

Measuring The Clean Development Mechanism's Performance and Potential

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1. Introduction.

The Kyoto Protocol has entered into force despite US non-participation. One of its key components, the Clean Development Mechanism ("CDM") is a regime for the creation and trading of greenhouse gas ("GHG") offsets. An offset is a tradable instrument representing some volume of GHG that the seller has voluntarily agreed not to emit in exchange for the right to sell the offset. A seller will abate her emission of GHG and sell an offset when the cost of not emitting is less than the market price for offsets. A buyer in turn will purchase an offset when its value is less than the cost to him of not emitting some quantity of GHG. In the CDM, offsets are denominated in terms of Certified Emissions Reductions ("CERs") which represent 1 metric ton of CO₂ or its equivalent ("1 t CO₂e"). CDM projects must be located in developing nations while CDM buyers are either developed nation governments or private entities. Thus as well as being a market, the CDM is a subsidy from developed to developing nations.

The CDM was included in the Kyoto Protocol because negotiators believed that it would help to lower costs of compliance for signatories with binding commitments (the developed world) while facilitating sustainable development in the developing world. The costs would be lowered by trading because GHG reductions are in general cheaper in the developing world than in the developed. This difference exists because it is less expensive to build low GHG emission infrastructure from scratch than to replace or retrofit existing capital stock. Since most energy infrastructure to be built during the next 20 years will be in the developing world, low cost abatement opportunities exist there. Thus it is cheaper for developed nations to pay developing nations to build low-GHG emitting energy production and industry than to pay to reduce emissions domestically.

The CDM was intended to be and has in fact become the largest ever market based atmospheric pollution regulatory regime. During the past year, it has exploded in size as nearly 300 projects have been registered by the CDM Executive while over 396 Mt CO₂e of CERs futures contracts with an estimated value of greater than \$2 billion changed hands in 2005, representing a 600% increase over 2004. A significant body of research has examined the theoretical underpinnings of GHG trading mechanisms. But only now, with CDM and the European Union Emissions Trading Scheme ("EU ETS") finally producing a track record is empirical analysis of these regimes possible. My research aims to answer three questions about this large and growing experiment in the regulation of atmospheric pollution:

- (1) Is the CDM an efficient subsidy? That is, does it accomplish the environmental objectives of the Kyoto Protocol at the lowest possible cost?
- (2) Is the CDM an effective market mechanism? Does it induce participation by low cost providers of emission reductions? To what extent are market participants able to extract rents through strategic behavior?
- (3) Is the CDM an effective political mechanism? How does it compare to past experience with other offset and permit based emissions trading programs?

2. Methods.

I constructed a database of all CDM projects that have reached the validation phase, for whom registration has been requested, or that have been registered by the CDM Executive Board. This represents every project that has successfully passed through or is currently in the official CDM project approval process. I refer to this as the "CDM pipeline".

The database contains project type, estimated annual emissions reductions for each project, date of project initiation, as well as various other related parameters. I also monitor capacity of energy related projects (not shown).

By combining estimates of annual emissions reductions with estimated dates of project start-up, I derive the total volume of CERs likely to be supplied to the CDM market during the Kyoto Protocol's First Commitment Period (2008-2012) by projects currently in the CDM pipeline.

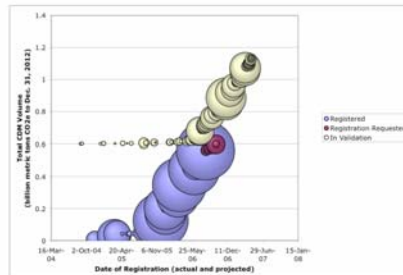


Figure 1: Volume of CERs deliverable during the first commitment period versus date of registration. Shown in blue are registered projects. Shown in purple are projects for which registration has been requested. Shown in yellow are projects currently being validated. Size of bubbles is a function of project size.

3. The CDM Pipeline

As illustrated by Figure 1, the past year has been a period of explosive growth for the CDM. As of mid-August, 2005, total CDM supply to 2012 was less than 50 million t CO₂e. Today, total supply is approximately 1132 million t CO₂e. This is a small fraction of global emissions (~25,000 million t CO₂e) but is quite substantial relative to agreed upon cuts by the EU25 under the Kyoto Protocol (8% of 1990 baseline = ~300 million t CO₂e).

Note that large projects dominate supply. The 20 largest projects, out of the 985 shown in Figure 1 make up 50% of the supply of emission offsets. The largest 10% of projects make up 77% of supply. Thus understanding the economic, environmental, and political characteristics of these small number of large projects is crucial to evaluating the success of the CDM.

Figure 2 shows that, contrary to expectation, energy sector projects do not dominate the CDM. Rather, HFC-23 abatement projects, which capture and destroy this potent greenhouse gas which is a byproduct of the manufacture of HCFC-22, a common refrigerant, are the most important class of project, followed by capture and destruction of CH₄ emitted by landfills and N₂O emitted during the manufacture of nitric and adipic acid.

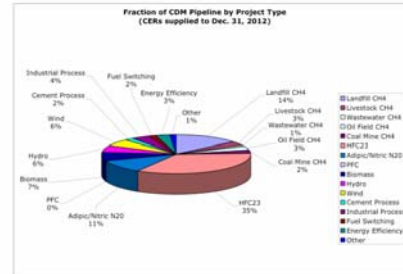


Figure 2: The makeup of the CDM pipeline by project type. By far the largest project category is HFC-23 abatement by HCFC-22 refrigerant manufacturers. Landfill CH₄ capture and destruction and capture of N₂O during adipic and nitric acid production are also important. Together, these three sectors represent 58% of the CDM offset supply.

4. The Case of HFC-23

HFC-23 is a byproduct of the manufacture of HCFC-22, one of the most commonly used refrigerants. For each kg of HCFC-22 produced, between 15 and 30 g of HFC-23 is produced. Because HFC-23 has a global warming potential of 11,700, 15 to 30 g of HFC-23 is equivalent to 0.18 to 0.35 tons of CO₂.

Capture and destruction of HFC-23 is relatively simple and inexpensive. Developed world producers of HCFC-22, led by Dupont, have instituted voluntary programs to capture and destroy HFC-23 at their plants. Developing world producers do not voluntarily capture their HFC-23. Also, developing world producers in general have a higher rate of HFC-23 production than developed world producers. There are no regulations in either developed or developing world countries regarding HFC-23 emissions or capture.

As shown in Figure 3, the value of CDM offsets produced by 1 kg of HCFC-22 production far exceeds the wholesale price of the refrigerant, thus potentially distorting trade and leading to shifts of production towards the developing world.

Figure 3: Calculation of the net value of the CDM subsidy to developing world HCFC-22 producers. As of early 2006, wholesale prices for HFC-22 were ~€1.60/kg. Thus an HFC-22 producer can earn almost twice as much by destroying a byproduct of HCFC-22 production as she can by selling the refrigerant.

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
Step 3: Estimate the cost per kg HCFC-22 (calculations are for facility capable of capturing and destroying 200 t HFC-23/yr)	Gross subsidy per kg HCFC-22 = €3.16 €3,000,000 investment @ 8% interest + €200,000 pe r year operating costs = €900,000 pe r year cost.
Step 5: Calculate the Cost per kg HCFC-22	€900,000/200 t HFC-23 = €4500 t HFC-23 €4500 t HFC-23 * 3% HFC-23 = €135 t HFC-22 = €88.5 t HFC-22 €88.5 t HFC-22 * 1 t / 1000 kg = €0.09
Step 6: Calculate the net CDM subsidy	€3.16 - €0.09 = €3.07/kg HFC-22

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5. Analysis

(1) An Efficient Subsidy?

CDM is dominated by very low cost providers of emission offsets. Given scarce resources and if political will, we should not pay €9/ton when costs for 35% of the market are €0.09/ton.

(1) An Effective Market Mechanism?

On the one hand, CDM has brought lower cost providers of emission offsets into marketplace.

On the other, there is some evidence that HFC-23 producers artificially inflated baselines in order to manipulate market.

Apples and oranges: main buyers of CDM offsets are CO₂ emitters while main sellers are HFC-23, N₂O, and CH₄ emitters. Differences in gasses' global warming potentials leads to market distortions.

(1) A Successful Political Institution?

Previous U.S. and international offset markets have failed to induce significant, deep, participation by either buyers or sellers. CDM has induced significant participation by both buyers and sellers.

CDM has failed to induce significant participation on the part of large (>100MW) electric power generators. Participation by these GHG emitters is key to realizing potential of low cost emission reductions in developing world.

6. Proposals for Reform

Break the Basket of GHG Gases

- At least for purposes of international trading regimes, do not allow conversion between GHGs via their global warming potentials

Induce Broad but Shallow Participation

- Negotiate a series of protocols aimed at achieving 100% abatement of the "low hanging fruit". Possible targets include HFC-23, PFCs in AI production, N₂O from adipic and nitric acid production, and possibly CH₄ from large landfills and confined animal feeding operations.

- Attempt to induce broad but shallow participation in these protocols as a way of drawing in reluctant participants in GHG treaties (US, China, and India).

The Montreal Protocol's Multilateral Fund as Exemplar

- Use successful model of Montreal Protocol's Multilateral Fund as a model for non-CO₂ gas treaties.
- Developed nations pay actual cost of abatement rather than market price set by cost of CO₂ emission reduction.

Keep the CDM, but for CO₂ only

- Continue CDM market in future commitment periods (if any) but in modified form that allows/encourages participation by large energy generators.