

**Moving Toward A Consensus on Climate Policy:
The Essential Role of Global Public Disclosure**

By David Wheeler

Abstract

Among climate scientists, there is no longer any serious debate about whether greenhouse gas emissions from human activity are altering the earth's climate. There is also a broad consensus on two issues related to reducing emissions. First, developing countries must be full participants in global emissions control, because they will be most heavily impacted by global warming, and because they are rapidly approaching parity with developed countries in the scale of their emissions. Second, efficient emissions control will require carbon pricing via market-based instruments (charges or cap-and-trade). These points of consensus are sufficient to establish a clear way forward, despite continued disagreements over the choice of specific instrument and the appropriate carbon charge level. *Since all market-based systems that regulate emissions sources require the same emissions information, the international community should immediately establish an institution mandated to collect, verify and publicly disclose information about emissions from all significant global carbon sources. Its mandate should extend to best-practice estimation and disclosure of emissions sources in countries that initially refuse to participate.* This institution will serve four purposes. First, it will lay the necessary foundation for implementing any market-based system of emissions source regulation. Second, it will provide an excellent credibility test, since a country's acceptance of full disclosure will signal its true willingness to participate in globally-efficient emissions reduction. Third, global public disclosure will itself reduce carbon emissions, by focusing stakeholder pressure on major emitters and providing reputational rewards for clean producers. Fourth, disclosure will make it very hard to cheat once market-based instruments are implemented. This will be essential for preserving the credibility of an international agreement to reduce emissions.

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1. Introduction

Among climate scientists, there is no longer any serious debate about whether greenhouse gas (GHG) emissions from human activity are altering the earth's climate. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC IV, 2007), the likelihood of this effect is over 90%. Remaining debate in the scientific literature focuses on the size, timing and impact of global warming, not on its existence. Among social scientists and policymakers, another important debate focuses on appropriate measures to reduce emissions, accelerate development and diffusion of clean technologies, and support adaptation to the impacts of unavoidable climate change. A critical part of this debate has focused on the double-edged predicament faced by the billions who remain poor. If their societies ignore climate change, it may undermine the development process because global warming will have its heaviest impact on the South. If the South commits to carbon limits, on the other hand, the associated costs will be significant. This has created a crisis in North-South relations, as the South has seized on the idea that greenhouse emissions are a Northern problem that the North must solve, while the South remains free to overcome poverty without worrying about carbon emissions limits. Unfortunately, new research shows that this view is both incorrect and dangerous for the South, because its own accumulating emissions would already be sufficient to catalyze a climate crisis without any emissions from the North (Wheeler and Ummel, 2007). The lesson of this research is clear: Global emissions are a global problem, and everyone must be at the table to determine appropriate policies for reducing them.

The debate continues on appropriate measures to promote reduced emissions, clean technology development, clean technology diffusion, and adaptation to global warming. This paper focuses on the debate about regulation of carbon emissions sources: the contending positions on regulatory instruments and carbon pricing, the underlying points of agreement, and the implications for global policy. Section 2 shows why positions remain widely divergent on the scale, timing and stringency of needed measures to limit emissions. Section 3 discusses the regulatory options, while Section 4 identifies the emergent policy consensus and makes concrete suggestions for global action. Section 5 summarizes and concludes the paper.

2. The Debate Over Carbon Emissions Regulation

The international community has recently awakened to the possible existence of a critical threshold: an atmospheric CO₂ concentration, perhaps as low as 450 parts per million volume (ppm), beyond which large and irreversible damage from global warming is very likely.¹ But we are already very late in the game. By mid-2007, the atmospheric concentration had increased from its pre-industrial level, about 280 ppm, to 386 ppm. Under widely-varying assumptions in current forecast scenarios (IPCC SRES, 2000),² we will almost certainly reach 450 ppm within 30 years without serious efforts to limit emissions. Staying under this threshold, or even within limits 100-200 ppm higher, will involve very rapid global adjustment, with unprecedented international coordination of efforts and a very strong focus on cost-effective measures.

Although there is a global consensus for action, contention over appropriate measures remains serious because of disagreements about the timing and scale of future

¹ CO₂ is the primary greenhouse gas.

² Scenario descriptions are available online at <http://www.grida.no/climate/ipcc/emission/089.htm>.

climate change, the severity of its impacts, the choice of appropriate policy instruments, and the size of the incentives needed to promote needed reductions in carbon emissions.

Two debates propel the scientific controversy. The first is about climatic adjustment systems that are not completely understood. These include thermal absorption by the oceans; associated thermal convection currents at global scale; absorption and expulsion of carbon by terrestrial sinks; changing absorption of solar radiation as melting polar ice yields darker waters and land masses; radiation-blocking by cloud formations; and changes in carbon fixation by living biomass. The second debate is about the significance of enormous, potentially-unstable terrestrial and marine carbon deposits. A frequently-cited example is the carbon sequestered in permafrost regions, which will escape into the atmosphere if global warming continues (Zimov et al., 2006). Another is the carbon sequestered in the deep oceans, which may be expelled into the atmosphere as global warming affects deep-sea circulation. Recent research suggests that such an expulsion occurred during the rapid temperature rise at the end of the most recent ice age (Marchitto et al., 2007).

These factors make it difficult to forecast the timing and severity of global warming. Most climate scientists also believe that at least three elements of instability – icecap melting, permafrost carbon and deep-ocean carbon – are so large that they determine thresholds beyond which positive feedbacks would cause the atmospheric GHG concentration and temperature to increase rapidly over some range. Although scientists disagree about the timing of such “tipping” phenomena, few doubt that triggering them would have catastrophic implications because global society could not adjust rapidly enough to avoid enormous damage.

The dramatic tension here is supplied by three critical elements: Most climate-change impacts will be experienced by future generations; there is a real possibility that unrestricted emissions will precipitate a climate catastrophe at some point in the future; and massive inertia in the global climate system³ means that protecting future generations requires costly emissions control now. These elements have set the stage for heated debates among social scientists and policymakers about the timing and stringency of carbon emissions limitation.

Intergenerational Distribution

Economists continue to argue about the appropriate social discount rate (SDR) – the weight that we should apply to our descendants’ welfare in making benefit-cost decisions. This is extremely important for climate change policy, which must weigh large emissions control costs in the present against benefits that will accrue to people in the distant future. In brief, the SDR has two components. The first is a “pure” social rate of time preference, which reflects the response to the following values question: If we know that our grandchildren’s material status will be the same as our own, should we count their welfare equally with our own in making decisions about climate change policy? If the answer is yes, or nearly yes, then we should make significant sacrifices now to prevent adverse impacts on our grandchildren. If, on the other hand, we discount the fortunes of succeeding generations, then we will be inclined to let them fend for themselves. We will accept little or no sacrifice of consumption now to insure our successors against losses a century or two hence.

³ This inertia arises from the long duration of carbon emissions in the atmosphere, as well as the positive-feedback systems mentioned above.

The second component of the SDR reflects our assumptions about future progress. If world economic growth and technical progress continue at historical rates, and are not undermined by global warming itself, then our grandchildren will be far richer and better endowed with technical options than we are. In this case, in fairness, it makes sense for us to minimize our sacrifices now, even if we value future generations' welfare the same as our own.

Much of the recent controversy over climate change policy among economists reflects different views about the appropriate SDR. The Stern Review (2006) adopts a very low SDR, tilting the benefit-cost calculus strongly in favor of future generations, while Nordhaus (2007a,b) and others advocate a much higher SDR. Quiggin (2006) provides a clear summary of the issues and concludes that neither side has a conclusive case.

Risk

A previous section described several “tipping” scenarios that would have irreversible and potentially-catastrophic effects. Scientists can attach probabilities to such threshold effects, but they are inevitably somewhat arbitrary. Examples include disintegration of the polar ice sheets within decades rather than centuries, drowning the world's coastal cities and infrastructure before there is time to adapt; shutdown of the Gulf Stream, which would make Europe's climate much more like Canada's; and an upsurge of catastrophic damage from violent “superstorms”. We would undoubtedly invest heavily to avoid such catastrophes if we believed they were imminent. When they are deferred to the more distant future, however, the calculus becomes murkier.

The Benefits and Costs of Carbon Emissions Control

The Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC IV, 2007) acknowledges the possibility of threshold effects, but considers the science insufficient to incorporate them explicitly. Stern (2006) incorporates such effects, and the result is a strong tilt toward stringent (and costly) emissions control policy. Lomborg (2007) does not incorporate them, and this moderates his conclusions about appropriate stringency. While criticizing Lomborg's approach, Dasgupta (2007) argues that traditional benefit-cost analysis is ill-equipped to incorporate climate thresholds in any case.

Stern (2006), Lomborg (2007) and Nordhaus (2007a,b) have estimated the costs associated with various emissions targets.⁴ Stern and Lomborg focus on the cost of limiting the atmospheric CO₂ concentration to approximately 550 ppm. Lomborg estimates the cost at approximately \$52 billion annually, or 0.11% of global income,⁵ while Stern estimates the cost at 1% of income. Nordhaus (2007b) quantifies the costs associated with a variety of targets, using a social discount rate that is considerably higher than Stern's. Table 1 displays his results which, given his modeling assumptions, show that when emissions restrictions are tightened, the costs increase faster than the benefits. Lowering the atmospheric concentration limit from 700 ppm to 420 ppm, for example, increases discounted benefits (avoided damages) by \$7.4 trillion and increases discounted emissions control costs by \$25 trillion. While net benefits are positive for the

⁴ Carbon emissions from land-clearing are a very important source of global warming. However, the cost calculations reported in this section focus principally on industrial emissions, primarily from fossil fuel combustion. Introduction of population and deforestation effects generally relies on the assumption that the relevant variables change exogenously. For example, Nordhaus (2007b) imposes a logistic function on world population, roughly consistent with mid-range UN projections, that stabilizes global population at around 8.5 billion.

⁵ Based on global GDP of \$48.2 trillion (World Bank, 2006)

700 ppm limit relative to the no-control baseline (2.4 benefit/cost ratio), the converse is true for the 420 ppm limit (.5 benefit/cost ratio). The same message about incremental benefits and costs recurs throughout Table 1, which includes four temperature-increase limits, variations on the Kyoto Protocol, one version of the Stern Review results, and a recent proposal for rapid emissions reduction by Al Gore.

At Nordhaus' social discount rate, which tilts results more strongly toward the present than the Stern rate, near-term costs loom much larger than long-term benefits when sharp omissions reductions in the near future are needed to reach a target. As Table 1 shows, Nordhaus' approach yields negative net benefits (benefit/cost ratios less than 1) for the stringent programs of Stern and Gore when they are compared to the baseline case (no explicit emissions control). Of course, Stern and Gore do not agree with Nordhaus's conclusions, principally because they dispute his assumptions about the social discount rate and the risk of future climate catastrophes.⁶

Pricing Carbon

Nordhaus (2007b), Stern (2006) and others have estimated the carbon charges (or auctioned permit prices under cap-and-trade) that are consistent with different levels of emissions control. The underlying economic logic supports a charge that rises over time. At present, most damages are in the relatively distant future and there are plentiful high-return opportunities for conventional investment. Investment should become more intensive in emissions reduction as climate-related damage rises, and rising charges will provide the requisite incentive to reduce emissions. The optimal "ramp" for charges depends on factors such as the discount rate, abatement costs, the potential for

⁶ The stakes are clarified by Nordhaus himself, who notes that his cost estimate for Stern (1.5% of income) is 50% higher than Stern's own estimate.

technological learning, and the scale and irreversibility of damage from climate change (Nordhaus, 2007a). As we have seen, these factors remain contentious. It is therefore not surprising that different studies establish very different ramps. Nordhaus' preferred path begins at about \$8/ton of CO₂, rising to about \$23/ton by 2050. Stern's initial charge is 10 times higher -- \$82/ton -- and his ramp is steeper. IPCC IV (2007) cites a variety of studies whose initial values average \$12/ton, distributed across a range from \$3-\$95/ton.

We are clearly a long way from consensus on pricing carbon, but it is critical to make a start, with all countries participating if possible. Even if initial carbon charges are at the modest end of the range, the revenue implications are significant. Nordhaus' initial charge (\$8 per ton of CO₂), if applied to current Northern CO₂ emissions (16.5 Gt) uniformly, would generate over \$130 billion. Some of this revenue could be earmarked for financing clean-technology R&D, rapid adoption of clean technology by developing countries, and assistance to those countries for adapting to the global warming that is already inevitable. With such a revenue base, the annual clean-energy R&D budget recommended by Lomborg (2007) -- \$25 billion -- could easily be financed.⁷

To summarize, policy analysts continue to disagree about the timing and stringency of regulation because they have different perspectives on climate dynamics, the social discount rate, risk, and the implications of benefit/cost assessment. However, almost all contenders agree that some form of global emissions regulation is necessary. In addition, most agree that efficient emissions reduction requires implementation of a market-based

⁷ From a public finance perspective, it would be preferable to separate clean technology development decisions from revenues generated by emissions regulation. In practice (particularly in the US), however, earmarking is often the only way to allay public resistance to new charges or taxes.

instrument to regulate emissions sources – carbon charges, cap-and-trade, or some combination of the two.⁸

3. Instruments for Emissions Regulation

3.1 Three Waves of Regulatory Development

Creating effective incentives for carbon reduction will require some form of emissions regulation, which has developed in three “waves” since the 1960’s (Wheeler et al., 2000; Tietenberg and Wheeler, 2001). In the first wave, until the 1980’s for most countries, the focus was solely on “command and control” regulation. Polluters were given fixed regulatory limits (either quantities, waste-stream intensities, or required technology installations), and subjected to escalating penalties as they progressively exceeded these limits. While this has remained the dominant approach to pollution regulation in most countries, its inherent inefficiency has been aptly criticized on several grounds: It does nothing to reward polluters who reduce emissions beyond compliance norms, it pays no attention to differences in pollution control costs, and it frequently entails burdensome technical specifications that must be constantly updated.

In reaction, the second wave focused on market-based regulatory instruments. Broadly, these instruments are separated into two classes. Pollution charges impose a charge on each unit of pollution and leave polluters free to decide how much to pollute. Charges have desirable efficiency properties, since they enable polluters to treat the environment as another “priced input” and optimize accordingly. They have achieved acceptance in some countries, particularly for water pollutants. However, their influence

⁸ Because it focuses on regulation of emissions sources (e.g., power plants, cement plants), this paper does not consider market-based regulation of high-carbon production inputs such as coal. Direct, market-based regulation of coal may warrant serious consideration for two main reasons: Coal combustion is a huge source of carbon emissions, and coal is a high-bulk commodity that is easily tracked to the mines that produce it.

in many societies has remained limited because of inevitable uncertainty about the relationship between the charge and polluters' response. For dangerous pollutants, any given charge may prove insufficient to induce collective pollution reduction sufficient to reduce the hazard to a tolerable level. In principle, this can be handled through constant monitoring of the response, and adjustment of the charge to move total pollution to the desired level (Baumol and Oates, 1971). In practice, such adjustment has proven difficult because most political systems do not easily accommodate this kind of information-driven flexibility.

The other market-based approach addresses uncertainty about total pollution by imposing an overall limit on emissions, distributing unit emissions permits by some means, and then allowing polluters to buy and sell the permits as conditions warrant. Typically, marketable permit (or cap-and-trade) systems begin by accepting current total pollution and allocating permits to polluters in proportion to their emissions. From an efficiency perspective it would be far better to auction the permits, just as governments auction broadcast spectrum, but this has rarely happened in the case of pollution. After initial permits are issued, total allowable pollution is periodically reduced, and polluters are allowed to trade permits as their economic circumstances warrant. Over time, total pollution falls and economic efficiency is enhanced by the permits market. This approach is no panacea, however. Resolution of uncertainty about total pollution creates uncertainty about the price of polluting. This is the price of a unit emissions permit, which will vary over time in a complex trading system. Permit prices may prove inordinately high if overall reductions are too ambitious. In addition, marketable permit

systems require the creation of a new and complex trading institution that requires constant oversight.

In response to such difficulties, a third wave of regulation emerged in the 1990's. The third wave is public disclosure, in which governments require firms to reveal their emissions to the public. Public disclosure systems first emerged to address toxic pollution, because the sheer number of toxic pollutants exceeded the capacity of formal regulatory systems. Then disclosure systems spread to other pollutants, particularly in developing countries, as their advantages became apparent. First, their transparency and relative simplicity enhance their appeal in the weak institutional environments that characterize many developing countries. Second, they introduce more flexibility than formal regulatory systems, by substituting multiple agents with multiple incentives for a single formal regulatory agent. Whatever the formal requirement (command-and-control regulation, tradable permit price, unit pollution charge), many stakeholders will prefer environmental performance better than the requirement. Public disclosure empowers these stakeholders to make their influence felt through a variety of market and non-market channels (Wheeler et al., 2000; Tietenberg and Wheeler, 2001). Third, public disclosure demonstrably works. In both developing and developed countries, disclosure of plant-level pollution has led to rapid, significant reduction of pollution from many facilities (Dasgupta, Wang and Wheeler, 2005).

3.2 Public Disclosure in Developing Countries

Public disclosure has been particularly effective in developing countries, which will play an essential role in limiting global carbon emissions. Their experience with regulating local air and water pollutants provides a useful context for thinking about

carbon emissions regulation. Many developing-country environmental agencies began regulating pollution in the 1980's and '90's. Although most agencies are equipped to set legal standards for maximum allowable emissions levels, monitoring and enforcing compliance with these standards is often hindered by scarcity of technical personnel, weak information management, and corruption. In response, developing-country regulators have begun opting for second- and third-wave regulation. Some have turned to financial incentives by charging polluters for every unit of their emissions. Recent experiences with pollution charges in Colombia, China, Indonesia, and the Philippines have shown that managers opt for serious pollution control when they face regular payments for emissions (Wheeler et al., 2000).

Many agencies have also opted for public disclosure, which discourages corruption; strengthens enforcement through community and market pressure on polluters; and provides reputational rewards for clean firms. For example, Indonesia's environment ministry initiated its Program for Pollution Control Evaluation and Rating (PROPER) in 1994. Successful implementation of PROPER (Afsah, Blackman and Ratananda, 2000) has inspired similar programs in the Philippines (EcoWatch), China (GreenWatch – Wang and Wheeler, 2004), Vietnam (Environmental Information Disclosure), and India.

Table 2 provides summary evidence on the impacts of the disclosure programs in Indonesia, the Philippines, China, and Vietnam. In all four countries, public disclosure was intended to strengthen, but not replace, weak conventional regulatory systems. The tabulated results suggest that initial concerns about compliance were well-founded. Before disclosure, compliance rates were 37% in Indonesia, 8% in Philippines, 10% in Vietnam, 75% in Zhenjiang, China and 23% in Hohhot, China. After disclosure, the

compliance rate increased by 24% in Indonesia, 50% in Philippines, 14% in Vietnam, 10% in Zhenjiang, China (from a high base), and 39% in Hohhot, China. In light of the evident regulatory problems in all four countries, these improvements suggest that public disclosure had a very significant effect on reducing pollution.

4. Regulating Global Carbon Emissions

Which regulatory approach will work best for reducing carbon emissions? Both pollution charges and tradable permits have strong partisans; debate about their relative merits continues, along with contention over the appropriate carbon price level. But these disagreements should not be permitted to mask two fundamental points of agreement: *The global consensus supports some level of carbon pricing, established by some form of market-based instrument for regulation of carbon emissions sources.* This consensus is highly significant for policy, because all forms of market-based emissions source regulation require the same information on carbon emissions for credible monitoring and enforcement. The first step toward efficient global regulation of this type is therefore clear: *Establishment of an audited global inventory of all significant carbon emissions sources, that will provide the common database for market-based regulation once it is established.*⁹ Setting up the inventory is a major challenge in itself, since it requires common measurement standards, reporting protocols for emissions sources, and technical assistance to firms' managers and staff who will be charged with reporting emissions. An independent system for auditing emissions reports also has to be established. These tasks will take years to complete, so they should begin immediately.

⁹ The same database is also necessary for command-and-control regulation.

The next step toward efficient global regulation is also straightforward: *Once the global inventory is established, emissions from all sources should be reported to the public.* This is important for several reasons. First, it provides an entry point for countries that accept the principle of global regulation, without imposing formal sanctions on polluters. Second, disclosure is a necessary prelude to efficient carbon regulation. For command-and-control or market-based instruments to work credibly in the global arena, they will have to operate in a transparent, audited information environment. Starting disclosure now will work out the kinks in the information system, establish the principle of transparency, and develop generally-accepted emissions benchmarks for formal regulation. Third, disclosure will activate many stakeholders who will, in turn, pressure polluters to reduce their emissions.

After public disclosure is well-established, credible formal regulation can begin. Which system will be most feasible and desirable?¹⁰ To date, cap-and-trade systems have dominated the global discussion. They have the advantages of precedent (the Kyoto Protocol uses cap-and-trade) and relative certainty in the determination of overall emissions, particularly if disclosure has established a credible public information base. However, global cap-and-trade raises the prospect of significant international financial transfers if the overall emissions limit is really binding. The magnitudes are potentially large, and it seems unlikely that many national political systems could accommodate them very easily. In addition, the global institution needed to administer a cap-and-trade system would inevitably be large, complex, and charged with brokering the exceptions that haunt systems which control quantities.

¹⁰ Cogent support for charges can be found in Mankiw (2007) and Nordhaus (2007c). For useful assessments of the EU cap-and-trade system for carbon emissions, see Ellerman and Buchner (2007), Convery and Redmond (2007) and Kruger, et al. (2007).

There is also the problem of initial permit allocation. Auctions have proven difficult to implement, because existing polluters organize to fight them politically. But giving initial permits to those polluters would reward them with a valuable property right and disadvantage newcomers. In summary, a truly global cap-and-trade system seems problematic. If operated efficiently, it could enforce an overall emissions reduction target but the resulting permit price could not be predicted with any accuracy. Accordingly, a politically-acceptable cap-and-trade program will have to include rules for adjusting the supply of permits as the price response is revealed.¹¹

Emissions charges have several appealing characteristics in this context. First, they can be administered within each country on a fiscally-neutral basis. Charge revenues can be used to reduce other taxes, some of which may be highly distortionary. Second, charges don't require the establishment of a complex institution to establish new property rights and monitor exchanges within the system. Third, revenues accrue to society, while tradable permits that are distributed without auctions deliver the potential revenue streams to existing polluters. Of course, the principal weakness of charge systems remains – their quantity effects are uncertain, and adjustments will be necessary as those effects become apparent.¹² And in some societies (particularly the US), there is a deep aversion to new taxes that might not be mollified by a guarantee of fiscal neutrality. Finally, at the global scale, a uniform charge system would collide with the same complexities that make a uniform cap-and-trade system problematic. Countries with very

¹¹ For discussion, see Olmstead and Stavins (2006), McKibbin and Wilcoxin (2002) and Pizer (2002).

¹² For elaboration of this approach as applied to conventional pollutants, see Baumol and Oates (1971).

different initial conditions may simply refuse to accept a globally-uniform system that ignores the economic implications of those conditions.¹³

Given all these complexities, it seems likely that some countries will prefer charges, some will choose cap-and-trade, and some may choose inefficient quantity-based measures for political reasons (e.g., progressive elimination of coal-based power, through closure of mines, reduction of imports, and forced closure of coal-fired plants¹⁴). In this hybrid setting, international negotiations will probably focus on target emissions paths for participating countries. Continued participation and at least rough compliance will be motivated by public pressure; threats of sanctions in various economic arenas; the threat of punitive damages in an evolving international judicial system; the risk of severe political turbulence from environmental disasters; and the risk that recalcitrants will be shunned by their traditional allies.

Such a system will be far from perfect, but it would be unrealistic to expect a smoothly-functioning system in a world where country stakes in the climate-change problem are so diverse. *In any case, the first and second steps on the path forward – establishment and public disclosure of an emissions inventory -- are clear, doable and necessary for all that follows.* If the global community can accomplish these tasks in the near future, it will be well-positioned to move toward market-based instruments.

The EU, Canada and India have already established precedents for carbon emissions disclosure, by publishing audited emissions reports for large carbon emitters in

¹³ For example, Brazil's energy sector relies heavily on hydropower and biofuels which have zero net carbon emissions, while the US energy sector is heavily dependent on carbon-intensive coal-fired plants.

¹⁴ As noted in a previous footnote, market-based instruments could also be applied to coal itself, by auctioning permits to produce it, or by levying an emissions charge per ton produced.

the manufacturing and power sectors.¹⁵ Two NGO initiatives -- The Carbon Disclosure Project and The Global Reporting Initiative – have established guidelines and facilities for voluntary emissions disclosure by major emitters. In November, 2007, the Center for Global Development will establish a comprehensive benchmark for global disclosure by launching CARMA (Carbon Monitoring for Action). CARMA will focus on the power sector, the largest carbon emitter, by publishing an emissions inventory for 50,000+ power plants and 20,000+ power-producing companies. It will disclose reported or estimated current emissions, emissions in 2000, and future emissions based on published capacity expansion plans. This inventory, available online at www.carma.org as of November 14, will provide a complete downloadable database, updated quarterly, as well as tools for ranking and comparing power facilities, power companies, and geographic areas (countries, states/provinces, cities and, in the US, counties, congressional districts and zip codes). For the many thousands of plants and companies that have yet to report their emissions publicly, CARMA will provide best-practice emissions estimates. It will also invite non-reporting facilities and companies to submit audited emissions reports for publication.

5. Summary and Conclusions

In this paper, I have shown why policy analysts are still far from agreement on the appropriate price of carbon and the best market-based instrument for regulating carbon emissions. But most accept the need to price carbon at some level, using some form of

¹⁵ The European Pollutant Emission Register is available online at <http://eper.ec.europa.eu/eper/flashmap.asp>. The Register includes CO2 emissions reports for several hundred major emitters in the EU. Environment Canada provides greenhouse gas emissions reports at http://www.ec.gc.ca/pdb/ghg/onlinedata/DataAndReports_e.cfm. The Indian Power Ministry reports emissions at <http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm>.

market-based regulation of carbon emissions sources. And a growing consensus supports full inclusion of the South in global regulation, because its emissions alone are sufficient to catalyze a climate crisis. Neither the North nor the South will escape serious global warming unless the other region is fully engaged.

To lay the groundwork for comprehensive, efficient, market-based regulation, we recommend immediate establishment of an international institution mandated to collect, verify and publicly disclose information about emissions from all significant global carbon sources. This institution could be housed within the UN system, as part of an existing organization or as a new entity. It could also be established as an internationally-chartered NGO, with UN oversight and auditing. It will build on the general public-information precedents established by the UN Framework Convention on Climate Change (UNFCCC) and the Convention on Long-Range Transboundary Air Pollution (LRTAP). Its mandate should extend to best-practice estimation and disclosure of sources in countries that initially refuse to participate.

The institution will serve four major purposes. First, it will provide the emissions information necessary for implementing any market-based regulation of emissions sources. Second, it will establish an excellent credibility test, since a country's acceptance of carbon disclosure will signal its true willingness to participate in globally-efficient regulation. Third, global public disclosure will itself reduce carbon emissions, by focusing stakeholder pressure on major emitters and providing reputational rewards for clean producers. Fourth, disclosure will make it very hard to cheat once market-based instruments are implemented. This will be essential for preserving the credibility of an international agreement to limit emissions. Establishing a global emissions inventory and

disclosing it to the public are major tasks that will require years to implement. The work should begin now, so the supporting information base and disclosure system will be operational when a global agreement is reached on carbon charges and/or cap-and-trade. The first essential step is establishment of a stakeholders' working group that will determine the appropriate scope, institutional setting and operational protocols for global public disclosure of carbon emissions.

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Table 1: Benefit and Cost Estimates for Carbon Emissions Control Relative to No Policies to Slow or Reverse Global Warming

	Benefits (Reduced Damages)	Abatement Costs	Benefit/ Cost Ratio
	\$Trillion (US 2005)		
Nordhaus/DICE Optimal ^a	5.23	2.16	2.4
GHG Concentration Limits			
420 ppm	12.60	27.20	0.5
560 ppm	6.57	3.90	1.7
700 ppm	5.24	2.16	2.4
Temperature-increase limits			
1.5 °C	12.60	27.03	0.5
2.0 °C	9.45	11.25	0.8
2.5 °C	7.22	5.24	1.4
3.0 °C	5.88	2.86	2.1
Kyoto Protocol			
With US ^b	1.17	0.54	2.2
Without US ^c	0.12	0.02	5.0
Strengthened ^d	6.54	5.82	1.1
Stern Review discounting ^e	13.53	27.70	0.5
Gore proposal ^f	12.50	33.86	0.4
Low-cost backstop ^g	17.63	0.44	39.9

Source: Nordhaus (2007b)

^a Yale DICE model: Runs set to maximize the value of net economic consumption, assuming complete implementation efficiency and universal participation. Time discounting at 1.5% pure time preference rate, plus utility elasticity of 2.0.

^b Incorporates the Kyoto Protocol emissions limits (at least 5% below 1990 levels) for 2008-2012 (all Kyoto Annex I countries, including the US); no emissions reductions in non-participating countries.

^c Same as above, without the US

^d Sequential entry of the US (2015), China (2020) and India (2030), with 50% emissions reductions within 15 years. Every region except Sub-Saharan Africa assumed to reduce emissions significantly by 2050. The result is a global emissions reduction rate of 40% from the baseline by 2050, and a global emissions level somewhat above the level in 1990.

^e Emissions reduction path is determined by the DICE model using the Stern social discount rate. Then the model is re-run using this path, calculating benefits and costs with the standard DICE discount rate.

^f Global emissions control rate rises from 15% in 2010 to 90% in 2050; country participation rate rises from an initial 50% to 100% by 2050.

^g Emergence of a clean technology or energy source that can replace all fossil fuels at current costs.

**Table 2: Public Disclosure in Asian Developing Countries:
Changes in Polluters' Compliance Status**

Country / Program	Factories by Compliance Status		Compliance Status		Compliance Change	Total Factories Rated
	Non-Compliant	Compliant	% Non-Compliant	% Compliant		
Indonesia PROPER						
1995	92	54	63	37		146
1997	57	89	39	61	+24%	146
Philippines EcoWatch						
1997	48	4	92	8		52
1998	19	26	42	58	+50%	45
Vietnam Hanoi						
2001	45	5	90	10		50
2002	38	12	76	24	+14%	50
China GreenWatch Zhenjiang						
1999	23	68	25	75		91
2000	14	77	15	85	+10%	91
China Greenwatch Hohhot						
1999	43	13	77	23		56
2000	21	35	38	62	+39%	56

Source: Wheeler (2006)