

where MC is marginal cost. Equation (2) can be rewritten as

$$\text{percent abatement} = 1 - e^{-\alpha MC} \quad (2)$$

If MC = 0, percent abatement is zero. If MC > 0, percent abatement is positive. It can be easily checked that percent abatement increases in MC, but at a decreasing rate. This means that initial reductions in emissions can be obtained relatively cheaply, but that the marginal cost of abatement will eventually become very great as the level of abatement is increased. This same functional form was employed by Nordhaus (1990) in his well-known analysis of the economics of global warming policy.

Table 3

OLS regression results

Dependent variable: $\ln(1 - \text{percent reduction})$

Independent variables	Coefficient	Standard error	t-statistic
MC × Belgium	0.00316	0.00245	1.29
MC × Denmark	-0.00902	0.00559	-1.61
MC × France	-0.00119	0.00440	-0.27
MC × Germany	0.00119	0.00262	0.46
MC × Greece	0.00091	0.00250	0.37
MC × Italy	0.00351	0.00238	1.47
MC × The Netherlands	0.00357	0.00239	1.50
MC × Spain	0.00346	0.00238	1.45
MC	-0.00376	0.00238	-1.58

N = 31, F(9,22) = 5.11, D-W = 1.36, R² = 0.68, R² = 0.54.

The regression results are shown in Table 3. The independent variables include marginal cost and marginal cost multiplied by country dummies. Since a dummy is not included for the United Kingdom, the regression coefficient corresponding to MC represents the α coefficient for the UK. The α coefficient for Belgium is found by adding the regression coefficient for MC times the Belgium dummy (0.00316) to the coefficient for the United Kingdom (-0.00376), and is -0.0006. The α coefficients for all other countries are obtained using the same procedure. The only exception is Portugal, for which only one observation is available. The α coefficient for Portugal was obtained by substituting the values for percent abatement and MC for this single observation in Equation (2) and solving for α . The resulting estimates for all countries are shown in Table 4.

An examination of the regression results suggests that abatement costs may be very similar for certain groups of country. The coefficients for France, Germany, Greece, and the

and such a change would no doubt increase the statistical significance of the regression. However, it must be remembered that the analysis relies on very few observations, and that the data were not based on actual observations. Hence, it would be best not to carry out a statistical analysis of these data. The only purpose of the analysis is to develop cost functions that fit the data reasonably well.

Table 5 presents the 'actual' percent reduction values from Table 2 and the corresponding predicted values based on the α coefficients shown in Table 4. Equation (1) fits the data reasonably well for many countries, especially Belgium, Denmark, France, Germany, and the United Kingdom. However, Equation (1) does not fit the data well for Greece, Italy, the Netherlands, and Spain, especially when marginal costs are small. Notice also that with the exception of the United Kingdom, the cost functions tend to underpredict abatement for low values of marginal cost. Finally, notice that the cost functions seem to work best at predicting the abatement associated with high values of marginal cost.

While it might seem appropriate to employ alternative functional forms for Greece, Italy, the Netherlands and Spain, a different view would be that the data for these countries need to be examined more closely. For example, the engineering data indicate that marginal costs rise extremely fast in the vicinity of 26 % abatement for Italy, 16 % for the Netherlands, and 32 % for Spain. Greece is shown to be able to abate substantial amounts of emissions at very low cost. These features of the data should cause some concern. This paper assumes that the cost functions developed can be taken to be reasonable approximations of the true costs of abatement. However, their use in this paper is purely for illustrative purposes. It must be emphasized that the cost data employed in this paper, though based on research, are subject to substantial uncertainty — both as to their levels and comparability across countries.

Table 4 also shows what the α coefficients imply in terms of the abatement that would result from imposing a carbon tax of ECU 100 per tonne of CO₂. Very little abatement would be achieved by Belgium, Italy, the Netherlands and Spain. France, Germany, Greece and the United Kingdom would reduce their emissions by a much greater amount in percentage terms. Denmark and Portugal would abate their emissions very substantially. Again, these findings suggest that further work is needed to develop data on the costs of abatement for different countries.

Table 4

Estimated marginal cost functions

Assumed cost function: Percentage abatement = $1 - e^{-\alpha MC}$

	Estimated value for α^1	Estimated percentage abatement in 2010 for tax of ECU 100 per tonne CO ₂
Belgium	-0.0006	5.8
Denmark	-0.0128	72.2
France	-0.0049	38.7
Germany	-0.0026	22.9
Greece	-0.0028	24.4
Italy	-0.0003	3.0
The Netherlands	-0.0002	2.0
Portugal	-0.0167	81.2
Spain	-0.0003	3.0
United Kingdom	-0.0038	31.6

¹ The value for the UK is the coefficient for MC from Table 3. The values for all other countries except Portugal are found by adding the coefficient for MC to the coefficient for the dummy multiplier MC variable corresponding to each country. The value for Portugal was based on a single observation; substituting the values for MC and percentage abatement in the cost function gives the estimate of α for Portugal.

United Kingdom are very close in size.¹ So too are the coefficients for Belgium, Italy, the Netherlands, and Spain. Finally, the α coefficients for Denmark and Portugal also appear similar. It might be tempting to use group dummies in the regression instead of individual country dummies,

¹ Notice, too, that the t-statistics for the regression coefficients for France, Germany and Greece are very small, indicating that the regression coefficients are not significantly different from zero. In other words, the regression suggests that the α coefficients for these countries do not differ significantly from the α coefficient for the United Kingdom.

2.3. Cost-effective Community-wide abatement

Abatement for the Community is cost-effective if the marginal cost of abatement is the same for all countries. Table 6 shows how the abatement obligations should be allocated

to the different countries in order to stabilize emissions at the 1988 level by 2010 at minimum total cost. The data on costs pertain only to abatement in 2010. Ideally, one would want to compute the time path of costs that meet the agreed target. However, the required data were not available. Hence, the analysis of cost-effectiveness is in this sense partial.

If the Community target were met using a carbon tax, all individuals and firms would have an incentive to abate their emissions as long as the cost of abating a unit of emission were no greater than the tax. This implies that the cost-effective solution could be implemented using a carbon tax which equalled marginal cost for the cost-effective solution.

Table 5

'Actual' and predicted values for percent abatement

	Marginal cost (ECU/t)	'Actual' percent reduction	Predicted percent reduction	Difference
Belgium	15	0.009	0.009	0.000
	15	0.058	0.009	0.049
	39	0.108	0.023	0.085
	290	0.147	0.160	-0.013
Denmark	0	0.009	0.000	0.009
	6	0.109	0.074	0.035
	11	0.209	0.131	0.078
	32	0.309	0.336	-0.027
France	19	0.089	0.089	0.000
	43	0.192	0.190	0.002
Germany	15	0.046	0.038	0.008
	18	0.099	0.046	0.053
	43	0.152	0.106	0.046
	63	0.205	0.151	0.054
	138	0.258	0.301	-0.043
Greece	23	0.342	0.062	0.280
	56	0.375	0.145	0.230
	229	0.408	0.466	-0.058
Italy	22	0.184	0.007	0.177
	112	0.223	0.033	0.190
	413	0.264	0.117	0.147
	1 544	0.272	0.371	-0.099
The Netherlands	27	0.112	0.005	0.107
	136	0.156	0.027	0.129
	1 063	0.169	0.192	-0.023
Portugal	12	0.182	0.182	—
Spain	18	0.283	0.005	0.278
	143	0.319	0.042	0.277
	1 556	0.355	0.373	-0.018
United Kingdom	12	0.013	0.045	-0.032
	35	0.111	0.125	-0.014
	63	0.222	0.213	0.009

Table 6

Cost-effective CO₂-emission stabilization policy
Carbon tax = ECU 20 per tonne CO₂

	Percent abatement in 2010 emissions	Emission ceiling relative to 1988 level (%)	Total cost of abatement in 2010 (million ECU)
Belgium	1	-0	13
Denmark	23	-24	130
France	9	-10	340
Germany	5	-10	340
Greece	5	43	69
Italy	1	22	29
The Netherlands	0	13	7
Portugal	28	30	137
Spain	1	34	16
United Kingdom	7	-17	365
Total	5	-0	1 444

Table 6 indicates that this tax would be about ECU 20 per tonne of CO₂. This is equivalent to a tax of about USD 75 per tonne of carbon. It should be noted that this tax seems high given that emissions are only being reduced 5% in 2010.¹

As shown in Table 6, cost-effectiveness demands that Denmark and Portugal abate their emissions substantially, and Belgium, Italy, the Netherlands and Spain much less so. These findings follow naturally from the estimates shown in Table 4 for the percent abatement resulting from a tax of ECU 100 per tonne of CO₂.

While all countries would be required to abate their emissions somewhat in 2010, what is perhaps of more interest are the implied emission ceilings. Table 6 indicates that cost-effectiveness would require that Denmark, France, Germany and the United Kingdom reduce their emissions from the 1988 level by 2010. Belgium would be required to stabilize emissions over this same period. Greece, Italy, the Netherlands, Portugal and Spain would be allowed to increase their emissions.

To some extent, these results confirm conventional wisdom that the obligations should be tougher for the richer countries and weaker for the poorer EC countries. Denmark,

France, Germany and the United Kingdom would have to lower their emissions substantially relative to the 1988 level. Greece, Portugal and Spain would be allowed to increase their emissions by 43 %, 30 % and 34 %, respectively, above the 1988 levels.

However, this is arguably not a very good estimate of the burden imposed on the different countries. The poorer countries will be growing rapidly. Even if they are allowed to increase their emissions, substantial abatement may be required. Similarly, emissions in the richer countries may fall, even if no abatement policies are implemented. Hence, these countries may bear a very small cost, even if they are required to reduce their emissions substantially relative to 1988. The final column in Table 6 shows how the burden of costs would fall on the individual countries (the total cost function is derived in the Appendix). France, Germany and the United Kingdom bear a substantial portion of the burden. But notice that Portugal incurs a cost much greater than richer countries like Belgium, Italy and the Netherlands. Cost-effectiveness lowers the total costs of abatement for the Community as a whole. However, the required allocation of abatement responsibility may leave individual countries much worse off than if no agreement were reached at all. Hence, equity is at least as important as cost-effectiveness.

2.4. Advantage of the cost-effective solution

Before turning to the equity issue, it is important to indicate the attractiveness of the cost-effective allocation of abatement responsibility. Suppose that the stabilization policy were implemented by a requirement that each country could not increase its emissions in 2010 above the 1988 level. Then, as Table 7 shows, greater abatement would be achieved overall, because some countries would actually reduce their emissions below the 1988 level even while not bearing any abatement costs. However, the total cost of meeting the alternative policy is huge — over ECU 70 billion, or almost 50 times the total cost of the cost-effective policy. What is more, the burden of meeting this obligation would be less evenly distributed, and would be especially great for the poorer EC countries that are expected to be growing the fastest.

This analysis teaches that uniform obligations can prove very costly. It is common for negotiations to focus on uniform obligations, possibly because the available data do not offer compelling alternatives. The Montreal Protocol demands that all signatories (including the Community) reduce their emissions of CFCs 50 % relative to 1986; the sulphur emissions Protocol requires signatories to reduce sulphur emissions 30 % relative to the 1980 level; the nitrogen oxide

¹ See Barrett (1991) for a survey of carbon tax estimates.

Table 7

Costs of national CO₂-emission stabilization policy¹

	Percent abatement in 2010 emissions	Emission ceiling relative to 1988 level (%)	Total cost of abatement in 2010 (million ECU)
Belgium	1	0	9
Denmark	0	-1	—
France	0	-1	—
Germany	0	-6	—
Greece	34	0	2 983
Italy	18	0	28 150
The Netherlands	12	0	6 193
Portugal	45	0	370
Spain	26	0	32 844
United Kingdom	0	-10	—
Total	9	-4	70 549

¹ Emission levels (and associated costs) are calculated assuming that, if national emissions are projected to increase in the absence of an agreement, then abatement must be carried out to ensure that emissions do not increase. If, on the other hand, national emissions are projected to fall, then no abatement need be carried out. As examples, Belgium's emissions are projected to rise 1% between 1988 and 2010. To stabilize Belgium's emissions at the 1988 level, 1% abatement is therefore required in 2010. The cost of this is estimated to be ECU 9 million in 2010. Denmark's emissions are projected to be lower in 2010 than in 1988, and so no additional abatement is required to stabilize Denmark's emissions; the cost of stabilization for Denmark is therefore zero.

Protocol requires that signatories stabilize their emissions at the 1987 level; and so on.¹ EC directives also tend to impose uniform obligations. However, a major exception is the large combustion plants (LCP) Directive, which places different obligations on different countries. The LCP imposes the same obligations on Belgium, Germany, France and the Netherlands; imposes somewhat different and weaker obligations on Denmark, Spain, Italy, Luxembourg and the United Kingdom; and allows Greece, Ireland and Portugal to increase their emissions. Might a similar banding come close to the cost-effective allocation for CO₂ emission reductions?

One suggested proposal would require that Denmark, Germany and the Netherlands reduce their emissions 5% by 2000 relative to 1990; that Belgium, France, Italy and the United Kingdom stabilize their emissions; and that Greece, Portugal and Spain increase their emissions no more than 15% above the 1990 level by 2000. Table 8 extends this proposal out to 2010 so that the cost functions can be used to estimate the consequences for this proposal. Although the extension changes the nature of the proposal somewhat, Table 8 indicates that the banded CO₂ emission targets will prove very costly — about 35 times as costly as the cost-effective policy.

¹ The Montreal Protocol actually imposes a weaker uniform obligation on developing countries, and the nitrogen oxide Protocol allows the United States to specify an alternative base year to 1987 (the US specified 1978 as its base year).

Table 8

Costs of banded CO₂-emission targets¹

	Emission ceiling in 2010 relative to 1988	Emission ceiling in 2010 ² (million t CO ₂)	Percentage abatement in 2010	Total cost of abatement in 2010 (million ECU)
Belgium	0	109	1	9
Denmark	-5	58	3	2
France	0	370	—	—
Germany	-5	677	—	—
Greece	15	97	24	1 425
Italy	0	399	18	28 150
The Netherlands	-5	139	16	11 173
Portugal	15	32	37	241
Spain	15	225	15	10 475
United Kingdom	0	505	—	—
Total	-2	2 611	7	51 475

¹ It is assumed that Belgium, France, Italy and the United Kingdom stabilize emissions at the 1988 level by 2010; that Denmark, Germany and the Netherlands reduce their emissions 5%; and that Greece, Portugal and Spain increase their emissions 15% in 2010 relative to 1988. Given the Coherence (1991) projections, this implies that some countries (France, Germany and the United Kingdom) will not have to abate their emissions in 2010, but that the other countries will.

² Assumes that abatement up to a marginal cost of zero is undertaken. The emission ceiling constraint is not binding for France, Germany, and the United Kingdom.

3. Burden-sharing

Comparison of the burden of achieving the cost-effective solution will likely involve an analysis of more than costs. As already suggested, the cost burden is likely to be perceived to be important not on its own but in comparison with population and GDP. Table 9 presents some alternative indicators of the burden of meeting the cost-effective solution. Notice that costs per capita vary by a factor of about 50, while costs as a percentage of GDP vary by a factor of about 30. Variance in allowable emission levels is much smaller. Allowed emissions per capita vary by a factor less than four, while allowed emissions per unit of GDP vary by a factor of seven.

Perhaps more important than variance is the ranking of the relative burdens. Denmark bears a high cost per capita but also has a high allowed emissions per capita. Greece bears high costs per GDP but is allowed a high rate of emission per unit of GDP. Depending on the figures used, Denmark and Greece can be seen to do well or badly under the cost-effective solution. The point can be made clearer by considering how these figures might be used in negotiations. Denmark might argue that it would be required to bear too high a cost per capita, while other countries may reply by arguing that Denmark would still be allowed to emit more CO₂ per capita than the average. Greece might argue that

it would be required to bear too high a cost relative to its GDP, while other countries might counter by showing that Greece would be allowed much more emissions per unit of GDP than any other EC country. A consensus on 'just' burden-sharing is unlikely to be easy to reach.

3.1. Abatement benefits

The reason both the Community and individual countries are interested in abating their emissions is the expectation that the damages associated with potential global warming would be reduced, and that these benefits would exceed the costs of abatement in total.

Not much is known about the benefits of CO₂ abatement. The received wisdom is that these benefits are positive, at least for all countries taken together, although negative benefits cannot now be ruled out (see Nordhaus, 1990). Very little is known about how benefits vary with the level of abatement that is carried out.

A well-known analysis by Nordhaus (1990) suggests that the benefits of abatement are not very great. Nordhaus finds that the damage caused by a 3°C warming, which is likely to occur sometime in the second half of the next century, would likely be about one-quarter of one per cent of GNP.

Table 9

Alternative measures of burden-sharing for the cost-effective solution

	Cost per capita (ECU)	Cost as a percentage of GDP ¹ (% = 100)	Allowed emission per capita (tonnes CO ₂)	Allowed emission per GDP (tonnes CO ₂ per ECU)
Belgium	1,3	1,0	11,0	0,9
Denmark	25,3	14,3	9,0	0,5
France	6,1	4,2	6,0	0,4
Germany	5,5	3,3	10,5	0,6
Greece	6,9	15,5	12,0	2,7
Italy	0,5	0,4	8,5	0,7
The Netherlands	0,5	0,4	11,2	0,9
Portugal	13,3	38,8	3,4	1,0
Spain	0,4	0,6	6,8	0,9
United Kingdom	6,4	5,2	8,2	0,7
Total	4,5	3,6	8,3	0,7

¹ Costs as a percent of GDP multiplied by 100. As an example, the figure for Greece indicates that abatement costs are 0.155% of GDP.
Source: GDP and population data from Eurostat (1990).

Of course, this estimate is subject to much uncertainty, and, importantly, is based on data for the United States. However, Nordhaus cites other studies for Europe and other regions that yield similar results. Nordhaus (1990, p. 28) concludes:

'Climate change will lead to a combination of gains and losses with the likelihood of but a small impact on the overall economy and with no strong presumption that modest and gradual global greenhouse warming will on balance be harmful. CO₂ is a powerful natural fertilizer for trees and crops; people have recently voted with their feet for warmer climates; and technological developments have the potential to offset many of the harmful impacts of climate change. This is not a brief in favour of climate change. The studies reviewed here represent "best-guess" scenarios of climate change and omit uncertainties and possible non-linearities. None the less, these estimates provide a cautionary note that those who paint a bleak picture of desert Earth devoid of fruitful economic activity may be exaggerating the injuries and neglecting the benefits of climate change.'

If the Community target of stabilizing emissions by 2000 were the solution to the optimization problem of maximizing Community net benefits of CO₂ abatement, taking as given abatement by other countries, then the target would correspond to an abatement level where the marginal cost of abatement for the Community as a whole equalled the marginal benefit of abatement for the Community as a whole. Our cost-effectiveness analysis suggests that if the Community had undertaken this optimization exercise, the marginal benefit of abatement for the Community as a whole would be about ECU 20 per tonne of CO₂, or about USD 75 per tonne of carbon. Nordhaus's estimate of a one-quarter of one per cent loss in GNP corresponds to a marginal benefit of abatement of about USD 12.7 per tonne of carbon. This is substantially greater than the carbon tax indicated in this paper for the EC target. However, Nordhaus estimates an 'upper bound' for damage of 2 % of GNP, which corresponds to about USD 107 per tonne of carbon. Hence, the EC marginal benefit implied by this paper's analysis is within the range of estimates provided by Nordhaus.¹

Net benefits for the Community can be represented as the sum of net benefits for the individual members. In working out net benefits for individual countries, we need to know the marginal benefit each country places on CO₂ abatement. Potential global warming damage is likely to depend on GDP and the extent to which a country is vulnerable to potential climate change. Vulnerability will depend on the composition of GDP (for example, agriculture's share of

GDP), the extent of coast line, elevation relative to sea level, and so on. The local impacts of climate change are difficult to predict, however, and so vulnerability is difficult to assess.

To make progress, I shall estimate marginal benefits to individual countries based on two assumptions. The first is that benefits are proportional to GDP; this assumption is consistent with Nordhaus's analysis. As an alternative, I shall also assume that marginal benefits are proportional to agricultural output. This latter assumption attempts to introduce vulnerability into the analysis. However, it must be stressed that current research does not indicate that countries relatively more dependent on agriculture will necessarily be made relatively worse off by climate change. Indeed, because of CO₂ fertilization, countries with a large share of agriculture may not be significantly harmed; some may even benefit from climate change, at least for a 3°C increase in global mean temperature. The assumption that abatement benefits are proportional to agricultural output is made purely to illustrate the uncertainties. The analysis that follows is purely illustrative.

Since nothing is known about the shape of the marginal abatement benefit curve, I shall assume that marginal abatement benefits are constant over the range of abatement levels examined in this paper.² Estimates of marginal benefits based on these assumptions are shown in Tables 10 and 11.

Table 10

Marginal benefit calculation assuming marginal benefits are proportional to GDP

	GDP (billion ECU)	GDP as percentage of total	Marginal benefit (ECU/tonne CO ₂)
Belgium	127.0	3.2	0.6
Denmark	91.0	2.3	0.5
France	804.2	20.1	4.0
Germany	1 017.6	25.4	5.1
Greece	44.4	1.1	0.2
Italy	701.8	17.5	3.5
The Netherlands	193.2	4.8	1.0
Portugal	35.3	0.9	0.2
Spain	287.9	7.2	1.4
United Kingdom	696.6	17.4	3.5
Total	3 999.0	99.9	20.0

Source: GDP data from Eurostat (1990).

¹ It should also be noted that some analysts believe that Nordhaus underestimates benefits.

² This same assumption is implicit in Nordhaus's (1990) analysis. However, Barrett (1992a) assumes that marginal benefits decrease with the level of abatement.

Table 11**Marginal benefit calculation assuming marginal benefits are proportional to agricultural output**

	Agriculture's share of GDP	Agricultural output (billion ECU)	Agricultural output as percentage of EC total	Marginal benefit (ECU/tonne CO ₂)
Belgium	2	2.5	1.8	0.4
Denmark	5	4.6	3.3	0.7
France	4	32.2	23.0	4.6
Germany	2	20.4	14.6	2.9
Greece	16	7.1	5.1	1.0
Italy	4	28.1	20.1	4.0
The Netherlands	5	9.7	6.9	1.4
Portugal	9	3.2	2.3	0.5
Spain	6	17.3	12.4	2.5
United Kingdom	2	13.9	9.9	2.0
Total	—	139.0	99.4	20.0

¹ Estimates are pre-unification

Source: Agricultural share data from World Bank (1990), Table 3.

3.2. The 'full' cooperative outcome

Once we know marginal benefits, we can calculate the net benefits to each country of the EC stabilization target, which is assumed here to represent the full cooperative outcome for the Community as a whole. It must be stressed that the full cooperative outcome for the world as a whole would likely involve greater abatement on the part of EC countries, given the assumptions underlying this analysis. Hence, the EC stabilization target is taken to be a 'full' cooperative outcome only in this limited sense.

Table 12 shows the net benefits for each country corresponding to the EC stabilization target assuming marginal benefits are proportional to GDP. Italy gains substantially from the agreement, while Portugal suffers a negative net benefit. Denmark, Greece, and Portugal obviously have a strong incentive not to agree to implement the cost-effective solution without side payments, because they do better with no agreement at all. In fact, these countries would receive positive net benefits if the EC target were never implemented, because many EC countries would have an incentive to abate their emissions somewhat in the absence of a negotiated settlement, as discussed in the next section.

Table 12**Net benefits for 'full' cooperative outcome assuming marginal benefits are proportional to GDP**

	(million ECU)		
	Benefits	Costs	Net benefits
Belgium	86	13	73
Denmark	72	130	-58
France	576	340	236
Germany	734	340	394
Greece	29	69	-40
Italy	504	29	475
The Netherlands	144	7	137
Portugal	29	137	-108
Spain	202	16	186
United Kingdom	504	365	139
Total	2 880	1 444	1 436

Table 13 presents estimates of the net benefits to full cooperation when marginal benefits are assumed to be proportional to agricultural output. In contrast to the previous table,

Greece now receives a positive net benefit by virtue of its relatively large agricultural sector. The United Kingdom receives a negative net benefit because its share of agriculture is smaller than its share of GDP. Again, these results are not to be taken literally; they simply indicate the importance of benefit estimates to the analysis of reaching agreement.

Table 13

Net benefits for 'full' cooperative outcome assuming marginal benefits are proportional to agricultural output

	(million ECU)		
	Benefits	Costs	Net benefits
Belgium	58	13	45
Denmark	101	130	-29
France	662	340	322
Germany	418	340	78
Greece	144	69	75
Italy	576	29	547
The Netherlands	202	7	195
Portugal	72	137	-65
Spain	360	16	344
United Kingdom	288	365	-77
Total	2 881	1 444	1 437

3.3. The non-cooperative outcome

If negotiations failed, each country would want to choose an abatement level where its own marginal benefit of abatement equalled its own marginal cost (technically, this is the Nash equilibrium to the non-cooperative game). These abatement levels and the associated net benefits are shown in Table 14, assuming marginal benefits are proportional to GDP. A comparison of Tables 12 and 14 indicates that Denmark, Greece and Portugal would do better if negotiations failed, whereas all other countries would do worse. This information is therefore likely to prove important to negotiations. Certainly, Denmark, Greece and Portugal would argue that they must be made at least as well off with the agreement as without it.

Table 15 presents the corresponding results when marginal benefits are assumed to be proportional to agricultural output. In comparing Tables 13 and 15 we see that Denmark, Portugal and the United Kingdom receive higher net benefits if negotiations fail than if the full cooperative outcome is implemented without side payments. Hence, these countries are unlikely to agree to implement the full cooperative outcome without compensation. Again, these results indicate that benefits, as well as costs, are likely to prove important to negotiations.

However, the matter is even more complicated than this, for it may prove attractive for some countries to form coalitions. To see this, reconsider the case where marginal benefits are

Table 14

Net benefits for non-cooperative outcome assuming marginal benefits are proportional to GDP

	Percentage abatement	Abatement (million tonnes CO ₂)	Benefit (million ECU)	Costs (million ECU)	Net benefits (million ECU)
Belgium	0.04	0.04	14	—	14
Denmark	0.64	0.38	12	—	12
France	1.94	7.18	96	14	82
Germany	1.32	8.94	122	23	99
Greece	0.06	0.08	5	—	5
Italy	0.11	0.54	84	1	83
The Netherlands	0.02	0.03	24	—	24
Portugal	0.33	0.17	5	—	5
Spain	0.04	0.11	34	—	34
United Kingdom	1.32	6.67	84	12	72
Total	0.86	24.14	480	50	430

Table 15

Net benefits for non-cooperative outcome assuming marginal benefits are proportional to agricultural output

	Percentage abatement	Abatement (million tonnes CO ₂)	Benefits (million ECU)	Costs (million ECU)	Net benefits (million ECU)
Belgium	0.02	0.02	8	—	8
Denmark	0.89	0.53	13	—	13
France	2.23	8.25	87	19	68
Germany	0.75	5.08	55	7	48
Greece	0.28	0.36	19	—	19
Italy	0.12	0.59	76	1	75
The Netherlands	0.03	0.05	27	—	27
Portugal	0.83	0.42	10	—	10
Spain	0.08	0.21	48	—	48
United Kingdom	0.76	3.84	38	4	34
Total	0.69	19.35	381	31	350

assumed to be proportional to GDP. To take an extreme example, Denmark, Greece and Portugal might threaten to pull out of negotiations unless offered side payments. Suppose these countries demanded side payments of ECU 1 billion. Then the other seven countries would still be ECU 234 million ahead of the non-cooperative outcome if they made the payment, and so might be willing to agree to this demand.¹ However, they might do even better by forming their own coalition of seven countries, and choosing their abatement level independently of Denmark, Greece and Portugal. The outcome is shown in Table 16. The seven countries would gain ECU 1 054 million in net benefits, which is far greater than ECU 234 million. Hence, the seven countries would do better by forming their own coalition than to make the payment demanded by Denmark, Greece and Portugal. This example underscores the importance of analysing coalitions.

3.4. Coalition analysis

As the previous example illustrated, an agreement will be acceptable to all parties provided none can increase its net benefits by pulling out of the agreement, either on its own

or as part of a bigger coalition. A great many coalitions are possible. For example, coalitions could include the grand coalition consisting of all countries; coalitions consisting of all countries but one, where the non-member is Belgium, Denmark, etc.; coalitions consisting of all countries but two, where the non-members are Belgium and Denmark, Belgium and France, etc.; and so on.

Our interest, of course, lies in making side payments that ensure that the grand coalition consisting of all countries is acceptable to all countries in the sense that none could do better by pulling out of the agreement, either on its own or with other countries. Presumably, one would like to ensure that each country received a net benefit that reflected its individual contribution to the grand coalition. However, analysis is complicated by the fact that there are many ways in which the grand coalition can be formed; in fact, there are 3 628 800 ways in which a coalition of 10 countries can be formed! Each country has an interest in arguing that the coalition would be formed in a way that makes its contribution particularly great. Hence, sequencing is likely to prove a problem for negotiation.

The problem can be simplified if we can identify 'natural' coalitions, where countries in the natural coalitions act essentially as one. For example, in international negotiations it would make sense to treat all EC countries as a natural coalition, since the EC can negotiate on behalf of the member countries (see Barrett, 1992b). Within the Community, it might be reasonable to distinguish three natural coalitions: one consisting of the countries that have not proposed an emission target (Greece, Portugal, and Spain); one consisting

¹ The seven countries gain ECU 1 642 million in the full cooperative outcome and ECU 408 million in the non-cooperative outcome. Hence, if these countries were to pay Denmark, Greece and Portugal ECU 1 000 million, they would still be ahead by $1\,642 - 1\,000 - 408 = \text{ECU } 234$ million. Denmark, Greece and Portugal would lose ECU 206 million in the full cooperative outcome and gain ECU 22 million in net benefits from the non-cooperative outcome. Hence, if a side payment of ECU 1 000 were made, these three countries would be ahead by $1\,000 - 206 - 22 = \text{ECU } 772$ million compared with the non-cooperative outcome.

of the countries that have proposed stabilizing emissions at the 1988/90 level (Belgium, France, and the United Kingdom); and one consisting of the countries that have proposed deeper cuts (Denmark, Germany, Italy, and the Netherlands). If the analysis proceeds using just these three natural coalitions, the number of ways in which the grand coalition can be formed reduces to just six.

Table 17 presents the possible outcomes corresponding to these three natural coalitions when marginal benefits are assumed to be proportional to GDP. The non-cooperative outcome assumes that countries within each natural coalition cooperate, and hence choose abatement levels where their individual marginal costs equal their collective marginal benefit. Total net benefits in this non-cooperative outcome are ECU 925 million. This is substantially greater than the net benefits associated with the non-cooperative outcome without natural coalitions (ECU 430 million; see Table 14). The difference arises from cooperation within each natural coalition. Notice that the full cooperative outcome is the same as before. In both cases, each country sets its individual marginal cost equal to the collective marginal benefit for all 10 countries.

There are, however, a number of intermediate possibilities. Two natural coalitions may cooperate independently of the third. The table indicates the payoffs which the coalitions receive if cooperation is partial. For example, if natural coalitions A (Greece, Portugal and Spain) and B (Belgium, France and the United Kingdom) cooperate, they receive ECU 509 million in net benefits, whereas C (Denmark, Ger-

many, Italy and the Netherlands) receives ECU 631 million. Notice that coalitions earn higher net benefits by cooperating. For example, when A and B form a coalition, they earn ECU 509 million in total, which is greater than the amount they earn if a coalition is not formed (104 plus 357 or ECU 461 million). Notice also that the natural coalitions that do not cooperate also do better compared to the outcome where there is no cooperation. For example, C earns ECU 631 million when A and B cooperate, but only ECU 494 million when there is no cooperation.

Table 18 demonstrates the importance of sequencing. If C is the last to join the grand coalition, it contributes 1 436 (the net benefits to the grand coalition) minus 509 (the net benefits to the coalition consisting of A and B), or ECU 927 million. However, if C joins after A, it contributes 634 - 206 or ECU 428 million, and if C joins after B, it contributes 1 088 - 492 = ECU 596 million. Finally, if C is the first to join the grand coalition, it contributes ECU 631 million.

The different contributions are shown in Table 18. One approach to allocating the gains to full cooperation is to provide each country (natural coalition) with an amount of net benefits which equals the average of the contributions which that country (natural coalition) makes to the total, where the average is taken over all possible sequences through which the grand coalition can be formed. This value, known as the Shapley value (see Raiffa, 1982; and Friedman, 1986), is shown in Table 18 for each of the natural coalitions. Notice that each natural coalition receives more under this

Table 16

Net benefits to coalition formation by Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom assuming marginal benefits are proportional to GDP

	Percentage abatement in 2010 emissions	Actual abatement (million tonnes CO ₂)	Benefits (million ECU)	Costs (million ECU)	Net benefits (million ECU)
Belgium	1.1	1.2	65	11	54
Denmark	0.6	0.4	54	0	54
France	8.9	32.9	432	308	124
Germany	4.8	32.5	551	305	246
Greece	0.1	0.1	22	0	22
Italy	0.6	2.8	378	29	349
the Netherlands	0.4	0.6	108	7	101
Portugal	0.3	0.2	22	0	22
Spain	0.6	1.5	151	16	135
United Kingdom	7.0	35.4	378	333	45
Total	3.8	107.6	2 161	1 009	1 152

Part A — The definition of emission limitation targets

Table 17

Net benefits to alternative cooperative arrangements¹ assuming marginal benefits are proportional to GDP

	Net benefits (million ECU)
<i>Non-cooperative outcome</i>	
A	104
B	357
C	464
Total	925
<i>Partial cooperative outcome</i>	
A and B cooperate	509
C does not cooperate	631
Total	1 140
A and C cooperate	634
B does not cooperate	492
Total	1 126
B and C cooperate	1 088
A does not cooperate	206
Total	1 294
<i>Full cooperative outcome</i>	
Total	1 436

¹ Natural coalitions are as follows.
A: Greece, Portugal, Spain.
B: Belgium, France, United Kingdom.
C: Denmark, Germany, Italy, the Netherlands.

approach than if negotiations failed (i.e. the Shapley value for each natural coalition exceeds the net benefits corresponding to the non-cooperative outcome).

While the Shapley value has certain attractions as an arbitrated solution, it has a weakness in this case. A receives less under the arbitrated outcome than if it pulled out of negotiations and B and C cooperated alone. Hence, the Shapley values might need to be modified to ensure that A received at least ECU 206 million. Otherwise, it is hard for countries to argue strongly against the Shapley values. Every natural coalition receives more than it would by withdrawing on its own or as part of a coalition of two.

The Shapley value provides one means of calculating an arbitrated solution, but there are many other possibilities.

Table 18

The Shapley value to the coalition game assuming marginal benefits are proportional to GDP

Sequence of countries forming the grand coalition	A	B	C	
A, B, C	206	303	927	1 436
A, C, B	206	802	428	1 436
B, A, C	17	492	927	1 436
B, C, A	348	492	596	1 436
C, A, B	3	802	631	1 436
C, B, A	348	457	631	1 436
Average	188	558	690	1 436

The important lesson for negotiations is to develop a consensus view on the baseline, costs and benefits, and for compromises to search for outcomes that will resist divisions arising from the formation of coalitions.

3.5. Enlarging the game

The preceding analysis suggests that money transfers will be needed if the full cooperative outcome is to be achieved. Some parties may well protest about giving such transfers, and will look for an alternative means of gaining agreement. The obvious alternative is to widen the game to include other issues. For example, Denmark, Greece and Portugal do worse under the full cooperative outcome compared to the non-cooperative outcome when marginal benefits are assumed to be proportional to GDP. To make these countries better off, and hence willing to accept the full cooperative outcome, negotiators might try to link CO₂ reductions to another issue — one where Denmark, Greece and Portugal gain and at least some of the other countries lose, but where all parties gain when the two issues are resolved jointly.

While linking issues can facilitate agreement, it can also make agreement more difficult to reach if joint resolution proves impossible and the issues, once linked, cannot later be decoupled (Sebenius, 1991). Linkage must be carefully thought through.

Appendix

Calculation of total abatement costs

We know:

$$MC = \ln(1 - \text{percent reduction})/\alpha. \quad (\text{A.1})$$

Let E = emissions in the absence of abatement and x = abated emissions. Then (A.1) can be rewritten as

$$MC = \ln(1 - x/E)/\alpha. \quad (\text{A.2})$$

The total cost of abating z Mt of carbon is

$$TC(z) = \int_0^z \ln(1 - x/E)/\alpha dx. \quad (\text{A.3})$$

Let $w = 1 - x/E$. Then $dw = -dx/E$ or $dx = -Edw$.

Rewriting (A.3), we obtain

$$TC(z) = -(E/\alpha) \int_0^z \ln w dw, \quad (\text{A.4})$$

the solution to which is

$$TC(z) = -(E/\alpha)[(1 - z/E) \ln(1 - z/E) + z/E] \quad (\text{A.5})$$

Total abatement costs for country i depend both on α_i and E_i .

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	WRE	WG1	Average	
MERGE	1	1	1.00	
MERGE	0.709753	0.528835	0.62	
CETA	1	1	1.00	
CETA	1.016393	0.678451	0.85	
MiniCam	1	1	1.00	
MiniCam	0.341772	0.424424	0.38	
FUND	1	1	1.00	
FUND	0.150015	0.424424	0.29	
SGM	1	1	1.00	
SGM	0.068872	0.240117	0.15	
CPBRIVM	1	1	1.00	
CPBRIVM	0.265625	0.304615	0.29	0.429441

6

$$1 - .429 = .57 \approx .6$$

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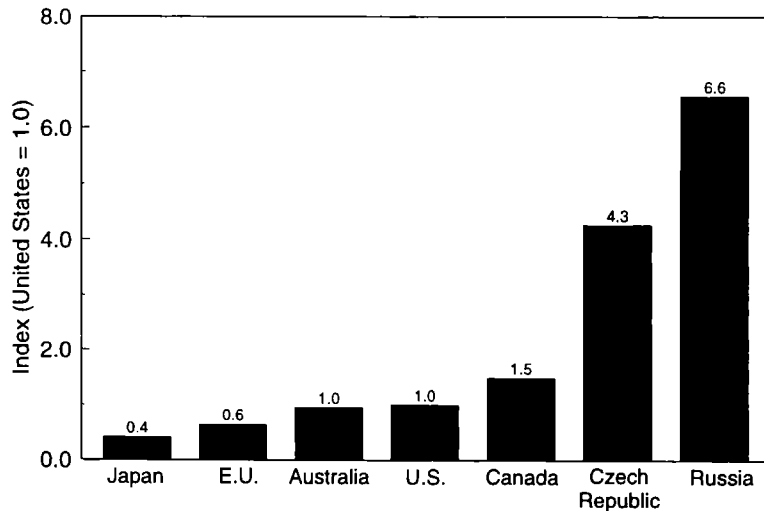
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In addition to the results of formal economic models, several key descriptive statistics also clearly illustrate the opportunities for economic gains from the trade of emissions allowances. For example, several Annex I countries have higher energy-to-GDP ratios than the United States (see Figure 14). Since these countries are less energy efficient than the United States, they present potentially attractive opportunities for U.S. firms to engage in trading and joint implementation projects, thereby securing reductions at relatively lower cost than might be available in the United States.

Several other Annex I countries, including Japan and the European Union are, on average, more energy efficient than the United States. These countries may find it relatively more expensive than U.S. firms to reduce carbon dioxide emissions domestically because they have already “squeezed out” most of the inexpensive improvements in energy efficiency.

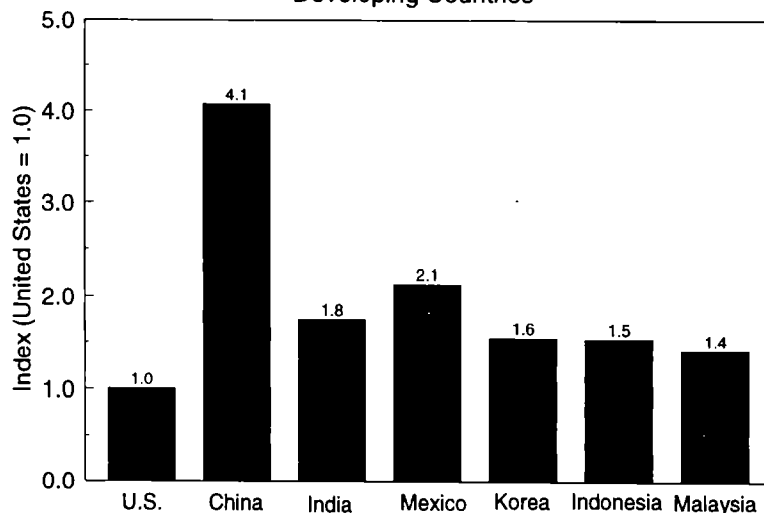
Figure 14. 1995 Energy/GDP Ratios for the U.S. and Several Other Annex I Countries



Source: Energy Information Administration 1997c.

Many large Non-Annex I countries also have much higher energy-to-GDP ratios than the United States (see Figure 15). A system of international emissions trading would provide the economic incentive for these countries to accelerate their transition to an energy efficient and carbon-lean economy. The very high energy intensity of many Non-Annex I countries suggests that many investments in energy efficiency would quickly pay for themselves, yielding negative-cost reductions. These low-cost opportunities could provide alternative options for

Figure 15. 1995 Energy/GDP Ratios for the U.S. and Several Developing Countries



Source: Energy Information Administration 1997c.

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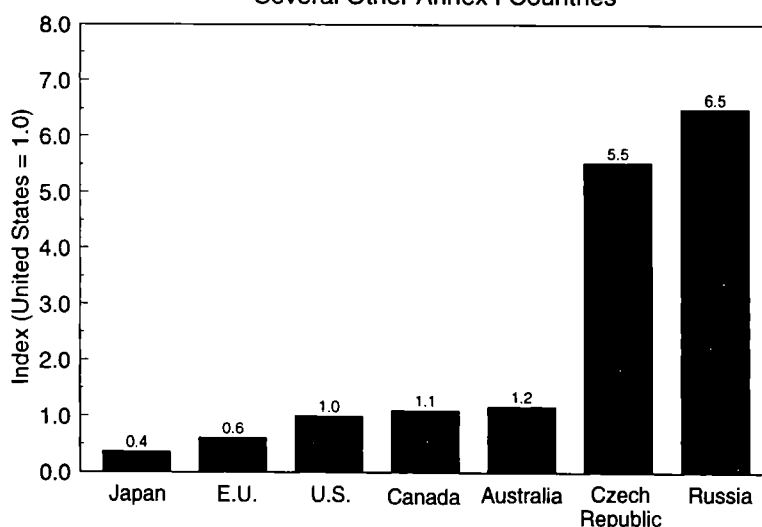
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U.S. firms to reduce emissions inexpensively through the Clean Development Mechanism, and, if developing countries adopted emissions targets, through international emissions trading. The Clean Development Mechanism and international trading would benefit both the industrial countries and the developing countries. For example, Chinese coal-fired boilers are only 2/3 as efficient as U.S. boilers. A recent World Bank study concluded that China could reduce its carbon emissions by 15 percent from its projected 2020 levels through zero- and negative-cost energy efficiency improvements. About 70 percent of these improvements would come as a result of market-oriented restructuring, with the remainder from particular technical projects. If China adopted a growth emissions target and undertook these sensible “no regrets” actions to achieve these emissions reductions, they would make their economy better off even before they gain the benefits from selling their excess emissions in the international trading market.

Similar to cross country comparisons of energy/GDP ratios, international comparisons of carbon dioxide emissions per unit of GDP provides insights on the opportunities for gains from trade. Countries vary by nearly two orders of magnitude in emissions of energy-related carbon dioxide per unit of GDP. At the low end are the poorest countries of sub-Saharan Africa: Rwanda, Burundi, Mali, and Chad. These are pre-industrial economies that still rely primarily on animal and human power supplemented by wood and crop wastes, rather than commercial fuels and their energy markets are underdeveloped. The OECD countries lie in the middle of this range. Within the OECD, countries with low population density, an abundance of fossil fuels, a cold climate, or large average dwelling size use more energy per unit of GDP. Thus, Canada, Australia, and the United States are among the most carbon intensive in the OECD. Industrial countries undergoing an economic transition away from central planning tend to be more carbon-intensive than most OECD countries. For every unit of output in Russia, more than six times the carbon is emitted than for the same amount of economic output in the United States (see Figure 16). These very high ratios in the former Soviet bloc countries are in part a result of the economic inefficiencies of central planning, including artificially low prices for coal and other fossil fuels, which in some cases still remain today.

Figure 16. 1995 Carbon/GDP Ratios for the U.S. and Several Other Annex I Countries



Source: Energy Information Administration 1997c.

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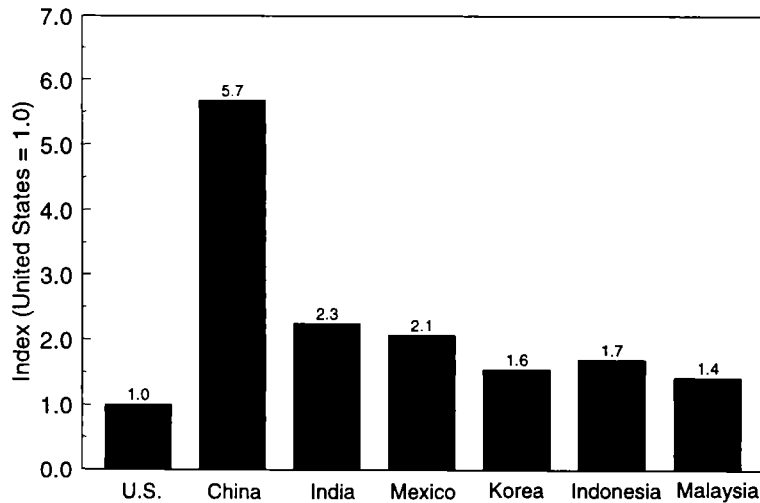
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China's economy is also carbon-intensive, primarily because of its reliance on coal for electricity generation. Other countries with high carbon emissions per unit of GDP include India, Indonesia, Egypt, Mexico, Venezuela, and South Africa (see Figure 17). All these countries are in the middle stages of industrialization, and most have large coal or oil reserves.

Figure 17. 1995 Carbon/GDP Ratios for the U.S. and Several Developing Countries



Source: Energy Information Administration 1997c.

Making International Trading Work

Since the agreement in Kyoto, there have been several signals reflecting the interest in transforming the concept of international trading into a practical, workable system. An early carbon emissions trade between two North American firms, a private sector proposal for an E.U. trading system, and cooperation among the Group of Eight countries illustrate this interest and potential to make trading work.

In March of this year, Niagara Mohawk Power of New York agreed to sell Suncor Energy of Canada 100,000 metric tons of greenhouse gas emissions, with an option for up to 10 million tons over a 10-year period. The potential value for this agreement could be about \$6 million.⁸ Niagara Mohawk plans to use some of the proceeds of the sale to undertake measures to reduce greenhouse gas emissions, such as improving power plant performance and energy efficiency and developing renewable energy resources. Suncor Energy will secure emissions reductions at a lower cost than what it would have to pay to achieve the same reductions through measures at their own facilities. A third party, the non-profit Environmental Resources Trust, will document the emissions reductions to be undertaken by Niagara Mohawk.

In May, the International Petroleum Exchange (IPE) of London submitted a proposal to establish a market in carbon dioxide emissions to the European Commission. The proposal calls for developing an emissions market in the United Kingdom and then expanding it throughout the European Union. The IPE recommends that free markets be allowed to evolve, and anticipates that a bilateral over the counter market and a futures market would likely evolve. A tracking system for

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NIAGARA MOHAWK AND SUNCOR ENERGY MAKE INTERNATIONAL GREENHOUSE GAS EMISSION REDUCTION TRADE

Deal Gives Suncor Energy Option to Purchase 10 Million Metric Tons of Emission Reductions From Niagara Mohawk over 10 Years

SYRACUSE, March 5— Niagara Mohawk Power Corp.(NYSE:NMK), of Syracuse, N.Y., and Canadian oil and gas company Suncor Energy Inc., today announced a ground-breaking greenhouse gas emissions trade. The two companies hope the agreement, which has a potential value of \$6 million (U.S.), will be a first step toward the creation of a global market and an international trading system for reductions in emissions of greenhouse gases, such as carbon dioxide.

The agreement has won praise from both the United States and Canadian governments as a demonstration of a market-based approach to reducing greenhouse gas emissions.

Suncor Energy has agreed to make an initial purchase of 100,000 metric tons of greenhouse gas emission reductions from Niagara Mohawk with an option to buy up to an additional 10 million tons of reductions over a 10-year period.

The agreement is designed to help Suncor Energy achieve its voluntary emission reduction targets, while providing Niagara Mohawk with additional funding for new projects that will further reduce global concentrations of greenhouse gases in the atmosphere. Under the terms of the agreement, a minimum of 70 percent of the net proceeds from the sale will be reinvested in such new projects, creating additional environmental benefits from the trade.

"Our agreement with Niagara Mohawk is part of Suncor Energy's broad-based action plan to address the risk of global climate change," says Rick George, Suncor Energy's president and chief executive officer. "Our first priority is to manage our own greenhouse gas emissions, and we have a solid track record in this area. But to meet the Kyoto targets we need the flexibility to pursue actions outside of our operations in Canada and internationally that reduce greenhouse gases in the atmosphere."

Suncor Energy's agreement with Niagara Mohawk follows close on the heels of Suncor Energy's participation in a forest conservation program in Belize and its investment in the generation of wind power in Alberta.

"This is a pioneering agreement," said Niagara Mohawk Chairman and Chief Executive Officer William E. Davis. "In the wake of the Kyoto conference, many have questioned whether economically efficient approaches such as this will work to address the risk of global climate change. By making this international trade, Niagara Mohawk and Suncor Energy are helping to forge a new market place that will help make those options viable."

Niagara Mohawk has reduced its own greenhouse gas emissions significantly below 1990 levels through a variety of measures, including power-plant performance and energy-efficiency improvements, use of less polluting fuels, and development of renewable energy resources. The

company has also been a leader in entering into emissions reduction trades with other companies and re-investing the proceeds in projects that result in further emission reductions. These trades include an earlier agreement with Arizona Public Service, which resulted in reductions of both CO₂ and sulphur dioxide emissions.

In order to implement the agreement, Niagara Mohawk's emission reductions will be documented and deposited into an account administered by the Environmental Resources Trust, a non-profit environmental organization founded by the Environmental Defense Fund.

"Coming just after the historic Kyoto climate agreement to limit greenhouse gas emissions, these companies are offering an actual example of international greenhouse gas emissions reduction trading – one of the most critical elements of the climate agreement, yet one that is not widely understood in many quarters," said ERT board member Daniel J. Dudek, who is also a senior economist at EDF. "Thanks to this trade, Niagara Mohawk and Suncor Energy are offering the world an opportunity for learning by doing."

Niagara Mohawk's Davis says now that the agreement has been reached, the two companies are ready to support further positive action. "We look forward to working with Suncor Energy, the United States and Canadian governments, and other companies to make this agreement a case study for an international trading system for greenhouse gas emission reduction credits."

George says he is optimistic that Suncor Energy's participation in a cross-border emission- reduction trade will encourage international policy development.

"Suncor Energy intends to be a leader in encouraging greenhouse gas reduction efforts in Canada, the United States and around the world," said George. "Our emission reduction purchase is just one part of a multifaceted strategy to reduce our own emissions, develop alternative energy opportunities, and invest in authenticated greenhouse gas emission reductions."

Niagara Mohawk is an investor-owned energy services company based in Syracuse. It provides electricity to more than 1.5 million customers in upstate New York, and natural gas to more than 530,000 customers in eastern, central and northern New York.

Suncor Energy is a Canadian integrated energy company operating an oil sands plant in Fort McMurray, Alberta; a conventional exploration and production business in Western Canada; a refining and marketing operation in Ontario and Quebec; and an oil shale development project in Queensland, Australia. Suncor Energy common shares are listed for trading on the Toronto, Montreal and New York stock exchanges.

**STATEMENT OF VICE PRESIDENT GORE
ON PROPOSED EMISSIONS TRADE**

The emissions trading agreement announced today by Niagara Mohawk and Suncor Energy is proof that our market-based strategy to combat climate change is already working.

In Kyoto, the United States won agreement on an international system of emissions trading to harness the forces of the global marketplace to fight global warming. We knew that, given the opportunity, businesses would find creative, cost-effective ways to reduce greenhouse gas emissions.

These two pioneering companies – one American, the other Canadian – are showing that ingenuity and entrepreneurial spirit can meet the challenge of climate change. Through this private sector transaction, Suncor can cut emissions for far less cost, and Niagara Mohawk can achieve significant earnings that it plans to invest in further clean energy projects.

The rules for trading are not yet final, but the market itself is already emerging. Barely three months after Kyoto, two major corporations are seeing and seizing an opportunity to protect our planet while building their bottom lines and growing the economy. I applaud their efforts.

FOR FURTHER INFORMATION CONTACT:

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Niagara Mohawk

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NEWS RELEASE

p22-3
IPE

IPE LAUNCHES PROPOSAL TO REDUCE CO₂ POLLUTION THROUGH EMISSIONS TRADING PLAN

Tuesday 5th May 1998

London:

The IPE today announced a proposal to establish a traded market in Carbon Dioxide (CO₂) emissions in order to secure maximum environmental benefits at minimum economic cost. The proposal has been submitted to John Prescott, UK Deputy Prime Minister and to the European Commission.

The world's first international treaty to combat climate change was signed in Kyoto, Japan, in December 1997, and one of the most important principles to emerge was that of a market based solution to pollution problems. At the same time, John Prescott, the UK's Deputy Prime Minister challenged the City of London to develop a mechanism for trading emissions permits. The IPE had positioned itself to take up this challenge, as a business development team had already undertaken initial research into the possibilities of emission permit trading.

Legislation is key for the establishment of a market, as without strictly enforced rules CO₂ producers will have no incentive to trade permits. The IPE calls for the UK government to take the lead within Europe by introducing legislation initially in the UK, and lobbying for wider take up within the EU.

The IPE is a strong supporter of a market based approach to pollution control as opposed to a top down regulatory approach such as a tax on emissions. Once overall targets for pollution and emissions reductions have been set by governments, the IPE recommends that responsibility for trading emissions permits is devolved to large CO₂ producers themselves. This will help to achieve the greatest environmental and economic benefits.

The main points of the IPE proposal to the UK government and European Commission are summarised below

3

The IPE proposes to develop a domestic emissions market with a view to expand it into Europe when market conditions allow.

The IPE calls for free markets to be allowed to evolve, while recognising that government plays an important part in the allocation process and the creation of legislation.

The IPE expects the ultimate evolution of two separate but related markets. The primary market will consist of a bilateral 'over the counter' market where deals are done between two parties. The IPE will play an active role in the development of a secondary market which would provide a risk management service to market participants. The IPE is willing to participate in the administration, monitoring and rule enforcement in both markets.

The IPE will provide a method of tracking emission permits as they are traded, assist in the collation of emissions monitoring data, and reconcile all emission transactions. Later, when market conditions allow, the IPE will launch a futures contract to facilitate risk management and forward planning.

The IPE calls for governments to ratify the Kyoto Protocol as soon as possible. The IPE would ultimately like to see legislation introduced not only at national level but inter-regionally so that as many countries and companies as possible can trade.

New entrants to the market would apply for permits through an auction administered by an independent organisation. The IPE is ready to take on this role.

Measurement should be based on calculating the amount of CO₂ emitted from the quantity of fuel used. Penalties should be available to enforce compliance.

The IPE is also willing to act as a reconciliation agent for all trades. This will include the monitoring of allocations to emitters and the collation of emissions data. Subsequently the Exchange will be able to monitor the positions of the market and ensure that emissions equal permits held.

Further details can be found in the paper published today entitled "A proposal to reduce CO₂ emissions in the European Union through the introduction of an emissions trading programme".

Lynton Jones, Chief Executive of the IPE said "the UK has a unique opportunity to lead the rest of the world in the establishment of a market in CO₂ emissions permits. Market based mechanisms, properly monitored and enforced, are undoubtedly the most cost effective and flexible way of achieving pollution reductions. The IPE's expertise in assisting with the development of competitive markets, and its 17 years of experience in global energy trading means that it is ideally placed to take the lead".

Notes to editors

The IPE is Europe's leading energy futures and options exchange and the second largest in the world. The IPE was founded in 1980 in response to increased price volatility in oil markets and volumes of trade have grown exponentially as more and more companies have taken the decision to manage their price risk.

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emissions permits would be designed, and the IPE would play a role in accounting emissions data and reconciling trades. In terms of the nature of the tradable permit, this proposal recommends that permits be denominated in units of carbon dioxide emissions, where emissions would be calculated from the quantity of carbon-based fuels used.

Also in May, the G-8 Summit in Birmingham, England yielded an agreement to work cooperatively on international trading, other flexibility mechanisms, and developing country participation. The Final Communique of the Summit noted that the G-8 countries "aim to draw up rules and principles that will ensure an enforceable, accountable, verifiable, open and transparent trading system." Continued cooperation among these countries could result in rules that would serve as the foundation for effective private sector trading in greenhouse gas emissions.

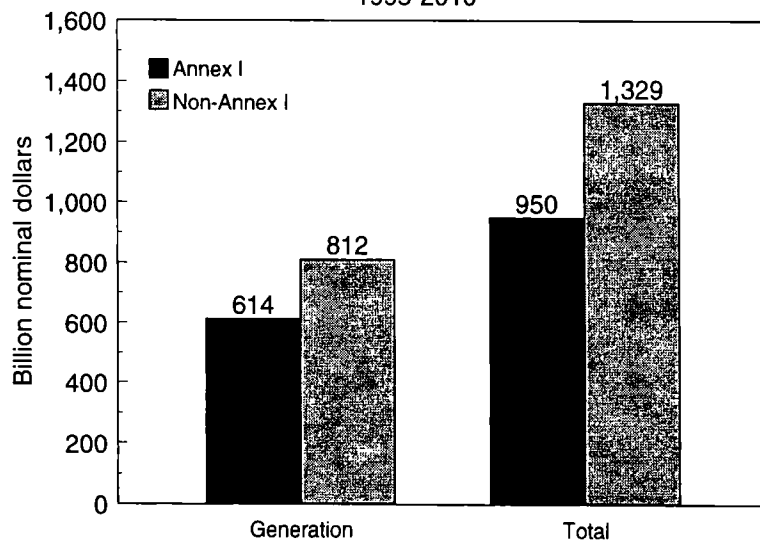
High Rates of Growth and Investment

Because of their high growth rates, developing countries have greater opportunities than the OECD to reduce emissions relative to baseline projections by installing new, carbon-efficient plants and adopting other new technologies. In contrast to retrofitting existing plants, new investment in carbon-efficient plants is a less costly approach to abate emissions.

Non-Annex I countries accounted for only 18 percent of world GDP in 1994 -- and only \$790 in GDP per capita, compared to \$12,200 for Annex I (Panayotou and Sachs 1998). At the same time Non-Annex I GDP grew at 5 percent annually (1990 to 1994), compared to 1.2 percent for Annex I. This has important implications for abatement opportunities.

Although Annex I countries still have, as a group, much higher economic output than Non-Annex I countries, the faster economic growth in Non-Annex I countries implies higher rates of investment. For example, investments in electric power generation are projected to be greater in Non-Annex I than in Annex I through 2010 (Energy Information Administration 1998; see Figure 18). Many of these Non-Annex I investment projects are likely to increase total generation, while a larger share of Annex I investments will likely

Figure 18. Cumulative Projected Electric Power Investments, 1995-2010



Source: Energy Information Administration 1998.

1998

The Birmingham Summit

THE BIRMINGHAM SUMMIT: FINAL COMMUNIQUE - Sunday 17 May 1998

The Birmingham Summit

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Introduction

1. We, the Heads of State or Government of eight major industrialised democracies and the President of the European Commission, met in Birmingham to discuss issues affecting people in our own and other countries. In a world of increasing globalisation we are ever more interdependent. Our challenge is to build on and sustain the process of globalisation and to ensure that its benefits are spread more widely to improve the quality of life of people everywhere. We must also ensure that our institutions and structures keep pace with the rapid technological and economic changes under way in the world.

2. Of the major challenges facing the world on the threshold of the 21st century, this Summit has focused on three:

- achieving sustainable economic growth and development throughout the world in a way which, while safeguarding the environment and promoting good governance, will enable developing countries to grow faster and reduce poverty, restore growth to emerging Asian economies, and sustain the liberalisation of trade in goods and services and of investment in a stable international economy;
- building lasting growth in our own economies in which all can participate, creating jobs and combating social exclusion;
- tackling drugs and transnational crime which threaten to sap this growth, undermine the rule of law and damage the lives of individuals in all countries of the world.

Our aim in each case has been to agree concrete actions to tackle these challenges.

Promoting sustainable growth in the global economy

3. In an interdependent world, we must work to build sustainable economic growth in all countries. Global integration is a process we have encouraged and shaped and which is producing clear benefits for people throughout the world. We welcomed the historic decisions taken on 2 May on the establishment of European Economic and Monetary Union. We look forward to a successful EMU which contributes to the health of the world economy. The commitment in European Union countries to sound fiscal policies and continuing structural reform is key to the long-term success of EMU, and to improving the prospects for

reliable, economic, safe energy supplies to meet the projected increase in demand. It is essential to encourage the development of energy markets. Liberalisation and restructuring to encourage efficiency and a competitive environment should be supported by transparent and non-discriminatory national legislative and regulatory frameworks with a view to establishing equitable treatment for both government and private sectors as well as domestic and foreign entities. These are essential to attract the new investment which our energy sectors need. We also recognise the importance of international co-operation to develop economically viable international energy transmission networks. We shall pursue this co-operation bilaterally and multilaterally, including within the framework and principles of the Energy Charter Treaty.

10. Considering the new competitive pressures on our electric power sectors, we reaffirm the commitment we made at the 1996 Moscow Summit to the safe operation of nuclear power plants and the achievement of high safety standards worldwide, and attach the greatest importance to the full implementation of the Nuclear Safety Account grant agreements. We reaffirm our commitment to the stated mission of the Nuclear Safety Working Group (NSWG). We agreed to deepen Russia's role in the activities of the NSWG, with a view to eventual full membership in the appropriate circumstances. We acknowledge successful cooperation on the pilot project of the International Thermonuclear Experimental Reactor (ITER) and consider it desirable to continue international cooperation for civil nuclear fusion development.

11. The greatest environmental threat to our future prosperity remains **climate change**. We confirm our determination to address it, and endorse the results of our Environment Ministers' meeting at Leeds Castle. The adoption at Kyoto of a Protocol with legally binding targets was a historic turning point in our efforts to reduce greenhouse gas emissions. We welcome the recent signature of the Protocol by some of us and confirm the intention of the rest of us to sign it within the next year, and resolve to make an urgent start on the further work that is necessary to ratify and make Kyoto a reality. To this end:

- we will each undertake domestically the steps necessary to reduce significantly greenhouse gas emissions;
- as the Kyoto protocol says, to supplement domestic actions, we will work further on flexible mechanisms such as international market-based emissions trading, joint implementation and the clean development mechanism, and on sinks. We aim to draw up rules and principles that will ensure an enforceable, accountable, verifiable, open and transparent trading system and an effective compliance regime;
- we will work together and with others to prepare for the Buenos Aires meeting of COP4 this autumn. We will also look at ways of working with all countries to increase global participation in establishing targets to limit or reduce greenhouse gas emissions. We will aim to reach agreement as soon as possible on how the clean development mechanism can work, including how it might best draw on the experience and expertise of existing institutions, including the Global Environment Facility. We look forward to increasing participation from developing countries, which are likely to be most affected by climate change and whose share of emissions is growing. We will work together with developing countries to achieve voluntary efforts and

(B)

GROWTH RATES OF POPULATION, GDP AND CARBON EMISSIONS, 1990-94 (IN PERCENT)

GROWTH RATES 1990-1994 (%)	ANNEX 1	NON-ANNEX 1	WORLD
Population	0.58	1.73	1.56
Real GDP	1.21	5.01	1.84
Combustion emissions ¹	-0.64	6.85	1.70
Land-use change emissions (average annual rate 80-85 vs. average annual rate 90-95) ²	-162.57	0.87	0.47
Total anthropogenic CO ₂ emissions (average annual growth 85-94)	2.81	3.60	3.34

¹ The sample includes 33 Annex 1 and 120 Non-Annex 1 countries

² The sample includes 25 Annex 1 and 84 Non-Annex 1 countries

(2)

David
Sachs

POPULATION AND GDP FOR ANNEX 1 AND THE REST OF THE WORLD, 1994

	ANNEX 1 (36 COUNTRIES)	NON-ANNEX 1 (130 COUNTRIES)	WORLD (166 COUNTRIES)
Population (billion)	1.19	4.14	5.32
Population Share	22.3	77.7	100
Population Growth (%)	0.98	1.73	1.60
Real GDP (trillion US\$)	14.70	3.026	17.73
Real GDP Share (%)	81.6	18.4	100
Real GDP Growth Rate (%)	1.21	5.01	1.84
Real GDP per Capita (US\$)	12,201	788	3,331
Real GDP per Capita PPP adjusted(US\$)	15,348	1,986	4,977

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replace existing power plants. When a power company in an OECD country considers building a new plant to replace a plant that is not near the end of its useful life, it weighs the total cost of building a new natural gas plant against the variable cost of continuing to operate its existing coal plant. Unless coal prices jump, or the existing plant is in poor repair, only a large rise in coal prices will justify scrapping the old coal plant. In contrast, when a power company considers building a new plant in a developing country it weighs the total cost of building a new natural gas plant against the total cost of building a new coal plant. Here, a small rise in coal prices would be sufficient to justify the decision to build a gas plant.

Market Distortions

Eliminating energy subsidies

Many developing countries and economies in transition continue to subsidize energy consumption. Elimination of such subsidies would represent opportunities to reduce government outlays and possibly taxes, while at the same time reducing carbon emissions and enhancing energy efficiency. Reduced reliance on fossil fuels would also reduce local air pollution, to the benefit of local public health and the local environment.

- Over 1995-1996, fossil fuel subsidy rates were ³¹~~25~~ percent in Russia, 20 percent in China, and 19 percent in India. Eliminating these subsidies would substantially improve energy efficiency. (8)
- Removing energy subsidies in Russia, China, India, Eastern Europe, Egypt, and Mexico could decrease carbon emissions by ¹⁰⁻¹²~~5 to 15~~ percent (Shah and Larsen 1991). Removing these subsidies would also reduce SO₂ and particulate emissions significantly. (8)

Management reforms

Another important opportunity for reducing carbon emissions lies in deregulation and reform of the energy sector. Reducing transmission losses for electricity, improving power quality, and better coordinating supply and demand in electric and gas systems can reduce private costs and carbon emissions at the same time. Individual customer metering, uncommon in many developing countries and economies in transition, would reduce needless energy consumption by providing an incentive for efficient use.

Tietenberg, T. (1992). *Environmental and Natural Resource Economics*. New York: HarperCollins.

*Tybout, J.R. and D. Moss. (1994). "The Scope for Fuel Substitution in Manufacturing Industries: A Case Study of Chile and Colombia." *The World Bank Economic Review* 8/1, 49-79.

United States Environmental Protection Agency. (1986). (AP-42) "Compilation of Air Pollutant Emission Factors." Supplement A, October, Vol. 1, Stationary Point and Area Sources. Research Triangle Park, NC.

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Chapter 5

GLOBAL CLIMATE CHANGE, ENERGY SUBSIDIES AND NATIONAL CARBON TAXES

Bjørn Larsen (World Bank)

and

Anwar Shah (World Bank)

INTRODUCTION

We are still no closer to answers on whether the buildup of "greenhouse" gases in the atmosphere could trigger a significant warming of the earth's surface. Nor do we know with any precision what the social and economic consequences of global warming might be. Yet countries all over the world are increasingly showing a willingness to act now, rather than wait for further scientific evidence:

At the June 1992 "Earth Summit" in Rio de Janeiro, more than 150 countries signed a treaty aimed at stabilizing greenhouse gases -- mainly carbon dioxide (CO₂), which is by far the largest contributor to the greenhouse effect. The UN Framework Convention on climate change specifies a series of obligations for participating countries to respond to this problem. Those obligations took effect when the Convention entered into force on 21 March 1994. Nineteen OECD countries and the European Union (EU) have ratified the treaty as of 1 May 1994 and face a later deadline to submit their climate change action plans to the Convention Secretariat.

Most industrial countries have adopted national targets of stabilizing CO₂ emissions at 1990 levels by the year 2000.

The findings, interpretations and conclusions expressed in this paper do not necessarily represent the views of the World Bank, its affiliates or its member countries. The authors are grateful for comments by two anonymous referees on a previous draft of the paper.

emissions is calculated from (4) by multiplying the change in fuel i by the respective carbon emission coefficients.

The estimates are presented in Table 3. The reductions are quite substantial in many of the large carbon emitting countries. The removal of energy subsidies is estimated to reduce annual carbon emissions relative to the baseline by nearly 25-30% in the former Soviet Union. Even with this change, carbon emissions per dollar of GDP in the former Soviet Union would still be twice as high as in the United States and more than three times higher than in most Western European countries. Negative taxation of energy may have contributed to this relatively poor carbon efficiency in the former Soviet Union. Carbon reductions from subsidy removal in most other subsidizing countries are estimated to fall in the range of 10-20% -- primarily because subsidies are less pervasive than in the former Soviet Union.

Table 3 CO₂ Emissions Reductions relative to Baseline 1990-2010

Percentage Reductions	
Former Soviet Union	25-30
China	5-10
Poland	20-25
India	7- 9
South Africa	13-15
Former Czechoslovakia	16-24
Mexico	4- 7
Brazil	3- 8
South Korea	3- 5
Venezuela	15-22
Indonesia	7-12
Saudi Arabia	7-12
Egypt	11-16
Iran	22-26
Romania	20-24
Bulgaria	10-12

Sources: Larsen (1994); and Larsen and Shah (1992).

Note: The range in emissions reductions reflects a range in subsidies estimated.

Given emissions projections to the year 2010, estimated reductions relative to baseline projections in non-OECD countries collectively are in the order of 10-12%. This relatively low percentage reduction is primarily due to relatively low subsidies, and thus low emissions reductions in China, and the fact that emissions are expected to increase at a substantially higher rate in China than in the countries of the former Soviet Union -- so that China's share of non-OECD emissions will be significantly higher in year 2010. Nevertheless, the estimated reductions in non-

OECD countries are equivalent to about 20% of emissions in OECD countries. It is estimated that the OECD countries would have to levy a carbon tax of 70 per ton in order to achieve the equivalent tons of reductions (see L. Shah, 1992).

The estimated CO₂ emissions reductions from subsidy removal in the non-OECD countries as a group are generally lower than presented in Burniaux et al (1994). The differences, however, can largely be explained by variations in the applied energy-demand elasticities. The relatively low elasticities applied to the countries with a high rate of energy subsidies in this chapter may be considered conservative. However, estimated carbon intensity in, for instance, the former Soviet Union (after subsidy removal) approach that of other middle-income countries with no or minimal energy subsidies and similar primary-energy composition.

Carbon Emissions Impacts of Subsidy Removal in OECD Countries

The CO₂ emissions impacts of energy subsidy removal in the OECD countries are much smaller. Estimated impacts on CO₂ emissions from the removal of coal-producer subsidies and coal-import restrictions are negligible (DRI/McGraw-Hill, 1994a). This is at first sight somewhat surprising, given that removals would lower the price of coal to consumers. However, the main domestic coal-consuming sectors are using coal by requirement at a level substantially higher than is indicated by the high prices paid.

The elimination of energy subsidies in the US is estimated to reduce CO₂ emissions by about 4% below the baseline by recycling the "revenues" through a change in the marginal labor tax and capital tax, while GDP would increase by 0.1-0.2% relative to baseline (Dale W. Jorgenson Associates, 1994). Full cost recovery of road transport in the US is estimated to reduce total CO₂ emissions in the US by 3-3.5% below the baseline, given that road transport contributes "only" about 30% of total emissions (DRI/McGraw-Hill, 1994b).

Based on projected baseline emissions² presented in Table 4, world emissions reductions from subsidy removal in non-OECD and OECD countries are

² Baseline OECD emissions are assumed constant, given that most OECD countries have committed to stabilize emissions at 1990 levels by year 2000, and some to further reduce emissions to 80% of 1990 levels by year 2005. Baseline emissions in the former Soviet Union and eastern Europe are based on Baron (1992), incorporating the impacts of restructuring but not subsidy removal (although subsidy may also induce structural changes). Baseline emissions in all other non-OECD countries are based on GDP projections less 0.5-1.0% annual autonomous energy efficiency improvements that may arise from other factors than energy prices.

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SUBJECT: Table + cover page, as requested.

Regards,

Kirk Hamilton

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Appendix box 1 Valuing subsoil assets 33

48 *Expanding the Measure of Wealth***Table 4.3 Subsidy rates and total subsidies for fossil fuels, 1990-91 and 1995-96**

Country or group	Subsidy rates (%)								Total subsidies		
	Petroleum products		Natural gas		Coal		Totals		(1995 US\$ millions)		(% GDP)
	1990-91	1995-96	1990-91	1995-96	1990-91	1995-96	1990-91	1995-96	1990-91	1995-96	1995-96
Russia^a	38	16	67	42	48	25	45	31	28,797	9,427	1.50
Eastern Europe											
Bulgaria	43	24	27	23	65	33	54	29	2,003	733	7.05
Czech Rep.		0	39	29	29	28	24	22	1,173	978	2.96
Hungary	2	2	28	34	na	na	13	16	548	560	1.47
Poland	28	1	40	6	63	26	50	18	4,653	1,692	1.97
Romania	27	2	64	54	80	33	54	37	4,743	1,876	7.24
Total	22	4	48	37	53	26	42	23	13,120	5,838	3.19
Asia											
China	55	2	na	na	37	29	42	20	24,545	10,297	2.42
India	21	15	na	na	32	27	25	19	4,250	2,663	1.06
Korea, Rep. of	0	na	na	na	na	na	0	0	42	12	0.00
Thailand	10	9	na	na	na	na	10	9	524	459	0.37
Total	30	5	na	na	35	29	33	16	29,362	13,430	1.19
Oil producers											
Egypt, Arab Rep. of	50	33	70	56	na	na	55	40	2,299	1,336	3.39
Indonesia	28	21	43	17	na	na	29	21	2,071	1,333	0.92
Iran, Islamic Rep. of	88	77	82	75	na	na	86	77	13,076	9,622	8.68
Mexico	32	12	31	39	na	na	32	16	5,403	2,271	0.66
Nigeria	60	38	na	na	na	na	60	38	928	592	1.87
Saudi Arabia	63	28	76	61	na	na	66	34	3,837	1,720	1.42
Venezuela	70	55	86	85	na	na	76	66	3,455	2,397	4.00
Total	54	38	64	59	na	na	56	42	31,067	19,272	2.26
Others											
Argentina	4	3	24	3	na	na	12	3	659	150	0.06
Brazil	26	0	na	na	na	na	26	0	2,193	11	0.00
South Africa	8	6	na	na	20	na	12	4	981	367	0.31
Total	16	3	24	3	20	na	17	2	3,833	528	0.06
OECD	na	na	na	na	na	na	na	na	12,453	9,890	0.05
Total	36	16	58	44	57	44	45	28	118,632	58,385	0.27

Note: A zero indicates less than 1 percent.

a. Estimates for Russia are for 1990 and 1994 in PPP dollars and are taken from Gurvich and others 1996. See technical appendix for details of derivation.

Source: Rajkumar 1996 for developing countries; IEA 1995 for OECD; Gurvich and others 1996.

Changes in real energy prices in China have occurred as part of the ongoing economic reforms (box 4.4). Reforms began in the 1980s and have continued into the 1990s. While most energy prices are still set by the government, efforts are made to base them on economic costs. Energy intensity in China has fallen by about 30 percent since 1984, which can be at least partly attributed to these reforms.

India has also continued to reduce energy subsidies, albeit more slowly than China. All petroleum products are at or above world prices, with the notable exception of kerosene, a fuel widely consumed by households. Coal pithead prices have also been raised, and since 1991 average

prices have covered operating costs, with some allowance for capital depreciation. Furthermore, prices for higher grades of coal are no longer fixed by the central government.

Because the pricing system does not sufficiently differentiate between mines, however, significant cross-subsidization of higher-cost mines by lower-cost ones remains, thus sustaining many uneconomic mines. Similarly, the degree of differentiation among grades of coal is low, resulting in cross-subsidization among lower grades. Removal of subsidies and market reforms may also promote coal-washing, which would reduce emissions per unit of coal used.

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Divider Title: _____

Opportunities for Cost-Savings through the Clean Development Mechanism and Joint Implementation

As noted, the Clean Development Mechanism (CDM) will allow companies in industrial countries to enter into cooperative projects to reduce emissions in developing countries -- such as the construction of high-tech, environmentally sound power plants -- for the benefit of both the companies and the developing countries (Kyoto Protocol, Article 12). The companies will be able to reduce emissions at lower costs than they could at home, while companies in developing countries will be able to receive the kind of technology that can allow them to grow more sustainably. The CDM will certify and score projects. This market-based mechanism provides opportunities for U.S. companies to meet emissions targets at lower costs and increases the opportunities to export energy and environmental protection technology to the emerging markets in developing countries. The CDM would build on the growing U.S. energy efficiency and environmental protection export industry (Berg and Ferrier 1997). (A1)

Joint Implementation (JI) will allow for companies in countries with emissions targets (Annex B countries) to invest in projects that reduce greenhouse gas emissions in other Annex B countries (Kyoto Protocol, Article 6). Like the CDM, this is a voluntary program that provides companies the flexibility and the opportunities to make good business decisions that result in emissions reductions at least-cost. (A2)

The CDM and JI will likely reflect many components of the existing Activities Implemented Jointly pilot program (AIJ). Under the 1992 Framework Convention on Climate Change, the U.S. government and others have commenced projects with characteristics similar to those that might be expected through the Clean Development Mechanism and Joint Implementation. (A3)

U.S. Efforts

To implement the pilot phase of the AIJ component of the Framework Convention, the Administration initiated the U.S. Initiative on Joint Implementation (USIJI) in 1993. The USIJI program supports the development and implementation of voluntary projects between U.S. and non-U.S. partners that reduce, avoid, or sequester greenhouse gas emissions. Projects are assessed based on a set of criteria that ensures proposed projects provide greenhouse gas reduction benefits and support the development goals of the host country. (A4)

As of June 30, 1997, the USIJI program had accepted 25 project proposals in 11 countries, helping U.S. firms tap the potential outside the OECD for low-cost greenhouse gas reductions while contributing to development goals in host countries (Environmental Protection Agency 1997). These projects include fuel switching, energy efficiency improvements, renewable energy, afforestation, reforestation, and improved agricultural management. A brief summary of a sample of these projects follows. (A5)

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**KYOTO PROTOCOL TO THE
UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE**

The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the

Conference of the Parties to the Convention at its first session,

in the context of the implementation of Article 4, paragraph 1, of the Convention, in accordance with the provisions of Article 4, paragraph 3, and Article 11 of the Convention, and through the operating entity or entities of the financial mechanism of the Convention, the developed country Parties and other developed Parties included in Annex II to the Convention shall:

(a) Provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in advancing the implementation of existing commitments under Article 4, paragraph 1(a), of the Convention that are covered in

Article 10, subparagraph (a); and

(b) Also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of advancing the implementation of existing commitments in Article 4, paragraph 1, of the Convention that are covered by Article 10 and that are agreed between a developing country Party and the international entity or entities referred to in Article 11 of the Convention, in accordance with that Article.

The implementation of these existing commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among developed country Parties. The guidance to the financial mechanism of the Convention in relevant decisions of the Conference of the Parties, including those agreed before the adoption of this Protocol, shall apply *mutatis mutandis* to the provisions of this paragraph.

3. The developed country Parties and other developed Parties in Annex II to the

Convention may also provide, and developing country Parties avail themselves of, financial resources for the implementation of Article 10, through bilateral, regional and other multilateral channels.

Article 12

1. A clean development mechanism is hereby defined.

2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

3. Under the clean development mechanism:

(a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and

(b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.

(A1)
5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

- (a) Voluntary participation approved by each Party involved;
- (b) Real, measurable, and long-term benefits related to the mitigation of climate change; and
- (c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

9. Participation under the clean development mechanism, including in activities mentioned in paragraph (a) above and acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

Article 13

1. The Conference of the Parties, the supreme body of the Convention, shall serve as the meeting of the Parties to this Protocol.

2. Parties to the Convention that are not Parties to this Protocol may participate as

observers in the proceedings of any session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, decisions under this Protocol shall be taken only by those that are Parties to it.

3. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, any member of the Bureau of the Conference of the Parties representing a Party to the Convention but, at that time, not a Party to this Protocol, shall be substituted by an additional member to be elected by and from amongst the Parties to this Protocol.

**Meeting the Challenge:
U.S. Industry Faces the 21st Century**

**The U.S.
Environmental
Industry**

**David R. Berg
Office of Technology Policy**

and

**Grant Ferrier
CEO, Environmental Business International**

for

**U.S. Department of Commerce
Technology Administration
Office of Technology Policy
Technology Competitiveness Program**

**Jon Paugh
Director**

September 1997

(2) Public Sector Customers

Governmental authorities that provide environmental services to their customers generate about one-third of industry revenues. These authorities are concentrated in the potable water and wastewater sectors, although there are many in the solid waste and recycling sectors, as well. These service authorities are large purchasers of products and services from other segments of the industry (e.g., equipment suppliers and laboratory services). The largest public sector customers of the industry at this point in time, however, are federal agencies in charge of the cleanup of contaminated sites.

Budgetary constraints and, more broadly, changing expectations of the roles of government are reshaping the environmental services market. Voters across the country are demanding more efficiency in, and lower costs for, these services, squeezing the revenue base of the authorities. While much of the U.S. environmental infrastructure is in need of upgrade, insufficient public funds are available to meet the task. Similar resource constraints are slowing the cleanup of federal sites.

New strategies for privatization of environmental infrastructure and of the cleanup work at federal sites are gaining momentum, along with incentives for the use of alternative solutions. To the extent these are adopted in federal procurement practices, increased efficiency and lower cost will come into play, and demand for innovative technologies and services will gain.

(3) The Emerging Global Market

A2

The rapid growth in overseas environmental markets has changed the U.S. environmental industry forever. With increased competition and declining profits in the U.S. home market, more companies are looking to foreign markets for opportunities to improve return on investment. Whether they seek to provide environmental infrastructure in developing markets or advanced products and services to foreign industrial customers, companies in the environmental industry see great opportunities in the increasing and changing demand overseas.

The \$453-billion global environmental market is growing faster than the global economy and at a pace that outstrips growth in the U.S. environmental market, as seen in Exhibit 4. This market is made up of two distinct parts: industrial markets where demand may be as sophisticated as in the U.S., and developing markets where demand is dominated by the need for environmental infrastructure (e.g., potable water, wastewater treatment, and solid waste disposal).

The most rapid market growth is occurring in the developing nations where booming populations, high-paced urbanization, and technological advances place tremendous burdens on the environment and create an enormous demand for improved infrastructure. In many of these countries, an environmental crisis of incomparable proportions threatens both today's and future generations. Demand in many of these countries is limited more by the inability to pay than by an absence of regulations requiring environmental protection.

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Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

*Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the
Conference of the Parties to the Convention at its first session,*

upon by the Conference of the Parties at its third session. Based on the work of, *inter alia*, the Intergovernmental Panel on Climate Change and advice provided by the Subsidiary Body for Scientific and Technological Advice, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall regularly review and, as appropriate, revise the global warming potential of each such greenhouse gas, taking fully into account any relevant decisions by the Conference of the Parties. Any revision to a global warming potential shall apply only to those commitments under Article 3 in respect of any commitment period adopted subsequent to that revision.

Article 6

1. For the purpose of meeting its commitments under Article 3, any Party included in

A3

Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:

- (a) Any such project has the approval of the Parties involved;
- (b) Any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur;
- (c) It does not acquire any emission reduction units if it is not in compliance with its obligations under Articles 5 and 7; and
- (d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3.

2. The Conference of the Parties serving as the meeting of the Parties to this Protocol may, at its first session or as soon as practicable thereafter, further elaborate guidelines for the implementation of this Article, including for verification and reporting.

3. A Party included in Annex I may authorize legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this Article of emission reduction units.

4. If a question of implementation by a Party included in Annex I of the requirements referred to in this paragraph is identified in accordance with the relevant provisions of

Article 8, transfers and acquisitions of emission reduction units may continue to be made after the question has been identified, provided that any such units may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

Article 7

1. Each Party included in Annex I shall incorporate in its annual inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, submitted in accordance with the relevant decisions of the Conference of the Parties, the necessary supplementary information for the purposes of ensuring compliance with Article 3, to be determined in accordance with paragraph 4 below.

Activities Implemented Jointly: Second Report to the Secretariat of the United Nations Framework Convention on Climate Change



Accomplishments and Descriptions of Projects Accepted Under the U.S. Initiative on Joint Implementation

Volume 1

USIJI is supported by:
Agency for International Development, Department of Agriculture, Department of Commerce,
Department of Energy, Department of Interior, Department of State, Department of Treasury,
and Environmental Protection Agency

I. Introduction

(A4)

Initiated in 1993 as part of the U.S. Climate Change Action Plan, the U.S. Initiative on Joint Implementation (USIJI) supports the development and implementation of voluntary projects between U.S. and non-U.S. partners that reduce, avoid, or sequester greenhouse gas (GHG) emissions. Final groundrules for the USIJI Program,¹ published in 1994, describe the purpose of the pilot program, outline the time line for evaluation and reassessment of the program, define eligibility criteria for domestic and non-U.S. participants, establish an Evaluation Panel to review potential USIJI projects, and define criteria for acceptance of projects into the USIJI portfolio.

Projects accepted into the USIJI Program are evaluated against nine criteria and four other areas of consideration. The criteria require that each project accepted into the USIJI Program demonstrate that it:

- has the acceptance of the host country government;
- will reduce or sequester net GHG emissions;
- was developed or realized because of the USIJI Program;
- provides data and methodological information sufficient to measure emissions with and without the project;
- provides for tracking and verifying the emissions reduced or sequestered by the project;
- identifies associated environmental and developmental benefits; and
- provides assurance that benefits gained will not be lost over time.

These criteria are intended to identify those projects that support the development goals of the host country while providing GHG benefits beyond those that would occur in the absence of the joint implementation activity. The criteria have been formulated to ensure that projects accepted into the program will produce real, measurable net emissions reductions. Net emission reductions achieved as a result of USIJI projects will be measured, monitored, verified, and reported.

The USIJI Program is directed by an Interagency Working Group, chaired by the Department of State, which has the primary responsibility for policy development. The USIJI Evaluation Panel is co-chaired by the Environmental Protection Agency and the Department of Energy, and includes representatives from the Agency for International Development and the Departments of Agriculture, Commerce, Interior, State, and Treasury. The USIJI Secretariat, an interagency staff, supports the day-to-day operation of the USIJI Program. Technical experts are drawn from a variety of organizations to assist the Secretariat in the proposal review process and to provide technical assistance to project developers.

The USIJI Secretariat offers a variety of technical services to support both the development and the implementation of USIJI projects. These technical services include: (1) technical assistance to aid project developers in calculating emission reduction benefits, developing monitoring and verification plans, and identifying sources of project financing; (2) capacity building to support human and institutional capacity building for joint implementation in select countries around the world; (3) information resources including technical guidance documents, databases, a fax-on-demand service, an information hotline, and

¹ The Groundrules and Project Criteria for USIJI are presented in Section V of Part One of this report.

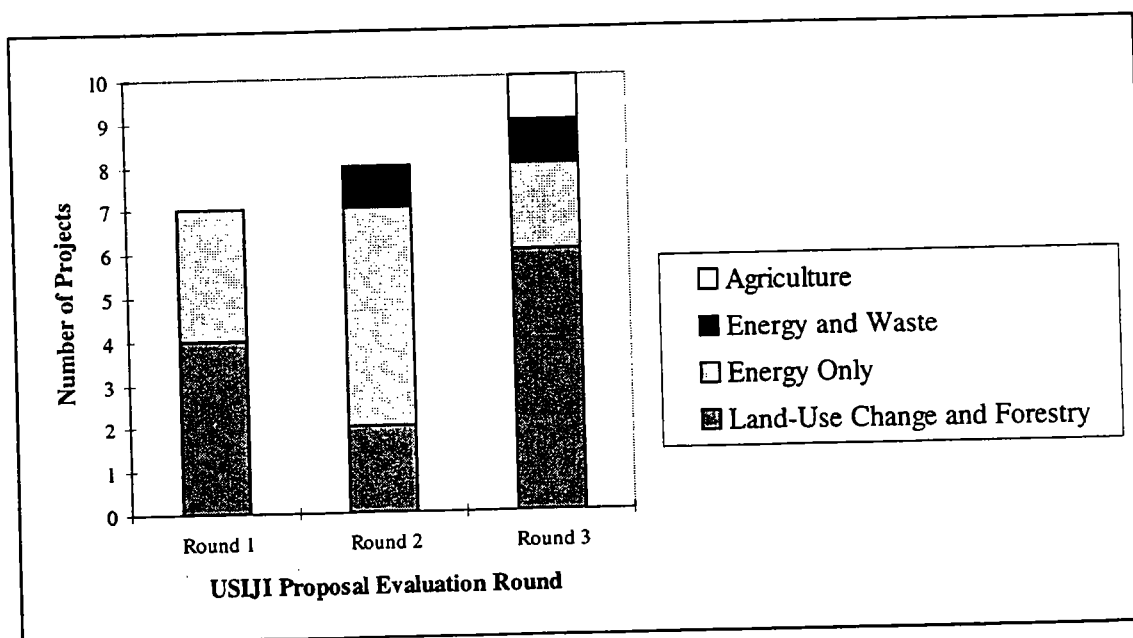
II. Summary of USIJI Projects

A5

As of June 30, 1997, the USIJI Program had conducted three rounds of proposal evaluations and accepted 25 projects from 11 countries. Seven proposals were accepted in Round 1 (announced in February 1995), eight in Round 2 (announced in December 1995), and ten in Round 3 (announced in December 1996). The following countries are currently hosting USIJI projects: Belize (2), Bolivia (1), Costa Rica (8), Czech Republic (1), Ecuador (1), Honduras (3), Indonesia (1), Mexico (2), Nicaragua (1), Panama (1), and the Russian Federation (4).

As the USIJI Program has grown, it has continued to diversify in terms of both the number of participating host countries and the type of project activities. The third round of proposal evaluations resulted in the addition of projects in five new countries—Bolivia, Ecuador, Indonesia, Mexico, and Panama—to the USIJI Program. The 25 USIJI projects accepted to date span four principal sectors: twelve projects are classified as land-use change and forestry projects, ten are classified as energy projects, two are classified as both energy and waste projects, and one is classified as an agriculture project. Figure 1 presents the types of USIJI projects according to the evaluation round in which they were accepted.

Figure 1. USIJI Projects by Sector and Proposal Evaluation Round



Within each sector, many types of project activities are used to achieve GHG emission benefits. In the land-use change and forestry sector, project activities range from forest preservation, forest regeneration, afforestation, and silviculture to agroforestry, sustainable timber harvesting and the manufacture of durable wood products. In the energy sector, project activities include fuel switching, energy efficiency improvements, cogeneration, capture of fugitive emissions, and alternative energy generation. The two multi-sector projects involve the conversion of biomass waste to energy. The agriculture project involves crop management for the accumulation of soil carbon.