

**Measuring the Clean
Development Mechanism's
Performance and Potential**

Michael Wara

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Program on Energy and Sustainable Development

At the Center for Environmental Science and Policy

Encina Hall East, Room 415

Stanford University

Stanford, CA 94305-6055

<http://pesd.stanford.edu>

About the Author

Michael Wara is currently a research fellow with the Program on Energy and Sustainable Development and a J.D. candidate at Stanford Law School. Wara's current research focuses on the emerging global market for greenhouse gases and the Post-Kyoto regime for reducing their emissions. His interests also include the interaction between climate, water, and endangered species management.

Wara holds a Ph.D. in Ocean Sciences from the University of California, Santa Cruz. His doctoral research focused on the interaction between long term shifts in global climate and tropical ocean/atmosphere dynamics.

Measuring the Clean Development Mechanism's Performance and Potential

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I. Introduction

Global warming is one of the most difficult and important challenges facing the international community. To date, the most substantial effort to address this problem is the Kyoto Protocol ("Protocol").¹ Although not adopted by the United States or Australia, this international agreement was adopted and ratified by every other large developed world country and entered into force on February 16th, 2005.² The Protocol is likely the largest ever international effort to combat a global environmental commons problem.

The Kyoto Protocol both incorporates and allows for numerous trading mechanisms, ironically inserted during its negotiation at the insistence of its most-prominent non-signatory.³ These mechanisms are quickly becoming, if they have not already become, the preeminent example of an attempt to deal with an international environmental problem using a market-based approach.

The U.S. and international community are currently at a critical juncture in terms their efforts to address the problem of global warming. Although the United States declined to join the Kyoto Protocol, market mechanisms to control CO₂ emissions are currently being developed by a coalition of 7 northeastern States⁴ and by California.⁵ In addition, many US firms will be forced to comply with the Kyoto Protocol in their international operations. Finally, the Protocol is set to expire at the end of 2012 and so

¹ Conference of the Parties to the Framework Convention on Climate Change: Kyoto Protocol, 37 I.L.M. 22, available at <http://unfccc.int/resource/docs/convkp/kpeng.pdf> (last visited April 3, 2006).

² UNFCCC, Kyoto Protocol, Status of Ratification, at http://unfccc.int/essential_background/kyoto_protocol/status_of_ratification/items/2613.php (last visited June 5, 2006). The Kyoto Protocol entered into force on the ninetieth day after at least 55 Parties to the Convention, including Annex 1 parties accounting for at least 55% of total 1990 carbon dioxide emissions ratified the treaty. UNFCCC *supra* note 1 at Ar. 25.1.

³ Daniel Bodansky, *Bonn Voyage: Kyoto's Uncertain Revival*, THE NATIONAL INTEREST, at 45 (Fall 2001).

⁴ Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont, Regional Greenhouse Gas Initiative Memorandum of Understanding (Dec. 20, 2005) available at <http://www.rggi.org/agreement.htm> (last visited June 5, 2006).

⁵ California Public Utilities Commission, Order Instituting Rulemaking to Promote Policy and Program Coordination and Integration in Electric Utility Resource Planning, Opinion on Procurement Incentives Framework, Decision 06-02-032 (Feb. 16, 2006), available at http://www.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/53720.htm (last visited, June 5, 2006).

negotiations for a future global warming treaty, including its market-based components, are now underway.⁶

The effort to curb global warming will not be easy and will almost certainly be costly. Motivating the necessary expenditures will require that the policies implemented to achieve a stable climate are both environmentally sound and cost-effective. This paper contributes to that process by presenting a critical empirical analysis of the current market for greenhouse gases (“GHGs”) under the Protocol. It is almost certain that any future global warming treaty will include market-based solutions. These markets for pollution, if they are to succeed in accomplishing a future treaty’s environmental goals, need to both incorporate the successes and eliminate the shortcomings of what has come before. Given the rapid development of the Kyoto Protocol GHG markets over the last 18 months and the incipient negotiations on a future treaty, the time is ripe for such an analysis.

The Clean Development Mechanism (“CDM”) a market based trading mechanism created by the Kyoto Protocol,⁷ functions by delivering a subsidy to the developing world in return for lower emissions of greenhouse gases. The subsidy offsets the cost of reducing GHG emissions, thereby encouraging less developed countries to emit less GHG than they otherwise would. As such, it represents the first attempt to address a global atmospheric commons problem using a global market. During the past 18 months, the CDM took on roughly the shape that it will likely have during the first commitment period of the Kyoto Protocol⁸. The goal of this paper will be to describe in some detail what that broad outline looks like and also what it can teach us about the design of future treaty architectures aimed at the control of GHG emissions and global warming.

The CDM was designed around the insight that the marginal cost of emissions reductions in developing, and especially rapidly developing, countries would be less than for developed ones.⁹ The idea was that paying to build efficient, low GHG emitting

⁶ Andrew C. Revkin, *U.S., Under Fire, Eases Its Stance In Climate Talks*, NEW YORK TIMES, Dec. 10, 2005, at A1.

⁷ *Id.*, at Ar. 12.

⁸ The first commitment period extends from January 1, 2008 to December 31, 2012. UNFCCC *supra* note 1, at Ar. 3.1.

⁹ See Michael A. Toman, Richard D. Morganstern & John Anderson, *The Economics of “When” Flexibility in the Design of Greenhouse Gas Abatement Policies*, Resources for the Future Discussion Paper 99-38-REV, 2-3, (1999).

industrial and energy facilities in the developing world as they were built would be far cheaper than prematurely scrapping or attempting to modify existing developed world capital stock.¹⁰ By means of the CDM, carbon dioxide (“CO₂”) emission reductions could occur in the developing world that would otherwise have occurred in the developed world at far higher cost.¹¹ Cost expectations focused on energy systems. The expectation was that by putting a price on CO₂ emissions in the developing world and linking that price to developed world cap and trade markets for CO₂, costs of CO₂ emission reductions in the developed world would be reduced. This paper will show that what has in fact occurred is something far different: the CDM has primarily proffered an exchange of CO₂ reductions in the developed world for reductions of various non-CO₂ gases in the developing world. Furthermore, because the price paid for reductions has become tied to the major developed world cap and trade market, the European Union Emissions Trading Scheme (“ETS”), a CO₂ only market, the price paid is between 10 and 100 times greater than the cost of most of these reductions.

The CDM can be looked at as a subsidy, a market, and a political mechanism. It is a subsidy in that it pays developing countries to pollute less than they otherwise would. It is a market in that its subsidy is delivered through the creation of Certified Emissions Reductions (“CERs”), tradable credits also usable as compliance instruments for developed nations’ Kyoto obligations. It is a political mechanism in that it induces developing world participation in the Kyoto Protocol. It is essential to evaluate the CDM’s performance using metrics appropriate to both subsidy/foreign aid, to markets, and to political mechanisms. Typically, a subsidy is evaluated in terms of the efficiency with which it produces a desired outcome for the subsidizer. Minimum cost for maximum outcome is the desired result. In evaluating the performance of a market-based trading mechanism for an environmental good, one may instead ask whether the market was efficient at identifying the lowest marginal cost supplier of an environmental good, in this case emissions reductions and whether supply and demand produced a price that reflected these costs. This political mechanism should be evaluated from the perspective

¹⁰ Janet Yellen, Prepared Testimony of Janet Yellen Chair, Council of Economic Advisors Before The House Commerce Committee Energy and Power Subcommittee (Mar. 4, 1998), *in* Federal News Service, Mar. 4, 1998, at 5.

¹¹ Toman et al., *supra* note 9, at 2-3.

of the goal it hoped to accomplish and from past experience with similar programs. The goal in the CDM's case is meaningful participation by the developing world in the global project of reducing GHG emissions. Relevant comparisons to other programs would compare the CDM's performance to date with other domestic and international atmospheric gas trading regimes. Ideally, the three types of evaluation produce similar conclusions. I will argue that they do not.

The CDM is neither functioning well as a market for emissions reductions nor is it a successful subsidy. As a result, it is creating skewed but powerful political institutions and interest groups whose interests are not aligned with the ultimate goals of either the UNFCCC or the Kyoto Protocol. Given the relatively poor performance, at least initially, of other markets for atmospheric pollution, this result is perhaps not entirely surprising nor should it be seen as a reason to abandon the CDM.

The CDM fails as a market because it has animated accounting tricks that allow participants to manufacture CERs at little or no cost. It fails as a subsidy because the developed world has had to purchase these emissions reductions at an extremely high premium that bears no relation to their cost. The CDM, even as it is supplying CERs to developed world parties to the Kyoto Protocol at prices that are less than they would otherwise have to pay, is an excessive subsidy that represents a massive waste of developed world resources. It is probably too late to change the structure of the CDM in order to address its shortcomings prior to the end of the first commitment period.¹² The aim of this paper is to argue that in the period after 2012, the financial resources currently devoted to the current CDM architecture might be far more efficaciously allocated in the international effort prevent global warming.

Further, I will argue that this goal need not compromise the notable success of the CDM as a political mechanism. For the CDM has produced remarkable participation on the part of the developing world in the Kyoto Protocol. Indeed, participation has been most active in those countries with relatively high rates of economic growth. In other words, exactly the developing countries whose efforts are most needed to help resolve the global warming problem. This notable achievement, quite at odds with the results of

¹² The Kyoto Protocol's First Commitment Period, the interval of time during which developed world parties to the treaty must comply with quantified emissions limits, extends from 2008 to 2012. *Supra* note 1, at Ar. 3.

similar offset based systems in the United States need not be sacrificed at the expense of environmental and cost effectiveness in a future international regime.

One possibility that might resolve the inefficiencies that currently exist in the CDM would be to recognize that although the six GHGs regulated by the Kyoto Protocol should also be regulated by any future climate regime, any future treaty or treaties should address each gas separately, at least so far as subsidized abatement is concerned. Instead, of one agreement incorporating a conversion factor for each GHG, a future climate regime might be composed of multiple agreements, each aimed at combating particular types of GHG emission. This de-linking would be based upon the economic costs and complexity of emission reduction. When compared to a theoretical ideal in which international trading in all markets for all gases was allowed, such a system would no doubt be sub-optimal. The goal of this paper will be to show that it would be a significant improvement over what the actual system of GHG trading has produced.

Currently, the Kyoto Protocol allows for the conversion of emissions of one gas into another based upon their global warming impacts¹³ rather than upon any calculation of the costs or complexity of abatement strategies. In terms of atmospheric chemistry, this conversion via each gas's 100-year global warming potential ("GWP")¹⁴ arguably makes good sense. However, the use of GWPs to allow conversion of emissions reductions of non-CO₂ gases to CO₂ emissions reductions leads, as will be explained, to many of the problems currently faced by the CDM. Addressing each gas as a separate problem in any post-2012 climate treaty would allow two improvements over the current regime. First, it would be possible to make sharp reductions in GHG emissions of non-CO₂ gases by paying a relatively small number of current emitters to abate at a much lower cost than is currently the case. This would allow relatively uncontroversial, low-cost early action on certain classes of emissions. Second, separate regimes for each gas would allow for the creation of a more sensible trading program involving CO₂ only, derived principally from energy systems but including other large emitters. Such a

¹³ UNFCCC *supra* note 1 at Ar. 3, Ar. 5 ¶ 3, Annex A. The Kyoto Protocol regulates carbon dioxide equivalent emissions defined in terms of a GHGs Global Warming Potential ("GWP") as defined by the Intergovernmental Panel on Climate Change ("IPCC").

¹⁴ A gas's GWP is defined as the relative ability of 1kg, compared with 1 kg of CO₂, to warm the atmosphere over a 100-year time horizon. Thus each gas is assigned a multiplier, ranging from 1 for CO₂ to as high as 22,200 for sulfur hexafluoride ("SF₆"). IPCC, CLIMATE CHANGE 2001, THE SCIENTIFIC BASIS, p. 388 (2001), available at http://www.grida.no/climate/ipcc_tar/wg1/248.htm (last visited on Apr. 6, 2006).

program has a good chance of substantially accomplishing most of the original goals of CDM. GWPs highlight the importance of addressing small but significant emissions of certain GHGs. They also lead to substantial unintended consequences if allowed to serve as a defacto currency exchange rate in a global market for GHG emissions reductions.

In what follows, I will first briefly introduce the Kyoto Protocol and the Clean Development Mechanism. Then I will present a description of the current state of supply to the CDM market. Next I will analyze the economic incentives presented by the CDM to several specialized industries that produce small quantities of very potent greenhouse gases. Finally, I will describe how the price of and demand for emissions reductions has evolved over the previous two years and speculate as to future trends. I will conclude with an evaluation of the overall efficacy of the CDM, suggest how, in the post-Kyoto period, to modify the subsidy to developing nations aimed at inducing their continued participation in the effort to curb global warming, and offer several possible routes of transition from the current treaty architecture to a superior future one.

II. The Kyoto Protocol and the Clean Development Mechanism

A. The Kyoto Protocol

The international agreements aimed at controlling greenhouse gas emissions are hierarchically structured. The most general and overarching agreement, known as the United Nations Framework Convention on Climate Change (“UNFCCC” or “Convention”), adopts as its goal to stabilize GHG concentrations in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system.¹⁵ The UNFCCC has been signed and ratified by 189 countries,¹⁶ including all the major emitters of greenhouse gases.¹⁷ Although the goal defined by the

¹⁵ United Nations Framework Convention on Climate Change, May 9, 1992, 31 I.L.M.849, at Ar. 2, available at <http://unfccc.int/resource/docs/convkp/conveng.pdf> (last visited Apr. 3, 2006).

¹⁶ UNFCCC, Status of ratification, at http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php (last visited, May 30, 2006).

¹⁷ Compare UNFCCC, United Nations Framework Convention on Climate Change Status of Ratification, available at http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/ratlist.pdf (last visited Apr. 3 2006) with UNFCCC, GREENHOUSE GAS EMISSIONS DATA FOR 1990-2003 SUBMITTED

UNFCCC is very ambitious, the Convention contains no provisions that compel action to accomplish it. Rather, it lays out a process through which various protocols containing more specific commitments might be negotiated.¹⁸ The first of these protocols was negotiated at Kyoto in 1997.¹⁹ The Kyoto Protocol as it has come to be called, establishes binding caps on emissions for developed nation parties and parties with economies in transition (“Annex I parties” or “Annex I nations”).²⁰ These caps are limits on emissions of GHGs during the 2008-2012 period.²¹ The caps are set as reductions below each party’s 1990 emission level²² of six GHGs: CO₂, methane (“CH₄”), nitrous oxide (“N₂O”), hydrofluorocarbons (“HFCs”), perfluorocarbons (“PFCs”), and sulfur hexafluoride (“SF₆”).²³ Emissions reduction commitments specified by the Kyoto Protocol are typically 5-8% below the emissions baseline, although some parties successfully negotiated a commitment of no reduction below the baseline or even an increase above it.²⁴ Additionally, different levels of economic growth or stagnation since 1990 mean that while some Annex 1 nations face steep cuts, others actually have excess allocations.²⁵

The Kyoto Protocol includes various “flexible mechanisms” aimed at reducing the cost of compliance for the Annex I parties. These include provisions allowing parties to trade their allowable emissions (“assigned amount units” or “AAUs”)²⁶ so long as such trading is supplemental to domestic actions.²⁷ Also included are provisions allowing Annex-1 parties to pay for emissions reductions additional to what otherwise would have occurred within other Annex I parties and then credit these reductions against their own assigned amount units.²⁸ This is known as Joint

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, (2005) at 21, 92-94, *available at* http://unfccc.int/resource/docs/publications/key_ghg.pdf (last visited Apr. 3, 2006). I define major emitters of greenhouse gases somewhat arbitrarily as those nations emitting more than 500 million metric tons (“Mt”) of CO₂ or its equivalent in other GHGs (CO₂e) per year. As of their latest reports of GHG emissions to the UNFCCC, this list included Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, the Russian Federation, Ukraine, the United Kingdom of Great Britain and Northern Ireland, the United States, and collectively, the European Union.

¹⁸ UNFCCC *supra* note 15 at Ar. 7, 17.

¹⁹ UNFCCC *supra* note 1, at Art. 28.

²⁰ *Id.* at Art. 3. Note that not all Annex 1 nations of the UNFCCC adopted commitments under Annex B of the Kyoto Protocol. The most notable of these are the United States and Australia. This paper will use the terminology “Annex I” nation or party to refer to a signatory that did adopt such a commitment. Other workers refer to these nations as “Annex B” nations or parties.

²¹ *Id.*

²² *Id.* at Art. 3, Annex B.

²³ *Id.* at Annex A.

²⁴ *Id.* at Annex B.

²⁵ *Compare*, UNFCCC, *supra* note 1. at Annex B with UNFCCC, Total Aggregate Greenhouse Gas Emissions of Individual Annex I Parties, 1990-2003, *available at* http://ghg.unfccc.int/graphics/graph1_05.gif (last visited Apr. 6, 2006). The most notable of these countries are Russia and Ukraine. Another nation whose compliance was made far easier by the chosen baseline is Germany. Germany’s allocation includes that of the former East Germany, where heavy industry and power demand collapsed after unification, thus leading to a large decrease in emissions relative to allocation and making the unified Germany’s and hence the European Union’s compliance challenge much more tractable.

²⁶ UNFCCC *supra* note 1. at Art. 3 ¶ 7.

²⁷ *Id.* at Art. 17.

²⁸ *Id.* at Art. 6.

Implementation (“JI”).²⁹ Finally, Annex I parties may pay for emissions reductions that are additional to those that otherwise would have occurred within a developing (“Non-Annex I”) nation that is a party to the protocol. The purchasing Annex I nation may then credit these emissions reductions against its assigned amount units. This provision is known as the Clean Development Mechanism.³⁰

The Kyoto Protocol was ratified by a sufficient number of Annex I nations to enter into force³¹ and by numerous non-Annex I parties³² but was not ratified by either the United States or Australia.³³ In addition, it now appears at least possible if not likely that one Annex I party, Canada, will either withdraw or fail to comply with the Protocol.³⁴ In order to induce a sufficient number of Annex I parties to ratify the treaty for it to enter into force, significant concessions were made to particular parties. Notably, the Russian Federation and Ukraine were allowed to join the Protocol with commitments of a 0% reduction below 1990 levels even though by the time of the negotiations, their actual emissions were far below the 1990 baseline because of the post-Soviet economic contraction.³⁵ These nations were able to join the Kyoto Protocol without fear of facing emissions reductions and with the prospect of future sale of their excess AAUs to countries that faced real cuts.³⁶

Before and after its entry into force, the Kyoto Protocol has been severely criticized. It has been criticized for doing little to combat global warming.³⁷ It has been criticized for being economically inefficient in requiring nations to reduce emissions too quickly.³⁸ It has been criticized for utilizing absolute emissions caps rather than

²⁹ JOANNA DEPLEDGE (UNDER CONTRACT TO THE UNFCCC), TRACING THE ORIGINS OF THE KYOTO PROTOCOL: AN ARTICLE-BY-ARTICLE TEXTUAL HISTORY, at 61, 64, U.N. Doc. FCCC/TP/2000/2 (2000), available at <http://unfccc.int/resource/docs/tp/tp0200.pdf> (last visited, Apr. 3, 2006).

³⁰ UNFCCC *supra* note 1, at Ar. 12.

³¹ *Id.* at Ar. 25 (At least 55 parties to the protocol representing at least 55% of 1990 emissions of GHGs must ratify for the treaty to enter into force.); UNFCCC, Kyoto Protocol Status of Ratification, available at http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf (last modified Feb. 28, 2006; last visited Apr. 3, 2006).

³² UNFCCC, KYOTO PROTOCOL STATUS OF RATIFICATION, available at http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf (last modified Feb. 28, 2006; last visited Apr. 3, 2006).

³³ *Id.*

³⁴ See, Doug Struck, *Canada Alters Course on Kyoto*, WASH. POST, May 3, 2006, at A16.

³⁵ Victor, David G., Nakicenovic, Nebojsa, and Victor, Nadejda, *The Kyoto Protocol Emission Allocations: Windfall Surpluses for Russia and Ukraine*, 49(3) CLIMATIC CHANGE, 263-277 (2001).

³⁶ Bernard, Alain, Paltsev, Sergey, Reilly, John M., Vielle, Marc, and Viguier, Laurent, *Russia’s Role in the Kyoto Protocol*, MIT Joint Program on the Science and Policy of Climate Change Report No. 98, 1-3 (2003), available at http://web.mit.edu/globalchange/www/MITJPSPGC_Rpt98.pdf (last visited Apr. 6, 2006).

³⁷ William Nordhaus, *Global Warming Economics*, 294 SCIENCE, 1293 (2001).

³⁸ Joseph A. Aldy, Scott Barrett, and Robert N. Stavins, *Thirteen Plus One: A Comparison of Global Climate Policy Architectures*, *Climate Policy* 3, at 391 (2003). For the argument that economically efficient greenhouse gas reduction trajectories differ little from business as usual in the short term but substantially from it in the long term, see, Alan S. Manne and Richard G. Richels, *On Stabilizing CO2 Concentrations – Cost-Effective Emission Reduction Strategies*, 2(4) ENVIRONMENTAL MODELING AND ASSESSMENT, at 251-265 (1997).

emissions intensity targets or a carbon tax.³⁹ It has been criticized for not committing the largest developing nations, most notably China and India, to binding emissions reductions.⁴⁰ Finally, its flexible mechanisms have been criticized as dependent on counterfactuals, namely an emissions baseline, that is either unknowable or politically determined.⁴¹ As a part of this criticism, at least 13 modified treaty architectures have been offered as alternatives or as improvements for the post-2012 period.⁴²

The most common response to these criticisms is that the Kyoto Protocol has been, since its negotiation in 1997, the only game in town when it comes to controlling global warming. Further, it has spurred the emergence and growth of institutions and capacities that will likely endure beyond its existence albeit perhaps in altered and improved form. Some of the most notable diplomatic successes of the twentieth century were the result of long series of negotiations and agreements. Institutions like the GATT and its successor, the WTO, and perhaps most of all, the European Union, that have ultimately delivered tremendous benefits to their members, began with modest and limited agreements. Members were not afraid to tinker with these institutions as they learned by doing. The Kyoto protocol has given birth to a whole set of institutions and has fostered capacity development both in the developed and developing world that will prove invaluable in ultimately overcoming the challenge presented by climate change.

This paper's aim is to take a close look at the actual, as opposed to the theoretical outcome of one of the Kyoto Protocol's most significant creations, a global market for GHG emission offsets. Most or all of the criticisms of the Protocol were made prior to the development of a substantial track record for the CDM or the other flexible mechanisms and so were of necessity theoretical in nature. Although to date there has been little use of Joint Implementation and no purchase and sale of AAUs, there has been an explosion of activity under the CDM that now provides a basis for an empirical critique of the Protocol. This critique aims not at undermining the rationale for the protocol but at understanding how, in the next phase of the international effort to avoid "dangerous interference" with the world's climate, trading can accomplish more than it has or is likely to under the Kyoto regime.

³⁹ William Pizer, *The Case for Intensity Targets*, Resources for the Future Discussion Paper 05-02, at 1-2 (2005). The case for setting intensity targets, which limit a country's CO₂ emissions per dollar of GDP is a consequence of Weitzman's insight that when uncertainty exists as to costs of abatement and the slope of the marginal benefit of abatement curve for an environmental good is relatively flat, a tax rather than a quantity control leads to a superior welfare outcome. See, William A. Pizer, *Prices vs. Quantities Revisited: The Case of Climate Change*, Resources for the Future Discussion Paper 98-02, at 3-4; M. L. Weitzman, *Prices vs. Quantities*, 41 REVIEW OF ECONOMIC STUDIES, 477-491.

⁴⁰ Yellen *Supra* note 10, at 3; George W. Bush, Letter from the President to Senators Hagel, Helms, Craig, and Roberts (Mar. 13, 2001) available at <http://www.whitehouse.gov/news/releases/2001/03/20010314.html> (last visited May 4, 2006). Note that developing nations are involved in the Kyoto Protocol through the CDM and so this criticism is of the extent of their involvement. UNFCCC, *supra* note 1, at Art. 12.

⁴¹ Chi Zhang, Thomas C. Heller, and Michael M. May, *Carbon Intensity of Electricity Generation and CDM Baseline: Case Studies of Three Chinese Provinces*, 33(4) ENERGY POLICY, 451 (2005).

⁴² Aldy et al., *supra* note 38, at 373.

B. Clean Development Mechanism

1. Structure of the CDM

The CDM is an attempt at a market-based solution for addressing the problem of global warming. It builds on experience derived from various regional markets for atmospheric pollutants, most notably the United States' experience with emissions trading under the Clean Air Act.⁴³ However, in contrast to previous market based atmospheric contaminant programs, CDM is not a cap and trade system because the host nations of CDM projects have no binding cap. The non-Annex I sellers of Certified Emission Reductions ("CERs"), the currency of the CDM system, have no limit to the mass of GHGs that they may emit under the Kyoto Protocol. This absence of a cap in the trading system necessitates a radically different and far more complex design than had been attempted for most previous pollution markets. Adding further complexity to the program is the fact that the CDM is the first atmospheric pollutant trading program that covers multiple gases and allows conversion between them through the medium of the common currency, CERs.

The clean development mechanism is a project-based system. This means that it accomplishes its objectives at the relatively fine-grained scale of individual projects that are validated by designated entities and registered with the CDM Executive Board ("CDM EB"), the mechanism's governing body, rather than at an industry or sector-wide scale. Each project wishing to participate in the CDM must prepare a Project Design Document ("PDD") that explains in detail how its future emissions reductions will be real, additional, and not induce leakage. It must also prepare a monitoring methodology that explains in detail how it will monitor emissions reductions made by the project. A project may also utilize a previously approved monitoring methodology. Real emissions reductions are ones that are monitored with sufficient care to insure that they actually occur. Additional emissions reductions are ones that are in addition to any that would have occurred absent the CDM subsidy. Leakage of emissions occurs when emissions reductions that would have occurred within a project absent the CDM subsidy instead occur outside it because of the subsidy.

All three of these concepts require that a hypothetical baseline of emissions be defined for each project, and in the case of leakage, the world outside the project. This baseline represents the timeline of emissions that would have occurred absent the subsidy provided by the CDM (and thus absent the emission reduction project). It is an attempt to represent the counterfactual of business as usual emissions in a world without CDM. The CDM project baseline is described in terms that vary by the project type. Nevertheless, several common variables can be seen in most PDDs.⁴⁴

⁴³ Yellen, *supra* note 10, at 5; *see also*, Robert W. Hahn and Gordon L. Hester, *Where Did All the Markets Go? An Analysis of EPA's Emissions Trading Program*, 6 YALE J. ON REG., 109, 151-153, detailing the successes and disappointments of the EPA program and suggesting that many of the program's failings stemmed from the need of regulators to satisfy multiple constituencies with divergent objectives.

⁴⁴ PDDs follow a standardized format that includes a general description of the project, a description of how the baseline for the project is determined, a specification of the duration of the project, an explanation

Project proponents often describe the regulatory baseline, that is, the flux of emissions permitted by local law and regulation.⁴⁵ They often describe the financial baseline, that is, the lack of an adequate return on investment without the benefit of the CDM subsidy.⁴⁶ They often describe typical technologies applied by the type of project in the PDD and how the CDM subsidized project exceeds these local standards.⁴⁷ Finally, they sometimes must describe a sectoral or national baseline for installations of the project type.⁴⁸ Ultimately, the CDM project proponents must quantify the hypothetical emissions that would have occurred in the future without the CDM project subsidy. Of course, project proponents and environmental regulators do not live in a world without CDM. As will be shown below, they have, given the potential for foreign subsidies, acted strategically in order to maximize many projects' baselines and so maximize the potential for the generation of CERs. The fact that most industries involved in CDM projects are already highly regulated makes this strategy attractive and not difficult to implement. An environmental regulator faced with the choice of preventing an emission with a domestically costly regulation or allowing it to be prevented by domestic polluters being paid a subsidy from an extra-national entity will have obvious political incentives for selecting the international subsidy over new regulation.

The end product of the CDM process is the issuance by the CDM EB of an emissions offset to the project participants. This offset can then be sold to an Annex I nation or a party within one that has obligations under the Kyoto Protocol. The offset, called a certified emission reduction or CER, assuming that certain CDM facilities are established, may be used by Annex I countries in lieu of emissions reductions within their territories for meeting emissions reductions targets.⁴⁹ Private parties that have been assigned emissions allowances by their governments may also purchase CERs and use them as permits to emit in excess of their assigned allocations or as an alternative to purchasing allocations from other participants in their domestic market.

of how the project's emissions reductions will be monitored, a quantitative estimate of the projects emissions reductions, a discussion of any other environmental effects of the project, and finally a synthesis of comments on the project by local stakeholders. CDM Executive Board, UNFCCC, Guidelines for Completing the Project Design Document (CDM-PDD), The Proposed New Methodology: Baseline (CDM-NMB) and the Proposed New Methodology: Monitoring (CDM-NMM) Version 04 (Jul. 8, 2005), at <http://cdm.unfccc.int/Reference/Documents> (last visited May 5, 2006).

⁴⁵ See, e.g., INEOS Fluor Limited, HFC Decomposition Project in Ulsan, CDM Project Design Document 0003, 17, available at <http://cdm.unfccc.int/Projects/JQA1094478108.13/view.html> (last visited May 4, 2006).

⁴⁶ See, e.g., Beijing Guotou Energy Conservation Company, Zhangbei Manjing Windfarm Project, CDM Project Design Document 0233, 9-11 (2005), available at <http://cdm.unfccc.int/Projects/DNV-CUK1136989231.92/view.html> (last visited May 4, 2006).

⁴⁷ Equipav S.A. Acucare e Alcohol-Equipav and Ecoenergy Brazil Ltda., Equipav Bagasse Cogeneration Project (EBCP), CDM Project Design Document 0205, 13-14 (2005), available at <http://cdm.unfccc.int/Projects/TUEV-SUED1135284723.4/view.html> (last visited May 4, 2006).

⁴⁸ See, e.g., Godawari Power and Ispat Limited, Waste Heat Based 7 MW Captive Power Project, CDM Project Design Document 0264, 35 (2006), available at <http://cdm.unfccc.int/Projects/SGS-UKL1139564002.3/view.html> (last visited on May 4, 2006).

⁴⁹ *Supra* note 1, at Art. 12.3(b).

The EU and Japan will be the likely major purchasers of CERs during the first commitment period.⁵⁰

The official public process leading to the production of CERs by a CDM project begins with the submission of its PDD to the CDM EB for a period of public comment. This comment process is a part of a project's validation by an independent Designated Operational Entity ("DOE").⁵¹ The project must also receive approval from its host country Designated National Authority ("DNA"), typically the host country's environmental ministry or agency, before being submitted for registration to the CDM EB.⁵² Once registered, a project must submit monitoring reports providing data to show how many CERs have actually been generated during a particular period. These reports must be both consistent with the monitoring plan as spelled out in a project's PDD and have been certified by a DOE.⁵³ At that point, the CDM EB will issue CERs into a project participant's account.⁵⁴ These CERs will eventually be transferable to a buyer who establishes an account with the International Transaction Log, a yet to be constructed database of Kyoto Protocol GHG accounts.⁵⁵

2. Goals of the CDM

The Clean Development Mechanism was created with three goals. First, it aims to accomplish the overarching goals of the Framework Convention. Second, it aims to encourage sustainable development in Non-Annex I nations. Third, the CDM is intended to reduce the cost of compliance with the Protocol for Annex-1 nations.

The Clean Development Mechanism is intended, according to the Protocol, to help in accomplishing the goal of the Convention of "prevent[ing] dangerous interference" with the climate system.⁵⁶ It aims to do this by assisting developing countries in reducing their emissions of GHGs. Thus the CDM is a significant and

⁵⁰ POINT CARBON, CARBON 2006: TOWARDS A TRULY GLOBAL MARKET, 5 (2006), *on file with author*. Canada was also likely to have been an important purchaser of CERs but actions by its recently elected conservative government have made it doubtful that it will comply with the Protocol. See, Doug Struck, *Canada Alters Course on Kyoto, Budget Slashes Funding Devoted to Goals of Emissions Pact*, Washington Post, May 3, 2006, at A16.

⁵¹ UNITED NATIONS ENVIRONMENT PROGRAM ("UNEP"), LEGAL ISSUES GUIDEBOOK TO THE CLEAN DEVELOPMENT MECHANISM, 32-34 (2004), *available at* cd4cdm.org/Publications/CDM%20Legal%20Issues%20Guidebook.pdf (last visited May 4, 2006).

⁵² *Id.*

⁵³ *Id.*

⁵⁴ *Id.*

⁵⁵ UNFCCC SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE, CHECKS TO BE PERFORMED BY THE INTERNATIONAL TRANSACTION LOG, at 3-4, 22nd Sess., Item 5(d), FCCC/SBSTA/2005/INF.3 (13 May, 2005) *available at*, unfccc.int/files/meetings/unfccc_calendar/pre-sessional/application/pdf/inf03.pdf (last visited May 4, 2006).

⁵⁶ UNFCCC *supra* note 1, at Art. 12.2.

indeed the only way in which Non-Annex I signatories to the Kyoto Protocol will contribute towards achieving its goals. A not unrealistic hope for the CDM was that by providing Non-Annex I nations with financial incentives for low-carbon intensity development, these nations' development paths might be nudged onto more climate friendly paths and engaged for the long haul.

The second CDM objective, sustainable development, is left largely undefined by the Protocol or the implementing directives of later conferences of the parties.⁵⁷ To the extent that the provision has teeth, it is given them by the requirement under the CDM that the host country DNA of a project must certify that it meets the DNA's standards of sustainability.⁵⁸ Although some DNA's have prioritized particular types of projects, they have not rejected other types that would otherwise be capable of producing CERs.⁵⁹

The third CDM goal, lowering the cost of compliance for Annex I parties, was thought possible for two reasons. The majority of additional energy capacity to be built up to and during the First Compliance Period (2008-2012) would be located in the developing world where rates of economic growth were highest and energy infrastructure was least developed.⁶⁰ Also, the relative cost of prematurely retiring high-carbon-emission intensity power plants is significantly higher than building new low- or zero-carbon emission energy capacity. Thus if the CDM could be used to subsidize the substitution of new clean power capacity in the developing world for premature retirement of old dirty power capacity in the developed world, it could substantially lower the cost of treaty compliance with no change in environmental outcome since the location at which an emission reduction of a particular quantity of CO₂ takes place has no impact on the environmental benefit – lower atmospheric greenhouse gas concentrations.⁶¹ As

⁵⁷ UNFCCC *supra* note 1, at Art. 12.2.; UNEP *supra* note 51, at 49.

⁵⁸ UNEP *supra* note 51 at 49.

⁵⁹ China's official CDM policy favors renewable energy, energy efficiency, and methane capture projects but the Chinese DNA has approved numerous other types of projects. *See* Measures for Operation and Management of Clean Development Mechanism Projects in China, Sec. I, Art. 4, *available at* <http://cdm.ccchina.gov.cn/english/NewsInfo.asp?NewsId=100> (last visited May 4, 2006).

⁶⁰ ENERGY INFORMATION ADMINISTRATION, U.S. DEPARTMENT OF ENERGY, INTERNATIONAL ENERGY OUTLOOK 2005, 65, 67 (2005), *available at* <http://www.eia.doe.gov/oiaf/ieo/index.html> (last visited May 4, 2006).

⁶¹ William D. Nordhaus, *Life After Kyoto: Alternative Approaches to Global Warming Policies*, NBER Working Paper No. 11889, 6 (2005) *available at* <http://www.nber.org/papers/W11889> (last visited May 4, 2006). Because CO₂ is a well mixed atmospheric gas with a long residence time, the extent to which it

will be shown in the next sections, the vast majority of emissions reductions generated by the CDM are not of this type and are in fact, extremely inefficient in terms of the cost of the subsidy compared to the cost of environmental benefits obtained.

III. Rapid Development of CDM in 2005

The CDM project pipeline began operation in December of 2003 when the first project was accepted for public comment and validation. It was not until November of 2004 that first projects were registered by the CDM EB⁶² and not until September of 2005 that the first CERs were issued to a project participant's account.⁶³ The past 12 months have seen an extremely rapid growth in the number, type, and total volume of emissions reductions in the CDM pipeline. Figure 1 shows the number of projects completing the registration process by month since the CDM began its activities. Beginning in the second half of 2005, the registration process picked up significant steam so that by the end of April, 2006, there were 181 projects registered and so able to produce CERs for sale in the carbon market.

causes environmental harm is a function of its concentration in the atmosphere rather than the rate at which it is being added at any one time.

⁶² See UNFCCC, Registered Projects, at <http://cdm.unfccc.int/Projects/registered.html> (last visited May 4, 2006).

⁶³ See UNFCCC, CERs Issued, at http://cdm.unfccc.int/Issuance/cers_iss.html (last visited May 4, 2006).

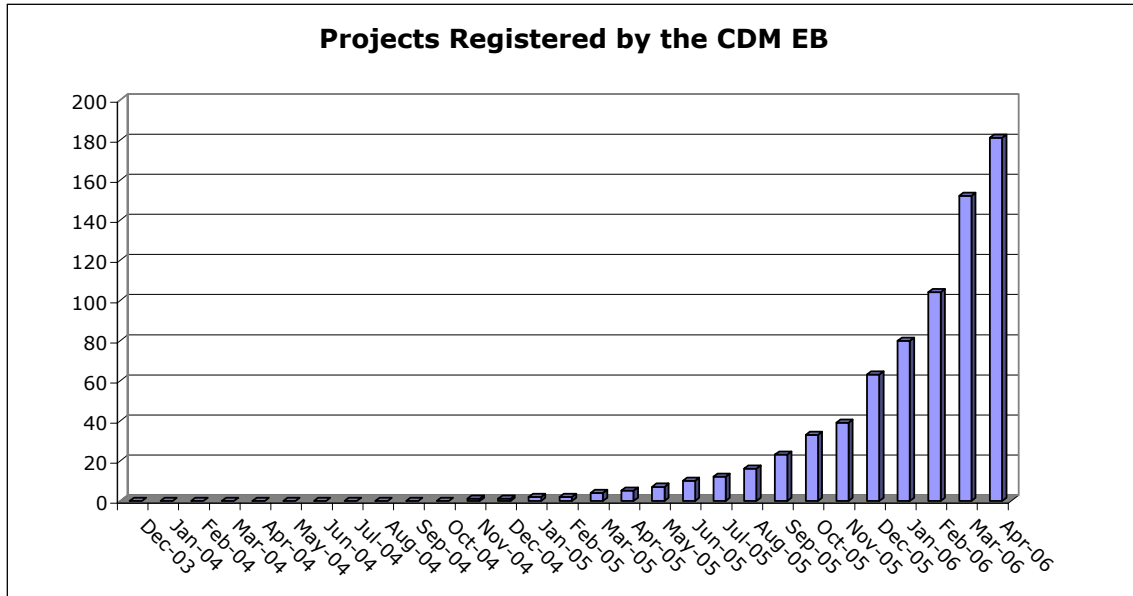


Figure 1: Number of projects registered by the CDM Executive Board since December 2003, when PDDs first entered the CDM pipeline. As of May 1, 2006, there were 181 projects registered by the CDM EB.

It was not until November of 2005 that the volume of CO₂ reductions deliverable by registered CDM projects began to grow large enough to play a significant role in Kyoto Protocol compliance. In the last quarter of 2005 and the first quarter of 2006, the potential CDM supply grew at a breakneck pace that established this flexible mechanism as an important factor in Kyoto Compliance. By April 1, 2006, more than 380 million tons (“Mt”) CO₂ equivalent (“CO₂e”)⁶⁴ had been registered for delivery via the CDM by the end of the first compliance period (See Figure 2). Another pattern emerging from the project registrations that have occurred over the past year is the dominance of large projects in the CDM. As can be seen from Figure 2, a small number of very large projects dominate the supply of CERs from registered projects. In fact,

⁶⁴ 1 ton CO₂e is the standard measure of greenhouse gas reduction under the Kyoto Protocol. It is the mass of any one of the six Kyoto gases equal to the 100-year global warming potential (“GWP”) of one ton of CO₂. GWP is defined as the time integrated radiative forcing from the release of 1 kg of a trace substance to 1 kg of CO₂. IPCC, *supra* note 14, at 385.

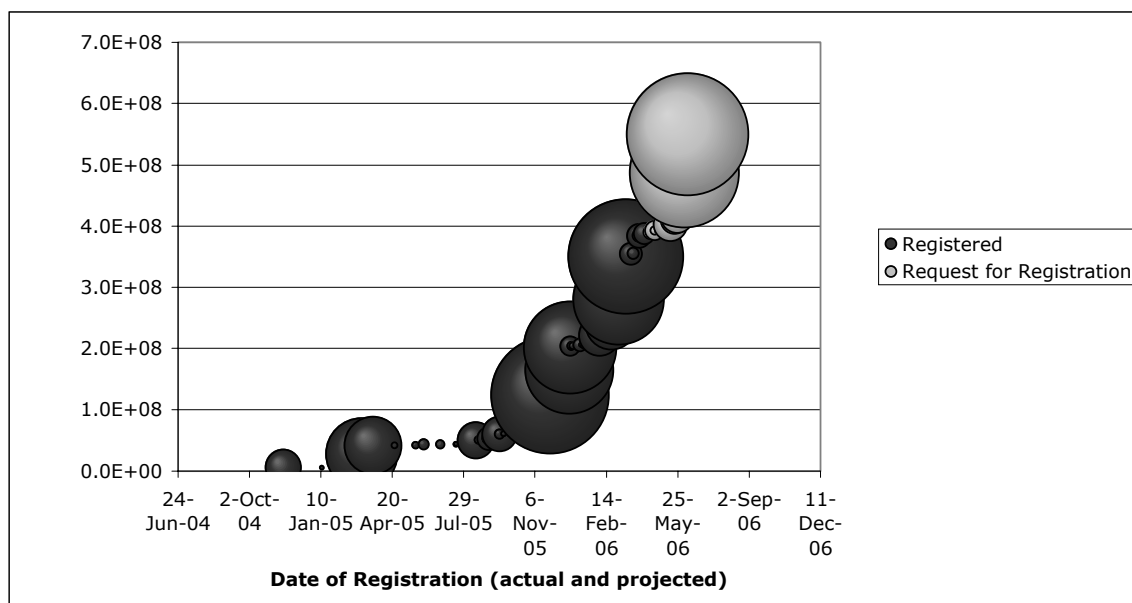


Figure 2. This figure illustrates the projects that have been registered or are about to be registered in terms of the CER supply they are projected to generate by the end of the First Compliance Period. The y-axis shows the total mass promised by December 31, 2012 of CERs to the carbon market from CDM projects; the size of each bubble shows the relative size of the particular project. The figure shows projects registered or that will be registered by June 7, 2006, if approved by the CDM EB.

the 10 largest projects (of the 221 shown here) represent 71% of the supply.

This trend of large projects dominating supply holds for the CDM pipeline as a whole, including projects registered, for whom registration has been requested, and those that have entered the validation stage. As of this writing, there are 702 projects in the CDM pipeline that will eventually, if all are registered and deliver reductions as promised in their PDD's, supply a total of 966 Mt CO₂e to the market for Kyoto Protocol compliance instruments.⁶⁵ This represents approximately 5% of Annex I 1990 GHG emissions.⁶⁶

An investment analyst focused on the carbon market estimates that there are perhaps another 500 Mt CO₂e of emissions reductions to be provided by projects that have yet to enter the pipeline but are in preparation.⁶⁷ The probability that these projects will in fact achieve registration and generate CERs for the first compliance period is a function of a number of highly uncertain variables. First, the shorter the interval before the end of the First Compliance Period, the less money to be made from CERs

⁶⁵ I count a project as in the CDM pipeline if it has advanced to the public comment phase of validation. UNFCCC, Projects open for comments at the validation stage, at <http://cdm.unfccc.int/Projects/Validation> (last visited, May 4, 2006).

⁶⁶ UNFCCC, GREENHOUSE GAS EMISSIONS DATA FOR 1990-2003 SUBMITTED TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, 15 (2005), available at http://unfccc.int/resource/docs/publications/key_ghg.pdf (last visited Apr. 3, 2006).

⁶⁷ Point Carbon, *CDM and JI Project Pipeline*, CDM-JI MONITOR, 2 May, 2006, at 3, on file with author.

and so the larger the transaction costs associated with registration and monitoring loom.⁶⁸ Second, without certainty about the shape of any future UNFCCC based trading program or subsidy, financial incentives to invest with post-2012 in mind are absent.⁶⁹ Finally, even for the 2008-2012 market, there is significant demand (and hence price) uncertainty because of the possible competition of CDM with both JI project based reductions and outright purchases of AAUs from Russia, Ukraine, and the remainder of Eastern Europe.⁷⁰ Whether these other alternatives are sought out by Annex I parties in turn depends, on the costs of domestic compliance, the price of CERs, and other political considerations.⁷¹

What was true of the 221 projects that make up the registered portion of the CER pipeline is also true of the pipeline as a whole. A small number of large projects dominate the potential supply that has reached the validation or registration

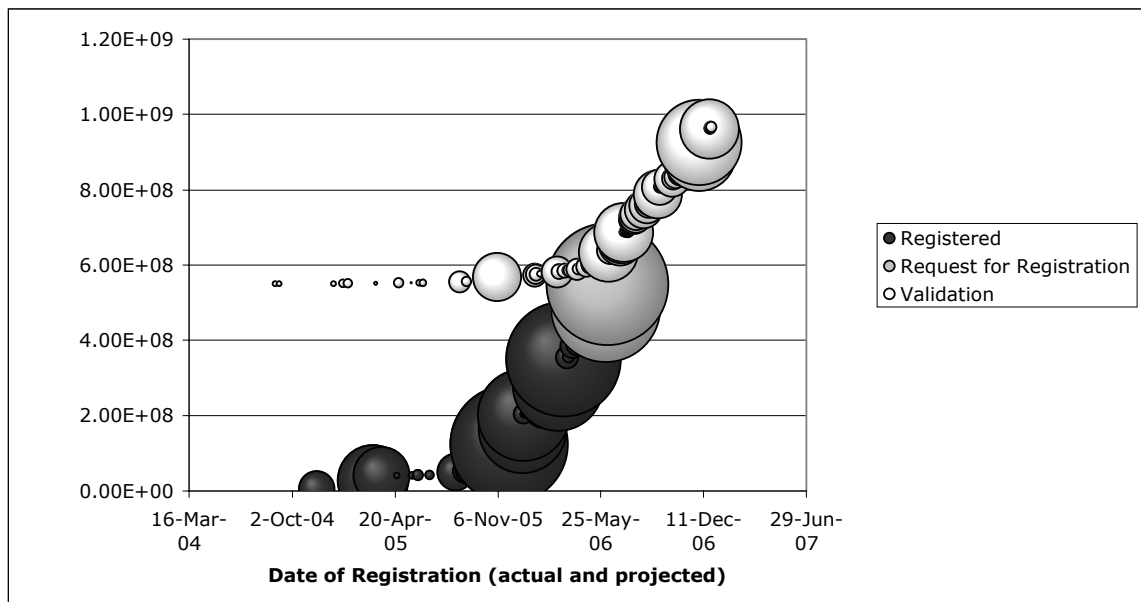


Figure 3: The total CER supply to December 2012 of all projects in the official CDM pipeline. Total supply, assuming that all projects in the CDM pipeline are registered and deliver CERs as promised in their PDDs is 966 MT CO₂e. An estimate of when validation stage projects will be registered is derived from the average time taken by currently registered projects to complete the process. Shown are projects in the CDM pipeline as of April 10, 2006.

⁶⁸ Eric Haites, ESTIMATING THE MARKET POTENTIAL FOR THE CLEAN DEVELOPMENT MECHANISM: REVIEW OF MODELS AND LESSONS LEARNED, 63-64 (2004), available at <http://carbonfinance.org/docs/EstimatingMarketPotential.pdf> (last visited on May 27 2005).

⁶⁹ *Id.*

⁷⁰ Russia was granted significant excess AAUs in negotiations leading up to its accession to the Kyoto Protocol as an inducement to join. SCOTT BARRETT, ENVIRONMENT AND STATECRAFT, 372-373 (2003). This concession, when combined with the post-Soviet economic contraction, leaves Russia with significantly lower actual emissions than its assigned amount under the Protocol. Point Carbon, *supra* note 50, at 8; Victor et al., *supra* note 35, at 263. Ukraine and the remainder of Eastern Europe also have excess assigned amount units due to economic contraction. *Id.*

⁷¹ See discussion *infra* Part VII.

phase of the CDM project process (See Figure 3). Indeed, more than 40% of the CERs promised for delivery by the more than 700 projects that have advanced to or past the validation stage can be accounted for by just 10 large projects.⁷² Taking the CDM pipeline as a whole, registered or soon to be registered projects, account for 221 out of 700 projects (32%) but 57% of the potential supply. This indicates a bias towards registration of large projects consistent with the impact that the relatively high transaction costs of the CDM project-based system impose on project proponents. It also suggests that an unknown number of smaller projects, although they have entered the official CDM process, will in fact never be registered. Since the total supply is dominated by the larger projects, this failure on the part of some fraction of small projects to achieve registration, will not significantly impact the supply of CERs to Annex I parties.⁷³

IV. Current Supply of CERs in the CDM Pipeline by Project Type

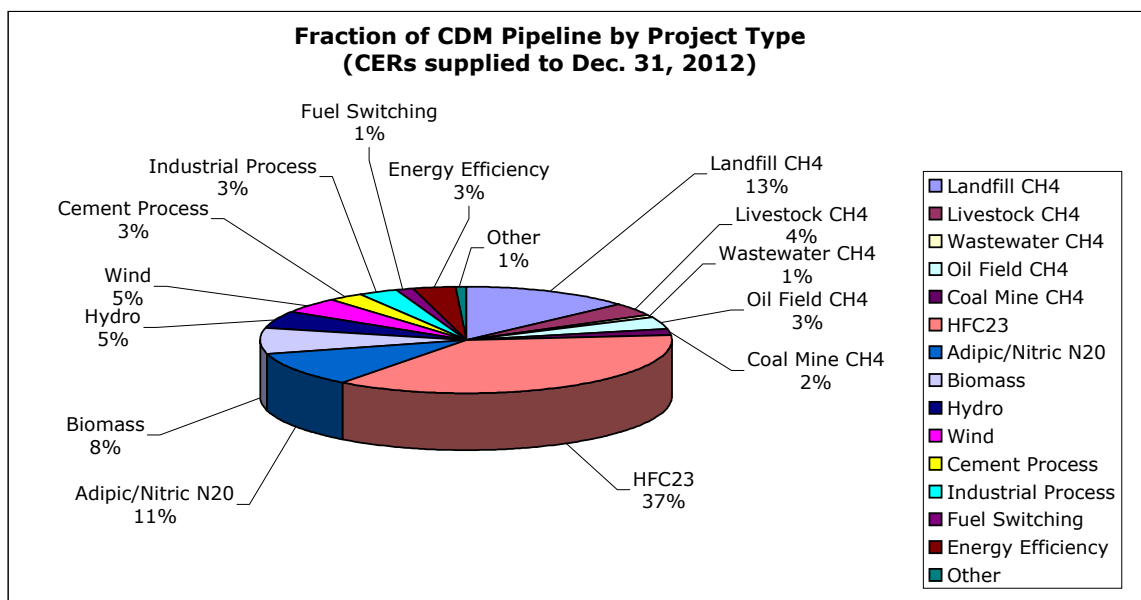


Figure 4. The fraction of CERs supplied by different project types.

The original intent of the CDM was to spur development of low-carbon energy infrastructure in the developing world both because it would achieve sustainable development goals and because it would substitute for early retirement of expensive

⁷² The CDM supply to Dec. 31 2012 of the 10 largest projects that have entered the CDM pipeline is estimated to be 409 Mt CO₂e while the pipeline as a whole has 966 Mt CO₂e. Thus more than 42% of CER supply is produced by less than 1.5% of the projects.

⁷³ For example, were the smallest third (233 of 700) of projects in the pipeline to fail to achieve registrations, total CER volume produced to Dec. 31 2012 would be reduced by only 2.7%.

high-carbon energy infrastructure in the developed world.⁷⁴ It comes as a great disappointment to find then that the CDM pipeline bears little if any relationship to this vision. Instead, the subsidy provided by purchase of CERs will largely insure that high GWP industrial gases such as HFC-23 and N₂O as well as CH₄ emitted by landfills and confined animal feeding operations (CAFOs) in non-Annex I nations are captured and destroyed. The very large projects dominating the supply of CERs are confined to two relatively obscure industries, adipic acid and HCFC-22 production. Adipic acid is the feedstock for the production of nylon-66 and produces abundant N₂O as a production byproduct.⁷⁵ HCFC-22 has two major applications. It is one of two major refrigerants that were phased in to replace the CFC's under the auspices of the Montreal Protocol to Protect on Substances that Deplete the Ozone Layer.⁷⁶ HCFC-22 is also the primary feedstock in the production of PTFE,⁷⁷ more commonly known by its Dupont brand name, Teflon. HCFC-22 production inevitably produces HFC-23 as an unwanted byproduct.⁷⁸ These two relatively small industries represent nearly 55% of the supply of CERs in the CDM to date.

Contrary to ex-ante predictions, CO₂ based projects, including renewable low-carbon energy, energy efficiency, and cement process modification projects account for just 29% of the CER supply to 2012. Renewable energy projects alone account for just 18%. 11 HFC-23 capture projects at HCFC-22 production facilities make up 37% of that supply while 3 projects that capture the N₂O made as a byproduct of adipic acid or nitric acid production account for another 11%. Finally, 140 CH₄ capture and flaring projects, mostly located at large landfills and CAFO's, account for another 24%. The bottom line is that the non-CO₂ gases dominate the supply of CERs to the carbon market, accounting for over 70% of the possible supply. Moreover, because the HFC-23, N₂O, and to a lesser extent, CH₄, projects are typically of larger size than the renewable energy projects, they are more likely to overcome the transaction costs associated with registration and production of CERs than the smaller hydro, wind, and biomass based energy projects that compose that CDMs renewable portfolio.⁷⁹

⁷⁴ See discussion *Infra* Part II(B)(2).

⁷⁵ R. A. Reimer, C. S. Slaten, M. Seapan, T. A. Koch, and V. G. Triner, *Adipic Acid Industry – N₂O Abatement: Implementation of Technologies for Abatement of N₂O Emissions Associated with Adipic Acid Manufacture*, in NON-CO₂ GREENHOUSE GASES: SCIENTIFIC UNDERSTANDING, CONTROL AND IMPLEMENTATION, PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM, NOORDWIJKERHOUT, THE NETHERLANDS, 8-10 SEPTEMBER 1999, 347, 347 (J. Van Ham, A.P.M. Baede, L.A. Meyer, and R Ybema Eds., 2000).

⁷⁶ A. McCulloch, *Incineration of HFC-23 Waste Streams for Abatement of Emissions from HCFC-22 Production: A Review of Scientific, Technical and Economic Aspects*, 2 (2005) at http://cdm.unfccc.int/methodologies/Background_240305.pdf (last visited May 4, 2006).

⁷⁷ *Id.*

⁷⁸ *Id.*

⁷⁹ Haites, *supra* note 68, at 45.

Even if renewable energy and energy efficiency projects continue to enter the CDM pipeline at their current rate, they will not equal the current combined N₂O and HFC-23 volume in the pipeline until sometime between middle 2008 and middle 2009 (Figure 5). The hypothesis that renewable energy and efficiency projects might make up even half of the CDM market in 2 to 3 years is unrealistic for a number of reasons however. First, as is explained above, the marginal economics of these projects means that they are unlikely to enter the pipeline late in the game because they will not have time to recoup their costs before the end of the first commitment period. Second, the assumption that no additional N₂O or HFC-23 projects will enter the pipeline is undoubtedly false. Although a substantial share of HFC-23 emissions in the developing world are already in the CDM pipeline, as will be detailed below, only a small fraction of the N₂O emitters that are likely to participate in the CDM have entered the pipeline. The first projects N₂O projects appeared in the pipeline almost 18 months behind the first HFC-23 projects. It is likely both based on the volume of known emissions, the favorable economics of these projects, and the small number currently participating,⁸⁰ that there will be a surge of N₂O abatement projects in 2006 and 2007.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Figure 6. An estimate of the time needed given current rates of renewable energy and energy efficiency projects entering the CDM pipeline and achieving registration of the time necessary for their total volume to equal the current volume of N₂O and HFC-23 projects in the CDM pipeline.

To date, relatively small numbers of CERs have actually been issued. This slow trickle will likely turn to a flood in the coming year as registered projects begin submitting monitoring reports to the CDM EB. In order for issuance of a CER to occur, a 3rd party monitor must audit a CDM project and certify that monitoring of

⁸⁰ See, *infra* Part VI(B).

the emissions reductions was adequate to ensure that they actually occurred⁸¹. Submission of this report to the CDM executive board will then cause the issuance of CERs to that project participant's account.⁸² The first CERs were issued by the CDM EB in late October 2005.⁸³ As of April 10, 2006, only 4.47 Mt CO₂e have been deposited into project participant accounts.⁸⁴ The fact that almost all of these issuances are to HFC-23 abatement projects (97%) is likely due to the superior financial and logistical capacity of these projects relative to either the CH₄ or renewable energy projects. The absence of N₂O derived CERs so far is likely due to the relatively recent registration of the two adipic acid projects. The pattern most evident in the early issuances of CERs is the dominance of large projects over small in terms of actually producing emissions reductions. Early issuance shows once again that the barrier represented by transaction costs is more substantial for small CDM projects. As discussed above, the classes of small and large projects are largely coextensive with the CO₂ projects versus the N₂O, HFC-23, and to a lesser extent CH₄ projects.

Contrary to theory and expectation, the CDM market is not a subsidy cum market mechanism by which CO₂ reductions that would have taken place in the developed world take place in the developing world. Rather CDM subsidies are paying for the substitution of CO₂ reductions in the developed world with reductions in developing world emissions of industrial gases and methane. Indeed, the types of emissions that make up the bulk of the CDM reductions do not even occur in the developed world, not because of an absence of adipic acid or HCFC-22 manufacture, but because Annex I industries, after recognizing the threat posed by these emissions and the low cost of abating them, have opted to voluntarily capture and destroy them.⁸⁵

While renewable energy projects do make up 384 of 700 (55%) of projects in the CDM project pipeline, they account for only 18% of the emissions reductions produced. It's important to also note that a significant proportion of the CERs generated by biomass projects are from the CH₄ emissions avoided because biomass is burned rather than allowed to biodegrade.⁸⁶ Much of the publicity surrounding the CDM has emphasized the number of renewable energy projects sponsored by the CDM while neglecting the relative volume of emissions,⁸⁷ hence CERs produced, and the relative scale of subsidy provided to various sectors. This emphasis provides a

⁸¹ UNEP, *supra* note 51, at 38.

⁸² *Id.*, at 39.

⁸³ UNFCCC, *supra* note 63.

⁸⁴ *Id.*

⁸⁵ Reimer et al., *supra* note 75, at 349; McCulloch, *supra* note 76, at 18.

⁸⁶ Anaerobic digestion of crop residues leads to significant emission of CH₄ that is prevented by collection and use of the waste as a fuel. Many biomass energy projects claim this emission reduction in addition to the fossil fuel based energy avoided. *See e.g.*, Camil Alimentos S/A, PTZ BioEnergy Ltd., and Bioheat International B.V., CAMIL Itaquí Biomass Electricity Generation Project, CDM Project Design Document 0231, 7-9 (2005), available at <http://cdm.unfccc.int/Projects/TUEV-SUED1135876215.5/view.html> (last visited May 4, 2006).

⁸⁷ Compare Figure 3, *infra*, with UNFCCC, Registration: Distribution of Registered Project Activities by Scope, at <http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html> (last visited May 4, 2006), and World Bank, About World Bank Carbon Finance Unit, at <http://carbonfinance.org/Router.cfm?Page=About&ItemID=24668> (last visited May 4, 2006).

false picture of the true subsidy flows being generated by the international market for carbon (See Figure 3).

At this point, it is clear that the CDM has induced market participants to produce a large number of emissions reductions in the developing world for sale to those nations with quantified emissions reductions under the Kyoto Protocol. In evaluating whether or not the CDM as actually realized is a success however, more is required. One must also ask, did the Annex I nations get their money's worth. If the answer is that they could have accomplished the same result at lower cost, then the magnitude of the result, in this case the reduced GHG emissions, is far less relevant to judging the overall success of the program. By way of answering this question, the next two sections will examine financial aspects of the two classes of large projects present in the CDM system.

V. HFC-23 Abatement Projects in the CDM

A. *Byproduct of HCFC-22 manufacture.*

There are 11 HFC-23 abatement projects currently participating in the CDM.⁸⁸ These projects consist of the capture and destruction of HFC-23 produced as a byproduct of HCFC-22 manufacture.⁸⁹ The primary use of HCFC-22 is as a refrigerant, although its use as a feedstock for fluoroplastics such as PTFE is also significant.⁹⁰ For every 100 tons of HCFC-22 produced, between 1.5 and 4 tons of HFC-23 is produced.⁹¹

An understanding of the economics of HFC-23 abatement projects must begin with an understanding of the atmospheric chemistry of HFC-23 because this chemistry lies at the heart of what makes them successful CDM projects. HFC-23 is an extremely potent and long-lived greenhouse gas. Its 100-year GWP is 11700.⁹² As a consequence of this high GWP and the rules of the CDM, which convert the other six Kyoto Protocol gases to CO₂e and hence CERs, using their GWPs, one ton of HFC-23 abated is considered equivalent to 11700 tons of CO₂. In other words, for every kg of HCFC-22 produced, between 15 and 30 g of HFC-23 is produced, and at least potentially, captured and destroyed. This 15 to 30 g of HFC-23 is equivalent to 175 to 350 kg of CO₂, or 0.175 to 0.350 CERs.

Although approximately half of HCFC-22 production occurs in the developed world,⁹³ there are essentially no byproduct emissions of HFC-23 there because major

⁸⁸ As of April 10, 2006.

⁸⁹ INEOS Fluor Japan Limited, Foosung Tech Corporation Co., Ltd., and UPC Corporation Ltd., Revision to approved baseline methodology AM0001 "Incineration of HFC 23 waste streams", 1 (2005) at <http://cdm.unfccc.int/methodologies/DB/128DEJUIF08LJESQJHJKBTK86E1HKB/view.html> (last visited May 4, 2006).

⁹⁰ McCulloch, *supra* note 76, at 4.

⁹¹ *Id.*, at 10.

⁹² *Id.*, at 21.

⁹³ *Id.*, at 4.

producers have voluntarily adopted measures to capture and destroy it.⁹⁴ Participation in voluntary abatement programs was substantial but not universal by 2004.⁹⁵ The situation in the developing world was, prior to CDM, quite different. There, HCFC-22 producers vented all HFC-23 produced to atmosphere.⁹⁶ One market analyst predicts that HCFC-22 production will grow by 6-7% per year to 2020 and by 16% per year in the developing world.⁹⁷ Thus, reducing Non-Annex I emissions of HFC-23 should be a goal of any treating aimed at curbing GHG emissions.

Non-Annex I producers of HCFC-22 have, to a remarkable extent, become participants in the CDM. Developing world production of HCFC-22 in 2005 was approximately 237,000 metric tons.⁹⁸ Assuming a 3% HFC-23 production rate, which has been fairly typical for the 11 HCFC-22 plants participating in CDM,⁹⁹ this equates to a production of 83 million CERs per year.¹⁰⁰ Taken together, the PDD's of the 11 HCFC-22 plants estimate that they will produce 56 million CERs per year. Using these estimates, it would appear that slightly more than 67% of existing developing world HCFC-22 production is currently participating in the CDM.

B. The Economics of HFC-23 abatement as a CDM project

The economics of HFC-23 projects create incentives for strategic behavior that if left unchecked, undermine the environmental efficacy of the CDM. Consider the 1 kg of HCFC-22 produced by a CDM project that the calculation above showed to be equivalent to 0.35 t CO₂e or 0.35 CERs. At current market prices of €9/CER,¹⁰¹ the production of 1 kg of HCFC-22 will produce a subsidy of €3.15. The cost of HFC-23 abatement is estimated to be on the order of €0.09/kg HCFC-22 (see Box 1)¹⁰² Thus the net from subsidy minus abatement costs to an HCFC-22 producer is approximately €3.08/kg HCFC-22. This subsidy compares quite favorably with the wholesale price for HCFC-22,

⁹⁴ *Id.*, at 18, 21;

⁹⁵ IPCC, Safeguarding the Ozone Layer and the Global Climate System: Issues related to Hydrofluorocarbons and Perfluorocarbons, 397 (2005), available at http://arch.rivm.nl/env/int/ipcc/pages_media/SROC-final/SpecialReportSROC.html (last visited May 4, 2006).

⁹⁶ McCulloch, *supra* note 76 at 4.

⁹⁷ *Id.*

⁹⁸ *Id.*

⁹⁹ The average HFC-23/HCFC-22 ratio of the 11 plants is 2.99± 0.58.

¹⁰⁰ 237,000 Mt HCFC-22 * 0.03 = 7110 Mt HFC-23; 7110 Mt HFC-23 * 11700 = 83,187 Mt CO₂e.

¹⁰¹ Data collected from publicly available reported trades of CERs is used to create this estimate. See Figure 6. As of the time of writing, significant price instability in the EU ETS had caused a cessation in trading in the CDM market as participants waited for a price signal from the European carbon market. See, Point Carbon, CDM-JI Monitor, May 2, 2006, at 2 (on file with author).

¹⁰² McCulloch, *supra* note 76 at 12. This value is derived assuming access an 8% return on the investment in destruction facilities (€240,000/y) plus €200,000 operating expenses and a production rate of 200 t HFC-23 per year, equivalent to 6666 t HCFC-22 per year, assuming a 3% HFC-23 production rate.

which as of fourth quarter, 2005 was approximately €1.60/kg.¹⁰³ Thus a developing world producer of HCFC-22 can earn nearly twice as much from its CDM subsidy than it can gross from sale of its primary product. Even when CER prices were only half of their current value, HCFC-22 producers found these calculations a compelling incentive to enter the CDM process.¹⁰⁴ Given these incentives, why the rate of developing world HCFC-22 producer participation is just 67% rather than 100% is a worthwhile question.

Box 1: Estimating the value of the CDM subsidy to HCFC-22 producers	
Step 1: Calculate CO ₂ e produced by 1 kg HCFC-22	1 kg HCFC-22 -> 0.03 kg HFC-23
	0.03 kg HFC-23 * 11700 = 351 kg CO ₂ e = 0.351 t CO ₂ e
Step 2: Estimate gross subsidy	0.351 t CO ₂ e * €9/CER = €3.16
	Gross subsidy per kg HCFC-22 = €3.16
Step 3: Estimate the cost per kg HCFC-22 (calculations are for facility capable of capturing and destroying 200 t HFC-23/y)	€3,000,000 investment @ 8% interest + €200,000 per year operating costs = €590,000 per year cost.
Step 5: Calculate the Cost per kg HCFC-22	€590,000/200 t HFC-23 = €2950/t HFC-23
	€2950/t HFC-23*3% HFC-23 = €88.5/t HCFC-22
	€88.5/t HCFC-22 * 1 t/1000 kg = €0.09
	Cost of subsidy per kg HCFC-22 = €0.09
Step 6: Calculate the net CDM subsidy	€3.16 - €0.09 = €3.07/kg HCFC-22

The economics of HFC-23 CDM projects were from a very early stage, a point of controversy.¹⁰⁵ The CDM methodology, without which HFC-23 projects could not advance to registration, went through several rounds of revision because of fears that HCFC-22 producers would produce gas simply to generate CERs and hence in effect, dilute the CDM's currency, at least in terms of its environmental effectiveness.¹⁰⁶

¹⁰³ Mack McFarland, Environmental Fellow, DuPont Fluoroproducts, *personal communication* to Professor Tom Heller, Stanford Law School, Fall 2005.

¹⁰⁴ Should CER prices fall from their current highs of €9 due to the fall in the value of ETS permits, HFC projects will remain economically attractive.

¹⁰⁵ Letter from Thomas R. Jacob, Senior Advisor, Global Affairs, Dupont, to Mr. Jean-Jacques Becker, Chair, CDM Methodology Board (June 3, 2004), at <http://cdm.unfccc.int/methodologies/inputam0001> (last visited May 4 2006).

¹⁰⁶ On the concept of tradable emissions permits as a property right, *see* Robert W. Hahn and Gordon L. Hester, *supra* note 43 at 101, 117; on the concept of tradeable emissions permits as a currency, *see* David G.

Ultimately, the CDM Executive board decided only to approve only those projects involving previously existing HCFC-22 production capacity.¹⁰⁷ No new plants or added capacity are currently allowed into the CDM.¹⁰⁸ In order to qualify for registration, a plant must have been in operation and able to supply both HCFC-22 and HFC-23 production data for at least three years in the 2000 to 2004 period.¹⁰⁹ This creates the obvious problem of how to create incentives to capture and destroy HFC-23 emitted incidental to the 16% annual growth of HCFC-22 production predicted to occur in the developing world¹¹⁰. The Executive board has asked for guidance from the conference of the parties as to what to do about new plant and added capacity.¹¹¹

Even with these highly restrictive rules on eligibility, there is relatively strong evidence that HCFC-22 producers participating in the CDM have behaved strategically to direct a greater share of the subsidy to themselves by artificially inflating their base year production in two ways. First, the fraction of HFC-23 produced by the production of HCFC-22 can be reduced by modification of the conditions under which chemical synthesis occurs. Dupont has been able to consistently produce, in its United States based HCFC-22 plant, HFC-23 byproduct percentages as low as 1.3%.¹¹² The economics of HCFC-22 production in the absence of a CDM subsidy dictate that HFC-23 production be minimized because it is in effect a waste product costing both energy and materials.¹¹³ For this reason, almost all plants have historically monitored the HFC-23/HCFC-22 ratio in their production.¹¹⁴ The CDM methodology eventually approved for HFC-23 abatement set 3% as the maximum percentage of HFC-23 byproduct allowable in the baseline data of a participating plant.¹¹⁵ The average of all reported baseline data at the 11 participating plants is 2.99% - very close to the maximum allowable value.¹¹⁶ This suggests that even if the project participants were not actually aiming for the 3% sweet spot that would minimize their production costs (due to wasted feedstocks) but maximize their CDM subsidy (due to more CERs for a given production rate of HCFC-22, they were certainly not as concerned with minimizing this percentage as developed world producers, not eligible for the CDM subsidy, seem to be.

Victor, Joshua C. House, and Sarah Joy, *A Madisonian Approach to Climate Policy*, 309 SCIENCE, at 1820 (2005).

¹⁰⁷ INEOS Fluor et al., *supra* note 89, at 3.

¹⁰⁸ *Id.*, at 1.

¹⁰⁹ *Id.*

¹¹⁰ McCulloch, *supra* note 76, at 4.

¹¹¹ INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT, EARTH NEGOTIATIONS BULLETIN, SUMMARY OF THE TWENTY-SECOND SESSIONS OF THE SUBSIDIARY BODIES OF THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE: 19-27 MAY, 2005, VOL. 12, NO. 270, at 2 (May 26, 2005) at <http://www.iisd.ca/climate/sb22> (last visited May 27 2005).

¹¹² Jacob, *supra* note 105.

¹¹³ IPCC, *supra* note 95, at 39

¹¹⁴ Jacob, *supra* note 105.

¹¹⁵ Letter from Thomas R. Jacob, Senior Advisor, Global Affairs, Dupont, to Mr. Jean-Jacques Becker, Chair, CDM Methodology Board, at 3 (Oct. 2, 2004), at <http://cdm.unfccc.int/methodologies/inputam0001> (last visited May 4 2006).

¹¹⁶ INEOS Fluor, *supra*, note 88, at 4.

In addition, at least some of the HCFC-22 plants participating in the CDM appear to have ramped up production during the baseline period (2000-2004) far beyond the expected growth in the sector (15%). Figure 5 shows the baseline data supplied by plants participating in the program compared with the predicted growth rate for the industry over the 2002-2004 period.¹¹⁷ Most plants exceeded the growth rates predicted for the developing world industry as a whole. These increases in HCFC-22 production amongst the 75% of developing world producers participating in the CDM led to a CDM participant production growth rate of 50% rather than 33%, as had been predicted ex-ante by market analysts.¹¹⁸ Whether or not these plants increased production due to demand for HCFC-22 or in anticipation of higher CER revenue is impossible to say given publicly available information. Nevertheless, a circumstantial case exists that at the least, rather than building new plants, HCFC-22 producers elected to add capacity at existing plants during the CDM baseline period in order to take advantage of the CDM subsidy.

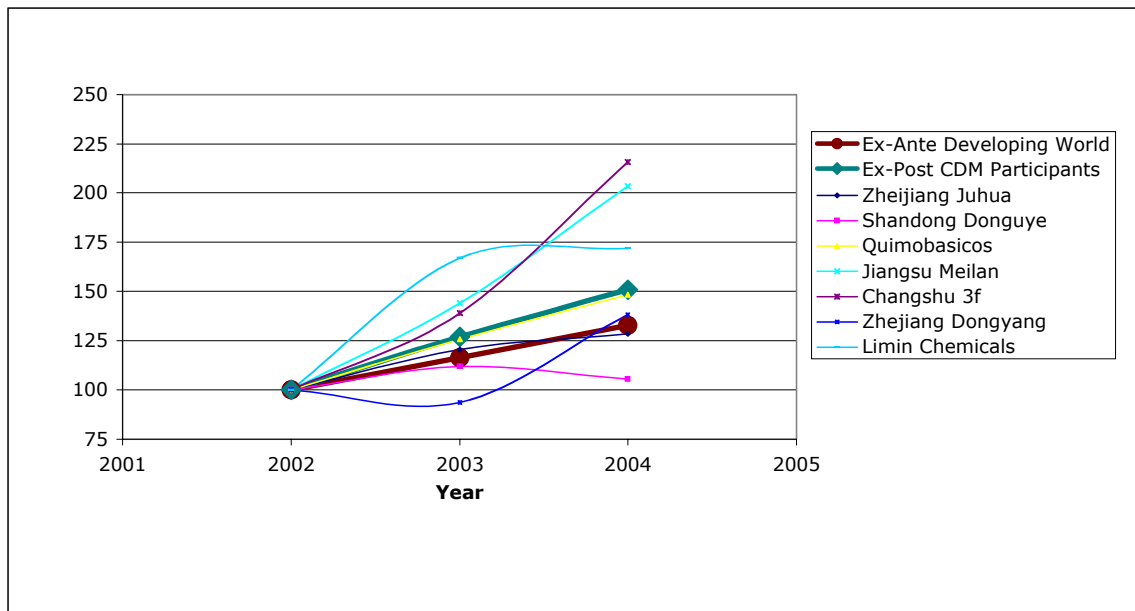


Figure 5: Percentage increases at HCFC-22 plants reporting multiple years of baseline data relative to ex-ante analyst predictions for the interval. 2002 = 100. Ex-ante developing world growth rate = 16.5%. Ex-post CDM participant growth rate = 25%. Thick lines show ex ante (filled circles) and average CDM participant (filled diamonds) rates of production growth.

In response to the windfall profits enjoyed by their domestic HCFC-22 producers as a result of the CDM, China has imposed a 65% tax on CER revenue generated by HFC-23 projects.¹¹⁹ In this way, as had been predicted by the critics of the CDM's baseline concept, Chinese environmental regulators have, rather than create regulation that

¹¹⁷ McCulloch, *supra* note 76 at 4.

¹¹⁸ *Id.*

¹¹⁹ Measures for Operation and Management of Clean Development Mechanism Projects in China, Sec. V, Art. 24, available at <http://cdm.ccchina.gov.cn/english/NewsInfo.asp?NewsId=100> (last visited May 4, 2006).

would eliminate a CDM project's eligibility, have instead acted to extract a substantial portion of the subsidy derived rent. This reduces the income from CERs to only 60% of that derived from the sale of HCFC-22. However, at prices greater than €15, even with a 65% tax, it will again make sense to produce gas solely for CER revenue.¹²⁰ Currently, CER futures contracts from HFC-23 projects are trading at from €9 to €16, very close to that point.¹²¹

The CDM provides perverse economic incentives to HCFC-22 producers that have led to a large fraction of the CER supply being produced by HFC-23 abatement. Even if some fraction of these reductions are "real and additional," they still may not be the best use of Annex I party resources for addressing non-Annex I GHG emissions. To abate all developing world HFC-23 emissions would cost approximately \$31 million per year.¹²² Instead, by means of CDM subsidy, the Annex I nations will likely pay between €250 and €750 million to abate 67% of Non-Annex I HFC-23 emissions¹²³. This is a remarkably inefficient path to an environmental goal. The difference between the cost of abatement and the subsidy provided by CDM also strongly suggests that a market based mechanism that allows inter-convertibility of HFC-23 and CO₂ generated reductions may be a poor choice of treaty architecture for any post-2012 protocol to the UNFCCC whatever other form it may take.

VI. N₂O Abatement Projects in the CDM

A. N₂O, a byproduct of Adipic and Nitric Acid Manufacture

Nitrous oxide is a potent greenhouse gas that was included in the Kyoto Protocol's both because of its global warming potential, 310,¹²⁴ and because of its rapidly increasing concentration.¹²⁵ While not all sources of N₂O are straightforward to regulate or control, the major industrial emissions of the gas from adipic acid production and from nitric acid production as I will explain below, can be prevented at relatively low cost. Thus, like the HFC-23 projects, these two sources of N₂O both present an opportunity for low cost greenhouse gas abatement as well as for strategic behavior on the part of CDM market participants.

N₂O projects have gotten a slower start than did the HFC-23 projects in the CDM. The first N₂O project was registered by the CDM EB in November of 2005, more

¹²⁰ A €15 CER price, taxed at 65% will net €1.60 after abatement costs and tax per kg HCFC-22 produced. The market price for HCFC-22 is approximately €1.60.

¹²¹ Point Carbon, *supra*, note 90.

¹²² McCulloch, *supra* note 76, at 21.

¹²³ 50 Mt CO₂e * €5 = €250,000,000; 50 Mt CO₂e * €15 = €750,000,000.

¹²⁴ UNFCCC, Report of the Conference of the Parties on its Third Session, Held at Kyoto from 1 to 11 December, 1997, at 31, U.N. Doc. FCCC/CP/1997/7/Add.1 (1998), available at <http://unfccc.int/resource/docs/cop3/07a01.pdf> (last visited, June 9, 2006); IPCC, CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE, 22 (1996).

¹²⁵ IPCC, *supra* note 14, at 253.

than 7 months after the first of the HFC-23 reduction projects.¹²⁶ Thus, as will be shown, although N₂O has the potential to play as much of a role as HFC-23 in the CDM, this potential has yet to be realized. In total, recent estimates of N₂O emissions from the two industrial processes indicate the possibility of producing 68.1 Mt CO₂e of emissions reductions if just four nations, China, Brazil, India, and South Korea participate fully in CDM based N₂O abatement.¹²⁷ This is a larger volume of emission reductions than is currently supplied by the HCFC-22 industry in these countries.¹²⁸ Currently, less than one quarter of this CER volume is in the CDM pipeline.¹²⁹

1. Adipic Acid

Adipic acid is the most important feedstock for the production of nylon 6-6. 19 facilities produce essentially the entire global supply.¹³⁰ For every kg of adipic acid produced, approximately 0.3 kg of nitrous oxide is emitted.¹³¹ Prior to the recognition that N₂O from adipic acid production constituted a measurable contribution to global warming, producers simply vented these emissions to the atmosphere. In 1991, the adipic acid industry was made aware of the significance of its emissions to the climate change problem.¹³² Since that time, major efforts by large producers have led to near total abatement of N₂O emissions from adipic acid production in the developed world at relatively low cost. This effort was first undertaken by Dupont, and then by a larger industry-wide effort.¹³³ By 2000, developed world producers had succeeded in reducing their emissions by more than 90% through a cooperative, international, voluntary effort. Developing world producers of adipic acid, who accounted for a small fraction of N₂O emissions in 1990, had become the dominant emitters. In 2000, emissions of N₂O due to

¹²⁶ The first HFC-23 project was registered on Mar. 8, 2005 while the first Adipic Acid project was registered on Nov. 27, 2005. See <http://cdm.unfccc.int/Projects/registered.html> (last visited June 9, 2006).

¹²⁷ This estimate assumes 90% abatement efficiency and uses year 2010 emissions estimates for the four nations. US Environmental Protection Agency, Global Anthropogenic Non-CO₂ Greenhouse Gas Emissions, Appendix C-3 (Dec. 2005 draft), available at http://www.epa.gov/nonco2/econ-inv/pdfs/global_emissions.pdf (last visited, Jun. 9, 2006).

¹²⁸ 55.71 Mt CO₂e as of May 8, 2006.

¹²⁹ 16.41 Mt CO₂e as of May 8, 2006.

¹³⁰ Heike Mainhardt, *N₂O Emissions from Adipic Acid and Nitric Acid Production*, in BACKGROUND PAPERS: IPCC EXPERTS MEETINGS ON GOOD PRACTICE GUIDANCE AND UNCERTAINTY MANAGEMENT IN NATIONAL GREENHOUSE GAS INVENTORIES 183, 184 (2002), available at <http://www.ipcc-nggip.iges.or.jp/public/gp/gpg-bgp.htm> (last visited, June 7, 2006).

¹³¹ *Id.*, at 187.

¹³² M. H. Thiemens and W. C. Trogler, *Nylon Production: An Unknown Source of Atmospheric Nitrous Oxide*, 251 SCIENCE, 932, 932-934 (1991).

¹³³ Mack MacFarland, Statement of Mack MacFarland, Ph.D., Global Environment Manager, DuPont Fluoroproducts, E.I. DuPont de Nemours and Company, Inc before the Committee on Science, U.S. House of Representatives, June 8., 2005 (Jun. 8, 2005); R. A. Reimer, et al., *supra* note 75, 348-349.

adipic acid production totaled approximately 50.4 Mt CO₂e.¹³⁴ By 2010, emissions are expected to grow by between 18% with much of the increase coming in the developing world.¹³⁵ Rather than abate emissions voluntarily, as developed world producers will likely do, at least some of these developing world producers have utilized the flexible mechanisms of the CDM to finance their N₂O emissions abatement programs.¹³⁶

2. Nitric Acid

The production of nitric acid also emits large quantities of N₂O. Nitric acid's primary uses are as feedstock for ammonium nitrate fertilizer and for explosives. If uncontrolled, on average 9.5 kg of N₂O is produced per ton nitric acid,¹³⁷ a much lower rate of emission than for adipic acid. However, this relatively low rate of N₂O production, when coupled with the massive needs of the fertilizer industry for nitric acid, leads to relatively high emissions. There are between 250 and 600 nitric acid plants, worldwide.¹³⁸ Existing technologies allow for the reduction of N₂O emissions from nitric acid plants by up to 98%.¹³⁹ In the developed world, the fertilizer industry has, because of the need to control NO_x emissions, to some extent reduced emissions of N₂O below what they otherwise would have been. Non-selective catalysts used to scrub NO_x from nitric acid plant flue gases also remove some fraction of the N₂O in the waste stream as well.¹⁴⁰ These systems were commonly installed in Nitric Acid plants constructed during the 1970's to meet NO_x emission requirements.¹⁴¹ Since then, catalysts that are selective for NO_x have come to dominate the U.S. and other developed world nitric acid industry. These catalysts do not remove N₂O from the flue gases.¹⁴² Selective catalytic reduction has come to dominate the nitric acid industry in the developed world however because it is far cheaper to operate for a

¹³⁴ U.S. Environmental Protection Agency, Draft Global Mitigation of Non-CO₂ Greenhouse Gases, IV-9 (2006), available at <http://www.epa.gov/nonco2/econ-inv/international.html> (last visited June 20, 2006).

¹³⁵ *Id.*

¹³⁶ See, e.g., Rhodia Energy Korea Co. Ltd., N₂O Reduction in Onsan, Republic of Korea, CDM Project Design Document No. 0099, Version No. 8 (Sep. 1, 2005), available at <http://cdm.unfccc.int/Projects/DB/DNV-CUK1127672024.44/view.html> (last visited Jun. 20, 2006); Rhodia Energy Brazil, N₂O Emission Reduction in Paulinia, SP, Brazil, CDM Project Design Document No. 0116, Version No. 4 (Oct. 12, 2005), available at <http://cdm.unfccc.int/Projects/DB/DNV-CUK1130160031.78/view.html> (last visited Jun. 20, 2006).

¹³⁷ U.S. Environmental Protection Agency, *supra* note 134, at IV-6-IV-7.

¹³⁸ Mainhardt, *supra* note 130, at 184. The large uncertainty in number is due to the fact that nitric acid plants are often a part of larger fertilizer or explosives manufacturing facilities. *Id.*

¹³⁹ Carbon CDM Korea Ltd. and Hu-Chems Fine Chemical Corp., Catalytic N₂O Destruction Project in the Tail Gas of Three Nitric Acid Plants at Hu-Chems Fine Chemical Corp., CDM Project Design Document, Version No. 1, 4 (Mar. 15, 2006), available at <http://cdm.unfccc.int/Projects/Validation/DB/U2ODRRPWUQQ6QTZ7ZILTXXHF5971KB/view.html> (last visited Jun. 20, 2006).

¹⁴⁰ U.S. Environmental Protection Agency, *supra* note 134, at IV-4, IV-6.

¹⁴¹ *Id.*, at IV-4.

¹⁴² *Id.*, at IV-6.

given NO_x abatement level than non-selective technology.¹⁴³ In the developed world, most often, there are no controls on NO_x or N₂O emissions from nitric acid plants and so both are simply vented to atmosphere. In 2000, nitric acid producers are estimated to have emitted 100.7 Mt CO₂e of N₂O.¹⁴⁴ Emissions of nitric acid derived N₂O are projected to increase 10% by 2010.¹⁴⁵

B. The economics of Adipic and Nitric Acid Abatement

The control of emissions from nitric and adipic acid production presents some of the same problems for the clean development mechanism that are presented by HCFC-22 projects, although in a slightly less extreme form. For neither adipic acid nor nitric acid producers will it likely ever make sense to produce their product solely for the sake of the revenues generated by the CDM. Nevertheless, the impact of CER derived revenues on these enterprises is likely to be substantial both because of the relative ease and cheapness with which these production processes can be modified to reduce their emissions and because of the possibility for leakage induced by the CDM subsidy. CER revenues may be sufficient to shift production towards those developing nations that can benefit from them and away from developed world producers. This possibility was of sufficient concern to the CDM EB that they have been willing to approve CDM project monitoring methodologies only for existing adipic and nitric acid production capacity.¹⁴⁶ This requirement, very similar to that in the HFC-23 abatement methodology, is a strong indication that trade distortion and leakage may be a problem. This concern is shared by the nitric acid industry in developed nations as well.¹⁴⁷ The following sections outline the basic economics of these two abatement opportunities in the context of the price for carbon offsets in the CDM and the value of the products.

1. Adipic Acid

Cost estimates for abatement of N₂O emissions from adipic acid plants are readily available because of the voluntary and cooperative program undertaken by developed nation producers in the 1990's. These show that the necessary capital investment for

¹⁴³ *Id.*, at IV-4.

¹⁴⁴ *Id.*, at IV-8.

¹⁴⁵ *Id.*

¹⁴⁶ See, Rhodia Polyamide Co. Ltd., Baseline Methodology for decomposition of N₂O from existing adipic acid production plants, CDM Approved Baseline Methodology AM0021, Version 01, 1 (Feb. 25, 2005), available at <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html> (last visited Jun. 20, 2006); Carbon Projektentwicklung GmbH, Catalytic N₂O Destruction in the tail gas of Nitric Acid Plants, CDM Approved Baseline Methodology AM0028, Version 01, 1 (Mar. 3, 2006), available at <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html> (last visited Jun. 20, 2006).

¹⁴⁷ European Fertilizer Manufacturers Association, The European Fertilizer Manufacturer's Position on the European Commission's Proposal for a Directive on EU Emissions Trading, 2 (Mar. 2005), available at <http://www.efma.org/Members/EFMA%20Positions/The%20EFMA%20position%20on%20Green%20House%20Gases/PDF%20docs/EFMA%20position%20on%20CEC%20proposal%20on%20EU%20emissions%20trading%20directive.pdf> (last visited Jun. 20, 2006).

90% to 95% N₂O abatement at a major facility is on the order of \$20 to \$60 per ton N₂O, including 7% depreciation.¹⁴⁸ The estimated net present value, assuming a 10% discount rate of an actual CDM adipic acid project is -€12.5 million.¹⁴⁹ This adipic acid plant produces 130,000 tons of N₂O per annum.¹⁵⁰ These figures imply that the cost of abatement if it must be amortized before the end of the first crediting period will be on the order of €16 per ton adipic acid produced (see Box 2).¹⁵¹ Thus CDM adipic acid project proponents believe that they can more cheaply abate their emissions than the developed world producers.

Box 2: Estimating the net CDM subsidy to Adipic Acid producers	
Step 1: Calculate CO ₂ e produced by 1 t Adipic Acid	1 t Adipic Acid -> 0.264 t N ₂ O 0.264 t N ₂ O * 310 = 81.84 t CO ₂ e
Step 2: Estimate gross subsidy	81.84 t CO ₂ e * €9/CER = €736.56 Gross subsidy per t Adipic Acid = €736.56
Step 3: Estimate the cost per t Adipic Acid (calculations are for facility capable of producing 130,000 t Adipic Acid per year and assume operation for six years, i.e. until Dec. 31, 2012)	€12.5 M investment / 6 years = €2.1 M/y €2.1 M/y / 130,000 t Adipic Acid/y = €16.03 Cost of Subsidy per t Adipic Acid = €16.03
Step 4: Calculate the net CDM subsidy	€736.56 – 16.03 = €720.53/t Adipic Acid

The value of the CDM subsidy these projects will receive, assuming a price of €9 per ton CO₂e will be on the order of €737 (see Box 2). Thus the net subsidy will be €720, or at current exchange rates, \$894.¹⁵² Although current spot and contract prices for adipic acid are not publicly available, as of August, 2005, they were \$1,150 to 1,180 and \$1,200 to 1,300.¹⁵³ Thus the CDM subsidy derived from N₂O abatement will be worth 55% to

¹⁴⁸ R. A. Reimer, et al., *supra* note 75, at 351.

¹⁴⁹ Rhodia Energy Korea Co. Ltd., *supra* note 136, at B.3.

¹⁵⁰ *Id.*, at A.4.3.

¹⁵¹ €12.5 million / (6 years * 130,000 t Adipic Acid per year) = €16.03 per t Adipic Acid.

¹⁵² 1 Eur = 1.24 USD, Average Interbank Rate for Apr. 23, 2006 to Apr. 29, 2006. See Oanda.com, FXHistory, Historical Currency Exchange Rates, at <http://www.oanda.com/convert/fxhistory> (last visited Jun. 20, 2006).

¹⁵³ ICIS LOR, Adipic Acid (Asia Pacific), 3rd August 2005, *on file with author*.

63% of the market price for adipic acid. Assuming that all eligible adipic acid producers register their plants as CDM projects to obtain the subsidy, then in 2010, total reductions will be on the order of 29 Mt CO₂e/y or at a CER price of €9, a total subsidy of €259 million.¹⁵⁴ This compares to a total abatement cost of €5.4 million.

The value of the CDM subsidy is unlikely to lead to severe trade distortion in the period leading up to December 31, 2012 because decisions on where to site a plant are not made based on subsidies covering such a short time frame. On the other hand, the CDM subsidy will give developing world producers a substantial ability to undercut the price of developed world producers and will, if continued beyond 2012, likely lead to a shift in production from the developed world where producers abate their N₂O emissions voluntarily to the developing world where producers are paid to do so. Just as with HCFC-22 producers, one must ask whether the CDM subsidy that pays adipic acid producer almost 50 times the cost of their N₂O abatement makes sense from an efficiency perspective. Spending on climate change mitigation is both limited and at times contentious. Given these constraints, developed nation governments have an interest in seeing each dollar go as far as possible.

2. Nitric Acid

As mentioned previously, N₂O emissions from nitric acid production are, in the developed world, only abated incidentally to NO_x emissions control. Emissions in the developing world are typically uncontrolled and are thus estimated to occur at a rate of 9.5 kg per ton nitric acid produced.¹⁵⁵ Thus one ton of nitric acid will produce approximately 9.5 kg of N₂O, or 2.945 t CO₂e. At a CER price of €9, this emissions reduction is thus worth €26.51 (see Box 3). Costs of emission reduction for the most common abatement techniques has been estimated €1.84 per ton CO₂e, equivalent to €5.42 per ton Nitric Acid.¹⁵⁶ As mentioned previously, most nitric acid is produced for use in nitrogen fertilizers, principally as ammonium nitrate. The average cost of

¹⁵⁴ Assumes participation by all Chinese, South Korean, Brazilian, and South and South-east Asian producers. See U.S. Environmental Protection Agency, *supra* note 134, at IV-9.

¹⁵⁵ *Id.*, at IV-6.

¹⁵⁶ *Id.*; Oanda.com, *supra* note 152.

ammonium nitrate for US farmers in April 2006 was \$414 (€326) per metric ton.¹⁵⁷ The likely total CDM subsidy, assuming complete participation of major producing nations by 2010, is on the order of €342.9 million per year while the total cost to abate the 38.1 Mt CO₂e emitted by these producers is between €70 and €102 million.¹⁵⁸

Box 3: Estimating the net CDM subsidy to Nitric Acid producers	
Step 1: Calculate CO ₂ e produced by 1 t Nitric Acid (HNO ₃)	1 t HNO ₃ → 0.0095 t N ₂ O
	0.0095 t N ₂ O * 310 = 2.945 t CO ₂ e
Step 2: Estimate gross subsidy	2.945 t CO ₂ e * €9/CER = €26.51
	Gross subsidy per t Nitric Acid = €26.51
Step 3: Estimate the cost per t Nitric Acid (calculations based on using the high temperature catalytic reduction method).	€1.84 per ton CO ₂ e * 2.945 t CO ₂ e/t HNO ₃ = €5.42/t HNO ₃
	Cost of Subsidy per t Nitric Acid = €5.42
Step 4: Calculate the net CDM subsidy	€26.51 – 5.42 = €21.09 per t Nitric Acid

In the case of nitric acid, in contrast to adipic acid and HCFC-22, the product is actually worth substantially more than the CDM subsidy. Nevertheless, the CDM subsidy, representing 6% of the current retail price, will provide developing nation fertilizer producers with significant price leverage in a commodified market with substantial international trade. In the long run, if a long run exists for the CDM, this is likely to lead to a substantial shift in production from developed nation producers to developing nation producers. In contrast to the case with adipic acid and HCFC-22, this shift would actually lead to a positive environmental outcome as developed world producers currently have no incentive to reduce their N₂O emissions. To the extent that their production is shifted to the developing world, global emissions of N₂O will be lower. However, at least in Europe, these producers are actively pursuing incorporation into the ETS.¹⁵⁹ In any case, there can be no question that the subsidy provided by the CDM to

¹⁵⁷ National Agricultural Statistics Service, U.S. Department of Agriculture, Agricultural Prices, 59 (Apr. 28, 2006), available at <http://usda.mannlib.cornell.edu/reports/nassr/price/pap-bb/2006/> (last visited Jun. 20, 2006).

¹⁵⁸ US Environmental Protection Agency, *supra* note 134, at IV-8. I assume full participation by China, India, Mexico, and Brazil in deriving the total N₂O emissions from nitric acid production.

¹⁵⁹ European Fertilizer Manufacturers' Association, *supra* note 147, at 1-2.

induce developing nation nitric acid producers to reduce their emissions of N₂O is far in excess of the cost of doing so. Once again, the CDM's market mechanism is proving to be an inefficient method for subsidizing emissions reductions.

VII. Demand for CERs

The relative efficiency or inefficiency of the CDM subsidy will be in part determined by the price of CERs in the market for Kyoto Compliance instruments. The CDM is a market based mechanism where price is a function of the supply of CERs and of demand for them in a market containing both domestic compliance options and the Kyoto Protocol's other Flexible Mechanisms. In addition to supply and demand, the price of CERs is very much a function of the political choices that are yet to be made by the three Annex I parties with significant gaps between current and allowed large emissions during the 2008-2012 period: the European Union, Canada, and Japan.¹⁶⁰ This section will examine what is known currently about likely demand for CERs in the international carbon market.

There are several decisions that important Annex I nations will need to make in the lead up to 2012 if they are to comply with the Kyoto Protocol's emission targets. For the European Union, these include whether and how to strengthen the EU Emissions Trading Scheme. By June 30, 2006, member nations must submit proposals to the European Commission detailing how they will allocate European Union Allocations ("EUAs") to ETS participants during the 2008-2012 period.¹⁶¹ The strictness of this allocation, which covers 45% of EU GHG emissions will impact both the extent to which private parties in the ETS attempt to purchase CERs and the extent to which member governments must resort to purchase of CERs in order to meet their targets¹⁶². In addition, EU member governments must still decide what mix of additional domestic policies and measures or the purchase of CDM, JI, or AAUs to use in meeting their obligations under the European Union's Linking Directive between the ETS and the Protocol's flexible mechanisms¹⁶³. A choice by the EU members to comply using domestic reductions would likely increase their costs of compliance while reducing the price of CERs and other Flexible Mechanism instruments. A choice to comply using international mechanisms would potentially raise prices of CERs, although not if EU members decide to comply by means of purchasing JI or Russian or Ukrainian AAUs¹⁶⁴.

¹⁶⁰ Point Carbon, *supra* note 40, at 5.

¹⁶¹ Press Release, European Commission, Questions and Answers on national allocation plans for 2008-2012 (Jan. 9, 2006) at <http://europa.eu.int/rapid/pressReleasesAction.do?reference=MEMO/06/2&format=HTML&aged=0&language=EN&guiLanguage=en> (last visited May 4, 2006).

¹⁶² Both governments at private parties have been actively purchasing CERs in anticipation of stricter national allocation plans. See, Point Carbon, *supra* note 40, at 23-24.

¹⁶³ Council Directive 2004/101/EC, 2004 O.J. (L 338) 18-19.

¹⁶⁴ Victor et al., *supra* note 27, at 268.

Canada, now under a new, conservative, government, must make a more fundamental choice: whether or not to even attempt to comply with the Kyoto Protocol¹⁶⁵. The Canadian shortfall is estimated to be 270 Mt CO₂e/y during the 2008-2012 period¹⁶⁶. To date, the Canadian government has expressed conflicting views as to whether it will be able to meet its commitment of a 6% cut below 1990 GHG emissions¹⁶⁷. A decision by Canada to comply would almost certainly raise the price of CERs, subject to the uncertainties about the purchase of JI and AAUs discussed above.

Finally, Japan must decide how to comply with its Kyoto commitment of a 6% cut below 1990 emissions levels. Currently, Japan is projected to fall short of this goal by more than 300 Mt CO₂e/y during the 2008-2012 period under a business as usual scenario.¹⁶⁸ Of course, the same uncertainties apply to Japan's decisions about how to meet its Kyoto Protocol commitment. It may choose the more expensive route of domestic compliance, or a variety of less expensive international compliance options of varying environmental credibility. Ultimately the choice is a political one that balances cost, international credibility, and environmental outcome.

One recent estimate of the shortfall between what current emission reduction policies, including the EU ETS are expected to produce, and the EU-15, Japanese, and Canadian commitments under the Kyoto Protocol indicated that these nations will need to produce an additional 5.5 Gt CO₂e worth of emissions reductions in order to comply with the treaty¹⁶⁹. Given the political uncertainties described above, rather than taking this number at face value, it seems more sensible to take this value as an order of magnitude estimate of the large challenge facing these Annex I parties if they are to comply with the Kyoto Protocol.

In comparison, the potential supply of CERs is not great enough to meet this demand, although it might approach meeting 20 to 30% of it.¹⁷⁰ In contrast, the estimated supply of excess AAUs awarded to Russia, Ukraine, and Eastern Europe is more than enough to meet demand.¹⁷¹ At the same time, it is widely recognized that the purchase of "hot air" from Russia, Ukraine, and Eastern Europe would likely be an abrogation of the environmental integrity of the Kyoto Protocol.¹⁷² If so, it is unclear why Europe, Canada, or Japan would be willing to make large financial transfers to these nations in order to be in technical compliance with the Protocol but with no actual environmental benefits produced. These political considerations would seem to point towards a first preference for CDM produced CERs on the part of nations committed to Kyoto Compliance but unable to meet their targets domestically. Given this preference and the rough magnitudes of the compliance shortfalls (5.5 Gt CO₂e)

¹⁶⁵ Doug Struck, *Canada Alters Course on Kyoto, Budget Slashes Funding Devoted to Goals of Emissions Pact*, WASHINGTON POST, May 3, 2006, at A16.

¹⁶⁶ Point Carbon, *supra* note 40 at 5.

¹⁶⁷ *Compare*, Struck, *supra* note 118, with Dennis Bueckert, *Once skeptics, Conservatives promise action on climate change*, CANADIAN PRESS NEWSWIRE, Feb. 24, 2006.

¹⁶⁸ Point Carbon, *supra* note 40 at 5. Note that this assumes Canadian participation, withdrawal of which would reduce this estimate by 1.35 Gt CO₂e.

¹⁶⁹ *Id.*

¹⁷⁰ Point Carbon, *supra* note 57.

¹⁷¹ Point Carbon, *supra* note 40, at 8.

¹⁷² Victor et al., *supra* note 27, at 268.

and CDM supply (1 to 1.7 Gt CO₂e), it can be seen that the marginal cost of supply of CERs is unlikely to determine the price of CERs because supply will not satisfy demand. This finding is consistent with current pricing in the market, as the next section will describe.

VIII. The Price of CERs

As of May 2005, CERs were trading for between €4 and 6 per ton CO₂e.¹⁷³ Over the next year, prices increased substantially (Figure 6), perhaps in response to the dramatic increase in the number of registered CDM projects and the first issuance of CERs during the fourth quarter of 2005 but probably more likely in response to the price of EU Allowances in the EU ETS.¹⁷⁴ During the last week in April, 2006, however, prices in the EU ETS crashed when several member nations' environmental ministries prematurely released the results of their emissions verifications for 2005.¹⁷⁵ The instability in the ETS market has caused CDM market participants to wait for a more stable price signal before re-entering the market. Thus the price of CERs as of the beginning of May 2005 was uncertain as well. Overall, in 2005, 396 Mt of CER forward contracts changed hands with a financial value of just under €2 billion.¹⁷⁶ This represents a greater than 600% increase over 2004 and implies an average CER price of about €5.¹⁷⁷

Before the last few months of last year, there was essentially no secondary market for CERs. This market has begun to develop and has generated a sharp run up in prices. In the secondary market, last year, 4 Mt CO₂e changed hands for a total value of €50M implying a CER value of €12.5/t CO₂e.¹⁷⁸ The new secondary market is both growing rapidly in size during the first few months of this year (Figure 6) and appears to be driving up prices in the primary market.

¹⁷³ Franck Lecocq and Karan Capoor, State and Trends of the Carbon Market 2005, 26-27 (2005), at <http://carbonfinance.org/util/DocItemDisp.cfm?CatalogID=1769> (last visited, May 5, 2006).

¹⁷⁴ Point Carbon, *CDM Market Comment*, CDM-JI MONITOR, 4 April, 2006, at 2, *on file with author*.

¹⁷⁵ When these verifications did not meet market expectations of under-allocation of permits, ETS prices fell from over €31 to less than €12. Fiona Harvey and Kevin Morrison, *Brussels fails to halt slide in carbon dioxide permit prices*, FINANCIAL TIMES, May 3, 2006, at Europe pg. 9.

¹⁷⁶ Point Carbon, *supra* note 40 at 22.

¹⁷⁷ *Id.*

¹⁷⁸ *Id.*

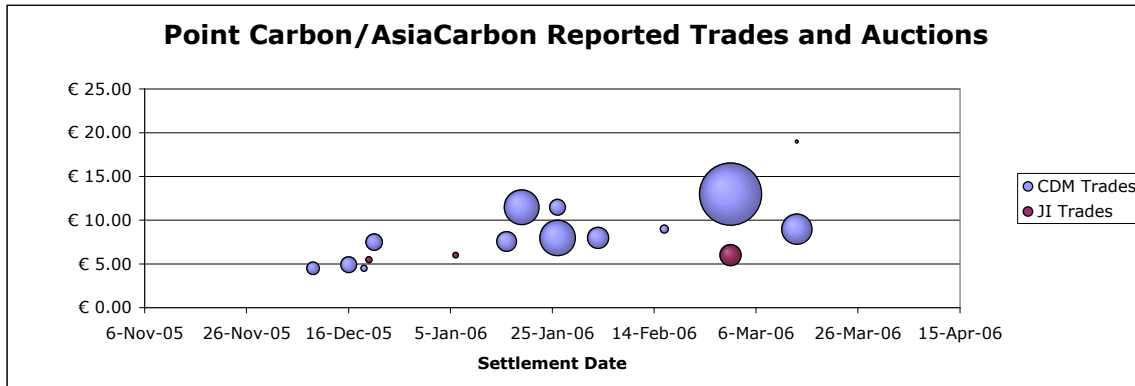


Figure 6: The price and volume of recently reported trades in the secondary CER market¹⁷⁹.

The main reason for the run up in price appears to be the increase in the price of EU Allowances in the EU ETS. This is shown by the strong correlation between EU Allowance prices as traded on the major exchange for these internal EU compliance instruments and the price of major CER transactions (See Figure 7). There appears, at least over the interval in which CER price data is publicly available, to be a relatively constant offset of approximately €15 between the two. This offset remained relatively constant even across major price changes for the two commodities. This discount makes sense given that EU Allowances are a readily exchangeable permit to emit whereas CER futures contracts as currently negotiated are a contract to deliver emissions reductions in a specified time interval. Whereas there is no delivery risk in a purchase and sale of an EU Allowance, there is substantial delivery risk present in any CER future contract.¹⁸⁰ This risk is derived from uncertainty as to the ultimate production of CERs by the seller,¹⁸¹ any country risk that may be present depending on the site of the CDM project, and regulatory risks associated with the establishment of the appropriate CDM accounting mechanisms and the as yet to be made decision by the government of the buyer to allow purchases of CERs by private party's.¹⁸² CER futures contracts typically allocate this risk to the buyer and so trade at a discount relative to the relatively risk-free EU allowances (Figure 7).

¹⁷⁹ Individual trades reported by Point Carbon and auction results reported by Asia Carbon.

¹⁸⁰ See, Lecocq and Capoor, *supra* note 126, at 33-34.

¹⁸¹ Depending on the magnitude of and on how contracts allocate this delivery the CERs being contracted for can vary by as much as a factor of 2. See, e.g., Point Carbon, *supra* note 127 at 1.

¹⁸² *Supra* note 116.

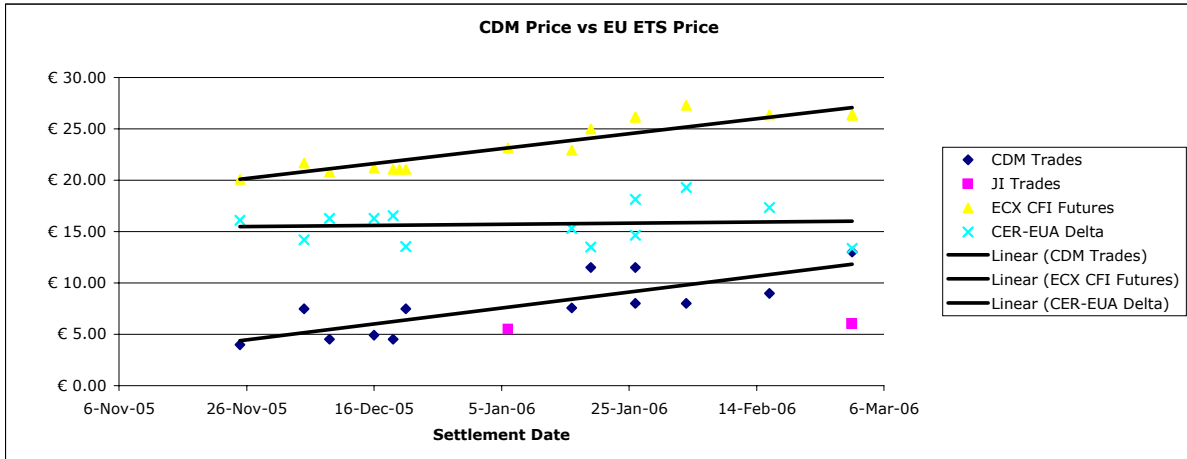


Figure 7: A comparison of the price of CERs to the price of EU Allowances. Shown in dark blue (diamonds) are the prices of reported CER secondary market transactions. In Yellow (triangles) are the settlement prices for EU Allowances on the same day as the CER trades shown in dark blue. In light blue (exes) is the difference in price between the CDM trades and the EU Allowance settlement price showing a relatively constant offset between the two over a large price change for both. Black lines are linear fits to the data.

Thus the relatively sparse data available indicate that CERs are trading at a relatively constant discount to EUAs. This shows that at least part of the goal of CDM is being accomplished - reducing the cost of compliance with the Kyoto Protocol. The data also indicate however that because of the limited supply of CDM projects, the price of CERs is likely being driven by the EUA price rather than the cost of emissions reductions in the developing world. Thus the reduction in the cost of compliance is coming as a result of the markets perception of an increase in risk and not, as intended, due to the lower cost of emissions reductions in the developing world. Assuming that the purchase of JI or AAUs does not play a major role in the compliance of the EU, Japan, or Canada, for the price of CERs to be driven away from the EUA price, supply would have to at least approach demand, as roughly represented by the current overshoot of the Kyoto target. This implies a CDM pipeline substantially larger than the current one.¹⁸³ Given the time left remaining before the end of the first compliance period¹⁸⁴ and the time and money necessary to prepare and shepherd a CDM project through the registration process, such a supply is unlikely to appear.¹⁸⁵ Indeed, as the regulatory risks and uncertainties implicit in the CER forward contracts are reduced as decisions about compliance strategies are made and CDM accounting facilities come on line, the CER price is likely to more closely resemble the price of EU Allowances.¹⁸⁶

¹⁸³ *Infra* Part VII.

¹⁸⁴ The first compliance period ends December 31, 2012.

¹⁸⁵ Haites, *supra* note 58, at 37.

¹⁸⁶ Point Carbon, *supra* note 127, at 4-5.

IX. Conclusions: the Post-2012 Regime:

The parties to both the Kyoto Protocol and the UNFCCC are now considering what to do to accomplish the goal of the UNFCCC after the first compliance period ends in 2012. Global carbon trading is likely to play a role in any future architecture. The point of this description of the current and likely future state of the CDM has been to point out that before we assume that trading of all gases from all types of projects is a good thing, it's worth looking at the empirical evidence from the trading program as it exists now. That evidence suggests that the CDM is an extremely inefficient subsidy producing rather limited environmental benefits at extremely high cost. At the same time, this evidence strongly supports the concept of a global trading regime as a means of inducing developing nations to curb emissions.

The CDM set three goals: to produce sustainable development, to help developing countries accomplish the objective of the UNFCCC, and to reduce costs of compliance for parties with quantitative targets. The evidence presented above points to the possibility that the CDM is accomplishing these goals, but only to a limited extent. It also shows that to the extent that developed world resources are to be transferred to the developing world to accomplish climate change mitigation, there may be more efficient ways of doing so than through the CDM as currently implemented. The CDM market as it has developed has failed to encourage, in substantial measure, the addition of low carbon intensity energy infrastructure in the developing world. Rather, it has induced producers of industrial chemicals to do, for a premium, what developed world producers of these products do for free. At the same time, what little renewable or low-carbon energy that has been financed by CDM subsidy has predominantly been on the margins of the energy sector. Rather than being the seed money that tips the balance of energy investment in favor of large low-carbon intensity projects, CDM has been largely irrelevant to major energy decisions made by the rapidly developing Non-Annex I nations.¹⁸⁷

Further, analysis of the financial incentives created for HFC-23 and N₂O emitters, suggests that it is worth considering whether any future carbon trading program should be limited to CO₂ rather than including the other greenhouse gases covered by the protocol. It seems fairly evident that the other gases can be abated at very low cost and at a relatively small number of facilities. Given these realities, it makes little sense for the developed world to subsidize their abatement at a price far in excess of cost. The major difficulty with this proposal is likely the expectations on the part of project proponents and of market participants that non-CO₂ carbon trading will continue. While this market expectation should not be taken lightly, it is the tail that should not be allowed to wag the dog. The purpose of the Kyoto Flexible Mechanisms was to accomplish emissions reductions at the lowest marginal cost possible. The CDM market has failed to accomplish this. In a world of limited resources, modifying it makes sound environmental and financial sense.

¹⁸⁷ For example, the CDM has failed to generate any fuel switching from coal to natural gas at major power plants (>250 MW) in China or India, to generate conversion of major power plants to combined cycle technology, or to induce construction of gas fired plants instead of coal.

Indeed, the international community already has significant experience in compensating developing countries for the reduction of dangerous atmospheric emissions by paying for the cost of abatement rather than for the market price. The Multilateral Fund of the Montreal Protocol has been very successful at accomplishing the phase out of the most harmful ozone depleting substances (“ODSs”).¹⁸⁸ This fund has operated from the principle that developed nations should pay any additional costs associated with the transition away from ODSs to new chemicals¹⁸⁹. Under a future climate change protocol, this model could be adopted for the purposes of HFC-23 and N₂O abatement in the developing world with resulting emissions reductions applied to Annex I countries based on their contributions to the fund or some other agreed upon metric. A Multilateral Fund style of program might be worth considering for landfill and CAFO emissions of CH₄ as well.

Adopting a multilateral fund type model for industrial emissions of these three gases has other advantages beyond just efficiency. First, a multilateral fund aimed at abating emissions of N₂O and HFC-23, and possibly CH₄ would allow better coverage of both industries so that maximum use of this low cost emission reduction strategy could be realized, both in the developing and the developed world. As noted previously, despite extremely strong financial incentives to do so, the CDM’s market incentives have only been able to produce about 2/3 of the abatement that is possible from the developing world HCFC-22 industry. Evidence from the Montreal Protocol experience suggests that a multilateral fund, backed by commitments from developing world signatories could do better.

Second, a strategy for these gases modeled on the multilateral fund would have the possibility of inducing a broader if perhaps shallower participation in a climate treaty. Non-participation is a fundamental problem with the Kyoto Protocol. Currently, the two largest emitters of GHGs, the United States, and China, are not participants in the components of the Kyoto Protocol that involve binding commitments. The United States refuses to take such an action without a similar commitment from China and India. Both of these nations refuse to undertake binding emissions limits for fear that such a commitment will limit their economic and social development. It is hard to see how the global commons problem of climate change can be resolved without their participation.

Climate change is a long-term problem that requires long-term solutions. Lack of meaningful participation by the key global players in the most important climate change regime is unlikely to set the world on the gradual path that it needs to take in order to resolve this global commons problem. Inducing these nations to enter into a series of Protocols to the UNFCCC that dealt individually with the more tractable, less expensive aspects of the climate change problem might well build a global institution more capable of taking on the far more difficult challenge of reducing CO₂ emissions from power generation. Such a gradualist strategy has been successful in two of the great diplomatic successes of the twentieth century, the WTO and the European Union. Neither attempted to solve all of the difficult dilemmas at the

¹⁸⁸ Richard Elliot Benedick, *Ozone Diplomacy*, 265-268 (1998).

¹⁸⁹ *Id.*, at 254-265.

beginning, but rather attempted to draw parties into a gradual process of accommodation that over time has produced substantial results.¹⁹⁰ New protocols to the UNFCCC that allow for rapid reductions in these trace gases offer the promise of building a solution to the problem of global warming in a piecemeal way that may encourage broader participation than has the grand bargain represented by Kyoto.

If on the other hand, negotiators wish to stick with the Kyoto framework in the years after the first commitment period, even without United States, Australian, and perhaps Canadian participation, there is yet another way to improve on the CDM. Nations are not required to purchase themselves or to allow private entities to purchase CERs. This is an option that Europe has chosen to adopt and it is one that Europe could mold so as to encourage the kind of CDM that all had hoped for and discourage the accounting gimmicks and over subsidization that have come to dominate the current market. The Linking Directive of the European Commission lays out the rules by which CERs may be imported into the EU ETS. It would be an easy matter for the European Commission to modify this directive to specify that post-2012, HFC-23 and N₂O project CERs would be either unexchangeable for EUAs, the GHG currency of the ETS, or taxed at a very high level. Either action would go a significant distance toward leveling the playing field for energy efficiency and renewable energy projects.

The CDM's final disappointment is that among the CO₂ projects actually in the current program, there are virtually no large-scale power projects.¹⁹¹ This is a major disappointment and failure of the CDM program in that the majority of GHG emissions from the developing world do and will in future come from emissions from highly inefficient and carbon intensive large energy projects. The small renewable energy projects currently typical in the CDM portfolio are unlikely to be more than marginal players in the energy market of the major developing countries, India, China, South Korea, and Brazil. The major driver behind the inclusion of global carbon trading in the Kyoto Protocol was the insight that it was far cheaper to build new low-carbon emission energy infrastructure in the developing world than to replace it prematurely in the developed world. The CDM has not even begun to accomplish this goal. Resolving this failure of the current CDM market should be a central goal of any future trading program. Under current rules for the calculation of additionality it is unlikely to be possible. Even with a modification of these rules to encourage cleaner energy, it is unlikely given the marginal costs of building low- versus high-carbon intensity large-scale power plants. Other workers have suggested that because of the politically determined nature of the energy sector business as usual "baseline", that the best course of action in addressing this critical component of developing world involvement in may be to directly address the politics of energy decision making in the critical developing countries with rapidly growing economies.¹⁹²

¹⁹⁰ But note that both of these treaty structures began with, and at least in the case of the EU, continue to have relatively small memberships when compared with the UNFCCC.

¹⁹¹ Out of 700 projects, only three will produce more than 250 MW of power. Only 23 will generate more than 100 MW. Meanwhile, China's electricity sector is growing at 4.8% or 100 billion kilowatt-hours per year. See, Energy Information Administration, *supra* note 50, at 98.

¹⁹² Thomas C. Heller and P. R. Shukla, Development and Climate: Engaging developing countries, in *Beyond Kyoto: Advancing the international effort against climate change*, 111, 117 (2003).

Whether or not the right incentives can be built into a market mechanism to drive low-carbon power development organically or such change must be precipitated by national policies and measures is beyond the scope of this paper. In any case, the CDM as currently constituted is not doing the job.

The preceding analysis has illustrated that the global carbon market does not live up to its current hype. The past year has seen it take on the rough mold that it will most likely have during the First Compliance Period. That mold is one of an extremely inefficient subsidy delivered to a small set of industrial chemicals manufacturers rather than as had been expected, a substantial push toward a low GHG emission and hence more sustainable future for the developing world. At the same time, the analysis shows that the incentives produced by the global carbon market do indeed have the potential to induce significant participation on the part of developing nations in the global effort to combat global warming. Moving forward, the challenge for the international community will be to maintain this active participation while honestly facing up to the flaws in the current CDM. If they can manage this, a far more efficient and therefore environmentally effective trading system is possible.