Greenhouse Warming and Efficient Climate Protection Policy, with discussion of Regulation by “Price” or by “Quantity”

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Draft Note: Greenhouse Warming and Efficient Climate Protection Policy, with discussion of Regulation by “Price” or by “Quantity” (Box 1)

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1. A new problem

The public can legitimately think of global warming as a “new problem.” For the last 200 years or so, the industrialized countries have developed the economies and culture of modern life based upon the massive use of fossil energy in industry, transportation, and households. Only in the last one or two decades have we learned that the burning of fossil fuels has raised by a third the trace concentration in the atmosphere of carbon dioxide, which is a heat retaining or “greenhouse” gas. We are thereby warming the earth’s surface in a way never remotely taken into account by the builders of the modern world. The case is comparable to the discovery by the public mind that smoking tobacco causes lung and heart disease.

To put the scientific and engineering work of thousands of people into a very short form, the intensified greenhouse effect is no longer seriously disputed. Nor is there an easy technical fix, a “catalytic converter” to remove the CO₂ that is produced when we burn coal, oil and natural gas. It is clear that greenhouse warming of the climate threatens to make major changes, predominantly damaging ones, in the environment in which humans evolved and on which we rely. Our problem is how to end the use of CO₂-emitting fossil fuels as quickly as possible, while preserving modern standards of living, and doing as little harm as possible to our economies.

In 1992, the members of the United Nations (including the United States, then led by the senior George Bush), meeting in Rio De Janeiro, agreed to work together to stabilize “greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system ... within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to allow economic development to proceed in a sustained manner.”

However, in spite of these good intentions, fossil energy use continues, and is even fast expanding, as large and growing third world countries, particularly the immense societies of Asia, press for economic modernization and industrialization. Greenhouse climate change is a major problem that presumptively requires a major response.

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2 There is abundant writing on the present and expectable effects of climate change. See Gelbspan, IPCC, Herman Daly, Andrew Revkin, and many others. This paper specifically refrains from the scare-mongering which is often encountered, but the situation should be evaluated in a precautionary mode, and the many unknowns and imponderables should be counted as dangers, and not as “easy outs” which excuse us from action. A single summary which is well borne in mind is Warren Broeker’s famous: “Climate is an angry beast, and we are poking it with sharp sticks.” (remark evidently appeared in TIME, 1997)
Nonetheless, one response to any new problem is to deny that it exists, or that it matters. Although the United States is by far the largest emitter of CO₂, in important parts of the American population, including the present Bush Administration, denial is still a prevalent attitude. Another common reaction, especially when trying to mobilize public support for a policy response, is to link a new problem to older and more familiar ones, and to draw up a combined set of policies that aim at several goals. The greenhouse warming issue overlaps more familiar forms of air pollution, such as sulfur, nitrogen, particulate matter, and even CFCs. It is easy to lump these issues together even though there are important analytical and operational distinctions among them. The breadth of the climate change issue also makes it appealing to link it to great historical causes, such as improving the lives of the poor, or seeking greater equality or equity in the distribution of wealth.

But, the worldwide greenhouse effects of modern industrial civilization, both those now occurring and the far larger potential ones, make this a problem that on its own and on the merits calls for a sharp focus and substantial efforts. It may be useful to work on it along with other issues, or to see climate change as part of a generalized problem of environmental protection and sustainability, but it will be a major historical failure if we are distracted from an adequate response to warming itself.

We are vulnerable to the pitfalls of denial and distraction because climate change, as well as being a new, unfamiliar problem, is not an easy one. Two of its particularities demand sharp adjustments in our habits of thought.

First, how far a pollutant or gas spreads in the atmosphere depends on how long it stays aloft. Particulate matter, or soot, drops out in a matter of days or weeks. It does not have time to go far from the smokestack that sent it out, and so can be dealt with locally. Sulfur is called a regional pollutant because it will be in the air weeks or months, and will therefore go further, often across a state or national boundary, before it is rained down. But CO₂, the main greenhouse gas, once emitted will remain in the air about a hundred years, spreading throughout the entire atmosphere; once emitted it really is everywhere and its effect is truly global. CO₂ from a coal power plant in Shanghai will affect Florida as much as it does China, and an emission from an SUV in Seattle will affect climate in New Delhi as much as it will in our Pacific Northwest. Suddenly, finding the perpetrator and the victim of climate damage is dramatically simpler than for earlier environmental problems—any fossil fuel burner anywhere is doing damage, and we are all victims. But this “global” characteristic of the greenhouse effect also challenges our reflex habit to localize a problem and its consequences as the first step in solving it.

Second, CO₂ in the air is odorless, invisible and harmless to health—indeed its presence at its old, pre-industrial, “natural” level is indispensable for life as we know it. The timescale on which climate change takes place (the century is a basic unit) is long, with many extended lags between causes and effects. Ordinary citizens live in the day-month-year timescale, so that it is understandably hard for them to feel the reality of climate change. But in the end, ordinary citizens control the policies of modern states, so that for there to be an effective policy response, the public must understand greenhouse warming, and understand that it is real. It will not be easy for the public, working through legislatures and governments, to vote the substantial investment funds needed for climate protection. Perhaps the hardest part will be to sustain an effort undeterred by the fact that the slow improvement that will come will also be nearly invisible. To
achieve genuine sustained climate protection, we will have to learn not to rely on what we see and feel, but like a pilot, to have confidence in our instruments—in this case, the relevant scientific community. Having confidence in instruments when they contradict our senses takes a high level of intellectual capacity, training, and self-discipline for individuals. It is even harder for large social aggregates trying to work together.

2. Going in two opposite directions at once, in Kyoto and international negotiations

The diplomacy of climate change often seem schizophrenic. Leaders of nations open conferences by talking about the imperative need to bring greenhouse climate change under control. Then, as the working sessions begin, delegates switch over to elaborating how their countries cannot sacrifice other interests or economic advantages to take significant climate protection steps right now. The conferences, and the many weeks of preparing for them, are devoted less to stopping global warming, than to arguing why each country should be able to minimize or postpone its effort, in order to save itself from economic pain, or even just from the turmoil and effort of changing comfortably familiar parts of life.

3. Working through national governments, although the real parties at interest are generations (age cohorts) worldwide

We live in the age of the nation-state, if perhaps in the latter part of that age. There is no practical alternative to conducting the effort to control global warming mainly through national governments. Among countries, it is governments that have the traditions and established procedures to communicate and deliberate together. Within countries, government action is necessary because carbon emissions are an economic externality, not reachable by the market acting independently.3

But in other important ways, the greenhouse problem is not a “governmental” nor an “international” one. The real adversaries, or competitive stakeholders (beneficiaries and payers), are not national populations in relationship to one another. Rather, the conflict of interest is between generations or age cohorts of the world population across all countries. Recent generations and the one now working are the beneficiaries of the present cheapness of carbon-based energy, while if there is a major commitment to climate protection, the present generation will pay the costs of developing and applying new non-fossil energy sources. On the other hand, future generations, perhaps starting with present children, will enjoy a better climate, and thus benefit from decarbonization if it is performed now, but will suffer a deteriorated

3 The emission of carbon in the form of carbon dioxide, a principal greenhouse gas, is an unavoidable by-product of burning fossil fuels, but its effects are so diffuse that they have little consequence for most buyers of the fuel, and do not enter into the price or desirability of fuel at the time of sale. The effects of the carbon on society as whole are therefore said to be external to the economic transaction. This means that the negative effects of the by-product will not be dealt with by the market, and if society wishes to do something about such long range and remote effects, it will have do so through some agency other than the market. Normally, the social agency taking action is the government. A common way to do so is to control the “external” effect by regulation, or by altering the market’s treatment of the commodity, for example raising its price through taxing it. For comparison, unlike the case of carbon emissions, the advantages of oil over coal (cleanliness, transportability, usability in internal combustion engines) were perceptible and important to buyers in the middle decades of this century, and led to the replacement of coal by petroleum in many uses by forces within the market, without the need for government action.
climate if the present generation avoids the costs of converting to non-fossil energy sources.

This generational opposition between those who will pay for climate protection and those who will suffer from climate change is not the kind of problem among countries we are accustomed to perceive and react to. It is not the sort of problem that the profession and institutions of diplomacy have developed to handle. Present and future generations exist in all countries, of course. But future generations, as such, are never directly represented in decision-making. Officials and citizens of the present must represent the interests and values of people of the future, a task that is performed very differently from one country and culture to another.

We interpret the great intergenerational issues in this case as international ones because governments and government departments are the only machinery we have, or at least the machinery we know best. But the issues themselves are not intrinsically national. This awkward fit between the problem and the tools we use to work on it is itself a problem, not to be lost from sight.

4. Methods: Short vs. long-range perspective; targets and timetables vs. programs and measures; regulating quantities vs. raising prices.

The approach to world climate protection in the Kyoto Protocol negotiated in December 1997 has been a process among nations and national governments. It may well be that the best course is to complete the ratification of the Kyoto agreement, and then reform it in subsequent rounds, but nonetheless, it is far from an optimal arrangement. Among other difficulties, the hesitation of nations to act, and perhaps their desire to “free ride,” tends to minimize the total “amount of solution” that can be collectively generated and applied. Concerned scientists agree that the goal set in the 1997 meeting in Kyoto (a 5% reduction from 1990 levels of emissions by industrialized countries in 2008-2012) is far too low in relation to the physical problem. Kyoto also is distorted by the accident of “hot air”, in which the former communist countries of eastern Europe receive credits (which they can sell to other countries) for large windfall carbon reductions created not by policy, but by the collapse of their economies a decade ago.

More fundamentally, Kyoto seriously misconceives the world’s response to global warming, which will necessarily be a large and complex pattern of social action over a long time. The protocol approaches climate protection not as the marathon that it is, but rather makes it a series of dashes. This is an understandable error, because at Rio in 1992, nations promised to reduce their emissions with no specification of amounts or deadlines, and all the talk produced no climate protection action at all. It is a natural swing of the pendulum to go from such a schedule-free non-performance to precise targets and timetables.

But the high value and long life of fossil energy infrastructure (coal railroads, oil refineries, auto engine foundries) mean that converting to non-fossil energy is not a short term matter, but rather an exercise in long term planning and sustained implementation over decades. Careful coordination will be required to

change the many links of the energy processing chain, a chain that runs, to take only one example, from coal under a Wyoming mountain to electric light shining on a page being read in Manhattan.\textsuperscript{5} What we need is not commitments for relatively small reductions of carbon emissions in a short interval (as were given at Kyoto), but rather firm engagements by countries to start long term courses of action which will produce a large reduction in carbon use over an extended period – on the scale of a 50%, or even 80% reduction over thirty to fifty years.

But a national effort, not to speak of performance, on such expensive and long-term engagements is obviously very difficult to measure, especially in the early stages of a long process. The hangover from the failure to generate action through the vague aspirations expressed in Rio de Janeiro in 1992\textsuperscript{6} is the belief that if results cannot be measured and verified at short intervals, there will be no performance. Without detailed specifications, it is assumed that even if a nation promises an effort, as the U.S. did in Rio in 1992, the country will not actually make that effort, as we in fact did not perform. But in Kyoto five years later, the need for short-term measurability worked at crosspurposes with the need for actual deep carbon reductions, which are intrinsically long-term achievements. The design of the system was skewed to make the visibility of national climate protection actions as important as their effectiveness. Detailed greenhouse gas reduction targets and timetables (T&T) were chosen over consensual policies and measures (P&M), which include carbon taxation. In an apparently unthought-out, but consequence-laden step, Kyoto chose quotas regulating quantities of emissions to be cut, rather than agreement on costs (prices) which governments would impose on emissions in their domestic markets, as the vehicle of reform. Why? Primarily because performance under quotas is more easily measurable.\textsuperscript{7} (See Box One, on quotas versus prices below)

(An American writer, David Victor\textsuperscript{8}, stresses one consequence of choosing to regulate by quantity rather than by price. A country which commits itself to certain emissions reductions, he points out, is thereby “entitled” by the Kyoto process to the balance of its normal emissions. For example, if the United States emits to the atmosphere 1.5 billion tons of carbon in the year 2000, and commits itself to reduce that to 1.4 BtC in 2010, it can be considered, if we look at the figures the other way round, to have received an entitlement from the Kyoto process to emit 1.4BtC in 2010. These entitlements to emit carbon (that is to say, to obtain energy from fossil sources, which in the short run are usually cheaper than non-emitting sources, such as renewable or nuclear power) are looked upon by Victor as having a monetary value.\textsuperscript{8} The backhanded creation by the international negotiating process of these entitlements seems to be an immense creation of wealth by the governments meeting at Kyoto. Immediately, the distribution of this wealth becomes a classic international bargaining issue, with innumerable varieties of claim upon it put forward. One claim is for eventual international per capita equality in carbon emissions, while Victor basically

\textsuperscript{5} For a description of the many stages in making energy usable, see Davis, 1990.

\textsuperscript{6} The Framework Convention on Climate Change, signed as a centerpiece of the United Nations Conference on Environment and Development. The Kyoto Protocol is an elaboration to be added to the FCCC, making more concrete and specific the broad engagements of the earlier treaty.

\textsuperscript{7} Richard Cooper, 1998, was one voice that took early note of this wrong turning

assumes a U.S.-centric system of distributing emission rights on “prior use”, or “grandfathering” principles, as indeed Kyoto did, or as will any system that uses percentage reductions from existing fossil consumption.

But there is a fatal flaw here. There is no need to move into an intensely complicated sharing out of fossil emission rights which have been placed under a quantitative cap worldwide, a process probably so adversarial that agreement could never be reached between the first and third worlds. The good being sought, which is indeed subject to standards of fair distribution, is not entitlement to use fossil energy, but rather, access to energy services. Energy services—the actual electric light shining on a page so that one can read it, the transportation from one city to the next, an operating computer, the warm house in winter—do not necessarily come from the use of fossil fuel, but can come as well from a photovoltaic panel, a hydropower dam, a wind turbine or a nuclear plant, none of which contribute to greenhouse warming. It is entitlement to energy services, not fossil fuel use, which needs to be allocated equitably, and this is in fact an easier problem.)

Let us re-focus on the single goal of reducing world emissions of carbon as much and as quickly as possible while imposing the least costs on the world’s economies. We want to frame the question as “economically” as possible and make our policy rational, both environmentally (rapid reduction of emissions and atmospheric concentrations of greenhouse gases) and economically (minimize costs). To keep focused on environmental goals and on economic efficiency, we set aside political goals and logics. These include preserving traditional preconceptions so as to assuage the psychological sensitivities of late adopters, preserving “face” for anyone, or safeguarding the sovereignty of the state or the prerogatives of a political party or bloc, or defending or altering status rankings among institutions and nations. We will also not expend resources to pursue moral goals, such as punishing sin or rewarding virtue. Recognizing the global nature of carbon’s distribution in the atmosphere, we’ll try not to exaggerate our attention to the politically-tinged issues of where the emissions came from, and who will pay for reduction measures. Because we are serious about reducing greenhouse emissions, we will try to get as close as we can to canonical, maximally efficient economic solutions, taking full advantage of the different cost structures for carbon reductions that we find.

We want to bear in mind the modern truth that often the best politics is good economics.9 By reducing carbon in the least expensive way (or, put another way, by getting the greatest carbon reduction for the least resources) we can make climate protection a more achievable policy. To the extent that reductions are cheap and economically sensible, with as little exertion as possible devoted to satisfying essentially political claims, the cuts should be easier to implement, with less stress and disputation about monitoring, enforcement, cajoling, coercing, and essentially paranoid preoccupations like sealing up every possible avenue for minor free-riding. The cheaper carbon reduction is, the stronger the logic of the whole decarbonization exercise, and many extraneous problems will be less preoccupying and obstructive.

9 As the quintessentially political figure, James Carville put it in the 1992 U.S. presidential campaign: “It’s the economy, stupid!”
5. We should use government (firmly and drastically), and then harness the strengths of the market.

Because greenhouse effects do not affect day-to-day energy markets, to move against greenhouse warming there must be Pigovian intervention by a non-market part of society, in a word, government. Because the prospective damages of global warming are major, governments must intervene quite deeply to re-shape markets drastically from their existing patterns, which are now, of course, defended as their “normal, natural” patterns. But that said, we want governments to bring in as little of other agendas, or non-economic baggage, as possible. We want them carefully to scrutinize command and control interventions for their efficiency, and to prefer the flexibility and creative problem-solving characteristics of market forces where these can be relied upon to help —or can be inflected by governmental action to tend toward our environmental goals.

We want to set up a system that will help governments see the necessity and general merits of what needs to be done, and to act in a broad-gauged, objective and dispassionate way. One aspect of the challenge that certainly calls on these qualities is making whole the inevitable economic losers from decarbonization, coal-miners, for example. Such “remedial” spending is an important part of doing matters right. If guaranteed ahead of time, it also neutralizes likely adversaries of decarbonization, and thereby improves the prospects of achieving climate protection goals. Such damage compensation should be accepted in principle by all sides.

What we want from governments and among governments, we can encourage by a well-designed system of cooperative effort. But the truly indispensable component remains wide and deep public understanding within all countries of the climate change danger and the basics of dealing with it. This need is immense, and is critical to the success of the effort to slow and halt climate change.

6. Main elements of a proposed approach: Internationally coordinated elimination of energy subsidies and imposition of a carbon tax at $25 per ton of carbon emitted. Half of tax proceeds to be returned to national economies (i.e., are revenue neutral), other half of tax proceeds to be internationally administered to support energy decarbonization on a worldwide, cheapest-first basis.

Assuming such forward impetus, and a focus on environmental goals and economic efficiency while letting political prerogatives slide, how should we proceed?

A. We recognize that among the greenhouse gases, only carbon is massive enough in its presence and economic role to be a political issue requiring mass understanding and support. Methane, nitrous oxide, the CFC substitutes and other significant gases such as sulfur hexafluoride (SF6) should be dealt with actively and vigorously at the administrative level, generally less in the public eye and away from the glare of media attention. This can easily be done in the wake of public conviction and eagerness to act against the marquee issue of CO₂.
B. All countries agree to revise their legislation and budgeting practices to de-subsidize fossil energy completely over, say, a period of eight years, ending in 2010. A system of international reporting and consultation, comparable to the more general one on energy use set up by the FCCC, will guide countries in fulfilling this commitment, and in making each country’s work as internationally transparent as possible. Technical assistance from centers of expertise such as the IMF, the World Bank, the WTO and the technical branches of the UN will be available both to countries and to an international office set up to oversee de-subsidization. (Other functions of an international climate protection office are discussed below.) While in a certain sense desubsidizing fossil energy is a housekeeping step necessary to make the carbon taxation discussed below effective, socially and politically it will undeniably be a controversial and very difficult process.

C. All countries agree to impose an internationally coordinated national tax or permit fee on the use of greenhouse fuels equivalent to $25 per ton of carbon emitted. This could be done over a period of three years, aiming to be fully achieved in 2007. If the tax is paid upstream by large energy producers and importers, government regulators would deal with a limited number of entities (say 500 in the U.S.) and their task would be administratively quite simple. The costs of the permit/tax, would, of course, be passed downward to be reflected in prices to end-users of energy products. $25 per ton of carbon emitted is equivalent to six cents per gallon of gasoline, or a 4% increase of the U.S. retail price, and $12.50 per ton of coal, equivalent at present to about 30% of the cost of coal to a power generator, and to about four tenths of a cent per kilowatt hour of coal-generated retail electricity to a household. Although $25 tC is proposed here, the proper level to set this tax initially would be subject both to technical evaluation, and to international negotiation. $25 tC is the lower of the two levels discussed in the U.S. Department of Energy’s Scenarios for a Clean Energy Future\(^{10}\), and is thought of as a moderate starting level to initiate the whole system of internationally coordinated taxing of fossil fuel. At the same time, it is likely that many emission reductions are available worldwide at a cost of $25 tC or less, and that these would be implemented by emitters rapidly because to do so is less expensive than paying the carbon tax. (Further discussion of setting the level of this tax after the initial period is given below.)

In the United States such a tax would raise about $40B per year (for scale, this is about fifteen percent of current defense spending). Worldwide it would realize about $160B per year. Those rightly concerned with equity should note that this tax, while it has an impeccable “polluter pays” logic of taxing carbon equally no matter its source, will be most heavily borne by high fossil-using economies. Its incidence will be smaller on economies which have lower fossil energy consumption, either through past policy (France) or through emerging from recent underdevelopment (China, India, 3\(^{rd}\) World in general). Because the tax will be universally applied, the issue of international flight of carbon-intensive economic activity does not arise.

D. One half of the proceeds of the $25 tC fossil energy tax/fee would be considered revenue neutral in each country, and after collection by the government would be remitted back to the domestic population or

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economy through tax reductions in other areas of each national economy. Each government would determine which existing taxes have the greatest drag on their economy, and which form of tax relief would be the most stimulative and helpful, thus making possible a “double dividend” from this policy.

E. The other half of the revenue earned by the fossil energy tax would be used to subsidize, incentivize and generally support carbon emission reductions through investment in either efficiency or non-greenhouse alternative energy sources anywhere in the world, the criterion for support being efficiency in long term carbon reduction. (See below for an example of such investment.) From the United States, at the level initially proposed in this paper, this would generate roughly $20B per year, and from the world as a whole, about $80B. These funds would be remitted to an international office that would apply them to energy efficiency and non-greenhouse energy projects, on a grant or loan basis, wherever the cheapest decarbonization gains presented themselves. (The international office could also support research and development work, and perhaps education and training.) In all likelihood the majority of such projects would be physically in third world countries, since most new infrastructure construction is in developing countries, and the economics of introducing non-fossil systems at the time of new construction are much more favorable than those of retrofitting, or of cutting short the life of existing energy infrastructure capital. Clearly, the existence of the fossil energy tax discussed above would already be giving carbon emitters a sharp incentive to seek non-fossil energy sources, and would make the subsidies drawn from the worldwide support funds of $80B go a great deal further. (As an alternative to an international office disbursing large scale investment funds for climate protection, it is possible, that for up to one half of an energy firm’s liability for carbon taxation, its home government would accept, in lieu of tax payments, certificates of emission reduction (CERs), which the firm would seek on an international market in which such CERs would be traded. The role of the international agency would then be limited to certifying such certificates, which itself is a complex task, including the thorny matter of establishing baselines against which to evaluate them. In principle, many CERs could be generated by seller firms or governments for less than $25 tC, and specialized intermediaries would emerge to stimulate their creation and the trading of them.)

Consider a possible transaction within this system: Let us say China decides to build a new one gigawatt (1,000 megawatts) of electrical generating capacity. The alternatives are a domestic coal-fired plant costing $800 per kilowatt, or a total of $800M, or nuclear/renewable facility(ies) costing $1,600 per Kw, totalling $1.6B. The international agency would offer China $800M of international climate protection funding to make its new gigawatt plant nuclear or renewable rather than coal-fired. Of the $800M, plausibly $600M could take the form of long term credits to permit capital-scarce China to acquire the capital-

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11 The degree to which the international agency should be rule-bound or free in making judgments of efficiency as between alternative carbon reduction investments (or CERs) is a significant and interesting question. The relatively spontaneous and creative, but highly purposeful decision-making used in the Marshall Plan, as discussed in Schelling, 1997, is well worth consulting (see refs).

12 Cf. Todd Johnson, World Bank et al. 1994. p. 47: “Chinese nuclear proponents anticipate that capital costs will fall to 6500 yuan/kW (US$1,180/kW in 1990 US$) by the year 2020 as China develops its own nuclear production industry. However, even at such low estimates, the levelized costs of nuclear power are 40 percent above the high estimates for modern coal-fired baseload generation in 2020. If the cost estimates of the international experts participating in this study (US$1,900-2700 kW) prove more accurate, nuclear power would be too expensive to compete with coal in China. (without subsidy-PL)
This credit would be repaid over the life of the plant by the $500M savings on a less expensive fuel supply, and by $100M of regional and local environmental benefits (sulfur, NOx and particulate reduction) which China would realize by not burning coal. $200M would be a straight non-reimbursable grant from the international climate protection fund against the additional cost of the nuclear/renewable facility, justified by the substantial reduction in global greenhouse gas emissions over the 50 year life of a large non-emitting plant. The cost per avoided ton of carbon for this arrangement is about $10 for the first twenty years, and the carbon elimination is enjoyed at no cost for the succeeding thirty year life of the plant. Such calculations of cost-per-ton-avoided would be the basic, but not overly rigid, yardstick for allocating these international carbon reduction funds.

As the international authority lends $600M and spends outright $200M to make a power plant in China nuclear/renewable rather than coal fired, all sides of the transaction, but especially the United States, must realize that the beneficial result of this spending is an improvement of the global atmosphere, which is a world wide public good, participated in by all countries.

It can be expected that the U.S. Congress, whose assent is essential to establishing such a system, may well be willing to tax and spend to reduce GHG emissions, but is reluctant to “send money out of the country.” At this point, as discussed above, the customary conception of the world as a collection of nations, with their respective frontiers, political interests and financial accounts, becomes an obstruction, and is better set aside. It is justifiable to do so with regard to the non-reimbursable grant of $200M, precisely because of the non-national, global nature of GHG emissions and atmospheric stocks of carbon. China is the locus but not the beneficiary of the $200M grant for a pure greenhouse reduction effect because such spending does not increase the quantity nor improve the quality of electricity that China receives from the plant. A kilowatt hour obtained from a plug in the wall to light a lamp or power a computer in Shanghai is no better for the Chinese consumer if generated by a nuclear plant or a photovoltaic array, than from a coal-fueled plant. The U.S. Congress has only incidentally sent the funding to China via an international agency; what it has really done is spent the money where it can be the most effective for the least-cost carbon reduction, a global and in a sense a non-geographical good. The Congress does have the alternative of setting up a system which would spend the $200M within the United States, but it would have to recognize that it had generated a smaller carbon reduction, and a smaller benefit for the U.S., than the same funds could generate if they were spent independently of national or geographic location, that is to say, in China in this example.

Note that this supportive intervention in the Chinese decision by the international agency or CER market fits well with an important characteristic of energy investments: in general the capital costs of renewable/nuclear power plants are higher than the capital costs of a fossil facility, but the nuclear/renewable installation will have lower operating (fuel) costs. Because of this, over the life of a plant, nuclear/renewable energy is likely not to be more expensive than fossil based energy, although it is more demanding at the up-front original investment stage. It is the third world country’s shortage of capital, not a poverty-based need for a permanently cheaper but dirty solution, that makes the international contribution of capital in the loan component of the package remarkably opportune and useful. The interest rate of the loan, of course, can be concessionary to an appropriate degree if that is desired.

At 85% reliability, a gigawatt plant produces 7.4 billion kWh/yr, which at 300 grams of carbon per kWh emits 2.2 million tonnes of carbon/yr. Estimating that $20 million per year is the annual cost of $200 million of capital with amortization in 20 years, we are avoiding annual emissions of 2.2 million tons of carbon for $20 million, or a little better than $10 per ton avoided.
That is the nature of reacting against a genuinely global danger. As discussed at the outset of this paper, greenhouse warming is a global problem because carbon emissions, due to their long residency in the atmosphere, distribute themselves (and their climate effects) throughout the entire earth’s atmosphere. Climate protection funds spent on the most economical carbon reductions regardless of location are being spent in the most efficient way possible to obtain a global public good, a reduction in greenhouse warming, which is of benefit indiscriminately to Americans, Chinese, and all other inhabitants of the world. Despite appearances in our example above, there is no transfer of resources or of value from the U.S. to China. The lowered operations costs and local air quality benefits to China of the greenhouse-free plant are accounted for separately (by the $600M loan), and the electricity China obtains from a greenhouse-free plant is in no way better or worse for its consumers than coal-generated power. Although we have used China and the United States in this example, the climate protection subsidy essentially is generated without respect to location, being paid through the carbon tax by any user of fossil fuel. It is spent without regard to location, and the benefit of reduced warming has no location, but is global. The global environmental and economic benefit, indeed, is maximized by the freedom from “where” and “who” constraints on climate protection spending. Governments become administrative agencies that collect the fossil energy tax and forward half of it to the international agency for spending, so political or any non-economic considerations are minimized. Built into this system is the maximum form of emissions trading, which is extremely lucrative and may well cut the cost of worldwide carbon reduction in half or better, by comparison with intra-national programs.15

7. Can third world nations be recruited into such a price-based (coordinated taxation) approach?

Any voluntary international arrangement must satisfy the interests of its members to attract their participation from the beginning, and to hold them throughout. A contributory project to create a public good is always vulnerable (though not necessarily mortally so) to free riding, and to gaming of various forms.16 The developing countries have not accepted quantified carbon reduction obligations under the Kyoto Protocol. Even under the FCCC signed at Rio, while endorsing its aims, they have effectively limited their contribution so far to no-regrets (costless) policies. Why would they (centrally China and India) join the arrangement proposed here? The answer is that these agricultural, often south-lying countries stand to suffer heavily from greenhouse warming. Their governments are aware of this, as has been demonstrated by serious efforts outside the Kyoto Protocol to reduce, for example, Chinese energy intensities, and by ongoing desubsidization of energy in China and India.

Is the plan proposed here equitable to them? The lion’s share of carbon protection investment funds will be invested on developing countries’ territories, as discussed above, since it is primarily they who are building new energy infrastructure, which offers the best investments for a carbon reduction dollar. Having projects done on their territory is not strictly speaking a benefit, but in practice it will bring employment opportunities as well as technology transfer ones. The “profit margin” on the construction work for

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16 The classic economized discussion is Olsen 1968.
individual projects will be open to negotiations in which project-accepting countries can seek to advance their interests and be as well paid as possible for the work that they do. That part of the carbon tax which is revenue neutral within a country is not a payment by a third world country, or a cost to it, but merely a purposeful rearrangement of its own taxation system. Moreover, there are several points of flexibility in the approach proposed here which could be used to attract countries reluctant to join. To mention two, the carbon tax, initially to be set at $25 tC, could be made adjustable with regard to countries, or groups of countries, in early rounds. China, for example, could start with a lower level of tax if the Chinese delegation could win that concession in international negotiations. Secondly, the percentage share of the tax’s proceeds that were returned to a country’s domestic economy, rather than being pooled internationally for climate protection investment, could be adjusted to give a larger share of third world country revenues back for the direct benefit of the local economy. For them, 70 or 85 percent of the tax could be held to be revenue neutral, where for OECD countries, only 50 percent would be retained in that way.

8. Downsides and liabilities of this approach

The liabilities of this proposal are in the political domain, having been consciously left there in the name of economic rationality. An approach such as is proposed here will undoubtedly find opponents in all countries who will portray it as intruding upon governmental prerogatives and national sovereignty. A big initial policy commitment does indeed take subsequent control away from local or national decision-making bodies, such as the U.S. Congress. It gives powers over decisions affecting Americans to foreigners, so we can expect that all the usual objections, some rational and some visceral, against the UN, the WTO and similar bodies will rise against it from the usual suspects. In the U.S., and in all countries, nationalists and xenophobes will resist, because attacking the problem of greenhouse warming on a plane of worldwide economic rationality, rather than by means of a collection of policies which are politically rational country-by-country, represents a further step in the knitting up of the world’s nations and economies. Many people fear and resist this trend, in some cases with justification.

Can a de-nationalized, economically rational world policy gain the support of 160-odd national governments, prevailing against nationalist, autonomist, political objections? At present, certainly not. In the United States, a tax-based approach to global warming was raised in the February 2002 report of the Council of Economic Advisors which served as the prelude to President Bush’s climate change policy announced in February 2002, about a year after the administrations rejection of Kyoto participation. The CEA report dismissed a tax-based climate policy, including an internationally coordinated one, as unrealistic and impractical, primarily for lack of experienced institutions to implement it. In fact, the intellectual

Here is the relevant extract from the CEA’s Economic Report of the President 2002, page 246:

“Yet concepts such as a worldwide tax on greenhouse gas emissions or a worldwide tradable permit system, sometimes advertised as solutions, are at best theoretical benchmarks against which to measure alternative, practical approaches. At worst, they can be a distraction from meaningful steps forward.

Why are such proposals impractical? Because they fail to recognize the enormous institutional and logistical obstacles to implementing any sweeping international program. Institutionally, it is important to learn to walk before trying to run. The United States implemented its successful SO2 trading program only after gaining experience in the 1970s and 1980s with netting and banking programs, experimenting with control technologies for more than 20 years, and recognizing the limitations of alternative command and control approaches. Most other countries have significantly less experience with flexible approaches. A
objections from the President's technical economic advisors to an international tax approach were remarkably mild, having to do only with problems of implementation. In the light of other decisions such as those on CAFE standards and New Source Review, it is clear that other voices heard by the administration and the Congress have considerably deeper objections to moving against global warming, based not on views of policy methods but on substantive economic interests.

The only conceivable way that the most rational course against the danger of global climate change could be supported by executive branches of government and legislatures around the world is if the public gains a broad and deep understanding of greenhouse warming and its causes, and if that knowledge leads to public desire to act against it. Achieving that awareness through public education, first and foremost in a United States now lagging far behind Europe, must be the proximate target for those who believe that acting soon and effectively against greenhouse warming is a great historical challenge to which we must respond.

End Main Text

Box One: Prices vs. Quantities

Two important questions are appropriate at this point. The first highlights a contrast between the recommendations of this paper and the methods chosen in the Kyoto Protocol. It can be summarized, “Why discourage carbon use by a tax that will make it more expensive, rather than by agreeing on national quotas for carbon reduction, allowing trading among fossil carbon users so that they collectively can find the cheapest carbon reduction arrangements?” The second question is, “After starting out at a rate designed to initiate the system, how high should the tax be, to strike the right balance between the need to reduce atmospheric carbon, on the one hand, and, on the other, the need to avoid macro-economic damage to national economies and the world economy?”

The first question leads us to the issue of whether it is better for a government seeking to control an environmental externality to regulate it by quantity (a quota, cap or some quantitative control) or to curb it by raising its price. Assuming that government policymakers have chosen a market approach over a command and control method, it comes to the question of how the government give its signals to the market. Should the signals take the form of regulations placing quantitative limits (caps or quotas) on the harmful externality, or should the signal consist of laws taxing the offending commodity in order to raise its price and thereby decrease demand for it and the quantity of it which is produced and sold. For the regulator who must choose between using a quantity tool, or price tool to discourage an undesired economic effect, which instrument is better?

A comprehensive analytic answer was given in 1974 by economist Martin Weitzman, then of MIT and now of Harvard, in a classic article, “Prices versus Quantities.” Weitzman makes it clear that an

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important element of the issue is a little like quantum indeterminacy in physics. If a fixed tolerable quantity of the pollutant is set as a cap or ceiling, there is no way of knowing with precision ahead of time what it will cost to find functional substitutes and to bring generation of the pollutant down to that limit. Therefore, at the international level, as participating governments enter into the arrangement for common action, they know their emission reduction commitments in terms of tons of CO₂, but they do not know what it will cost them to reach the agreed lowered emission level. This uncertainty in itself is a major disincentive for a country to agree to join the arrangement. If, on the other hand, to join the pact countries must know ahead of time only how much they will be obliged to spend, they can agree on a tax or permit fee arrangement which will fix the costs of the emission reductions effort to their economies. They will know that they will not have to spend more than an agreed amount, but they will not know how much pollutant reduction they will get—that will be determined only by the actual cycle of operations. Which method then, working through quantities or through prices, should be applied in a given case?

One case is quite clear: if the pollutant is harmless up to a certain quantitative threshold but then becomes catastrophic, we should regulate it by quantity, and to set the tolerated quantity a safe distance before the catastrophe is unleashed.

However, in general, Weitzman found that if each additional increment of the pollutant does not make much difference in the damage done, or if the amount of added damage from each marginal emission is not known, the price mechanism, is more effective. This latter case applies to greenhouse gas emissions, whose effects are buffered because it is not the marginal emission itself which does the damage, but the stock, or the concentration of carbon in the atmosphere. This stock grew over two centuries and is not immediately and directly related to a current year’s emissions.19 The moral of the price/quantity story with regard to GHGs is that regulation by price is likely to be more efficient (perhaps several times over) than regulation by quantity.20

Why, then, did the countries gathered in Kyoto in 1997 choose quantitative regulation (quotas), instead of price regulation (carbon taxes)? The American political phobia against taxation was certainly significant, and a second main reason was that even on a short term basis the signatories wanted to be certain about the amount of reduction to be achieved. This was understandable after the debacle of the Rio arrangements, which had not specified quantitative reduction targets (nor made any price arrangements), and had achieved no reductions at all. Anxieties on this score were intensified because no country wanted to proceed until it was known how far the other participants were proceeding, which may be called the “sidelong glance” phenomenon. Each country wanted to pin other countries down not to promise a certain effort against carbon emissions, but rather to promise certain results, which of course is a more doubtful matter, taking more courage from a government—or suggesting to a government that should limit the results it promised.

19 For discussion of this and other outcome-buffering factors, see Pizer, and James K. Hammitt’s work, as noted in biblio/ref list.

20 William Pizer (in Toman ed, 2001), suggests that price mechanisms can produce gains five times higher than even well designed quantitative targets.
But as a result of the choice to regulate through quotas (quantities) rather than taxes (price), each developed country participant at Kyoto was making a tentative commitment, subject to later ratification, to reduce carbon emissions by a certain amount for which it did not know the cost of fulfillment. The costs are prospectively very large, and truly unknown (although much speculated upon). It is also clear that costs of carbon reduction would vary greatly from country to country according to the nature of their energy sectors, which are very diverse. A large and central participant in the 1997 negotiations, the United States, which had failed to restrain rising fossil fuel use since 1992, faced costs that were both extremely unpredictable, and also likely to be very high. This uncertainty and the fear of important economic damage from high costs, certainly pushed the American delegation to lay great stress on measures by which it could reduce its costs (flexibility measures). The specter of important economic damage from high costs was also a major factor, probably the single most important one, in the American opposition to ratifying Kyoto, which has now made explicit and definitive by the Bush administration.²¹

That is why this paper proposes a path of agreed taxation, or price regulation, rather than an agreement to reduce emissions to agreed quotas, caps or quantitative limits. Since no one knows how much it will cost to reduce carbon emissions, the Kyoto approach amounts to each country’s committing itself to a fixed performance result, without knowing what achieving it will cost. On the other hand, an agreement among countries to tax carbon based fuels at a certain level, as proposed here, commits each nation to make a certain effort, at a fixed cost. The actual results of that effort are not known ahead of time, and are left for determination as the collective effort proceeds. This plan assumes that the countries make their efforts in basic good faith, which is reasonable because within each country there is a logic and domestic political support for a serious climate protection effort, and because the effort is quite verifiable by remote observation of the country’s economy, of the sort that the WTO and the IMF now routinely conduct on all countries’ economies. The actual emission reduction effects of raising the price of carbon energy will be seen as the exercise proceeds. The guidelines can be adjusted in the second cycle (after say, five years), both as emission-reducing effectiveness is judged to be high or low, as scientific knowledge about greenhouse climate change deepens, and as public opinion evolves, probably toward greater willingness to invest for climate protection.

Box-within-Box One: Beforehand Indeterminacy of Costs or Emission Reduction

Weitzman, in his article Prices vs Quantities, sees that a regulator choosing between the price and quantity instruments does not know in advance the costs of reducing an externality, in this case, carbon emissions. If the regulator did know costs, he could reach the same result through either applying an equivalent tax or applying the matching quantitative limit on emissions. That is to say, if his estimated costs prove exactly correct, he could reach the same desired carbon reduction equally well by the price or the quantity method. The expected outcomes if the real cost proves to be higher or lower than the estimated

²¹ Cf David Victor, in a brief article for GRIST Magazine, “Kyoto is Dead, an Upbeat Requiem.” (http://www.gristmagazine.com/grist/heartbeat/debates011700-b.stm) “What’s wrong with Kyoto is the obsession with emission targets and timetables. In market economies, governments do not control emissions directly, and thus it is extremely hard to set strict, binding future targets. More sensible would be a treaty that focuses on actions, with non-binding targets as milestones and long-term goals.”
cost, can be shown in a very simple matrix:

<table>
<thead>
<tr>
<th>Regulate by:</th>
<th>Price</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs are:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher than expected</td>
<td>I. Less carbon reduction than expected is achieved; the system can be adjusted to increase the tax, or to lower carbon reduction expectations in next cycle.</td>
<td>II. Gov’t must pay high costs to meet target, damaging its economy, or must renge on commitment or leave pact.</td>
</tr>
<tr>
<td>Lower than expected</td>
<td>III. More carbon reduction achieved; in next cycle, tax can be adjusted in either direction, to slow down climate protection, or to press harder since costs have been seen to be low.</td>
<td>IV. Carbon reduction stops when stipulated quantity reduction is achieved; some available reduction gains go unharvested. (US sulfur case)</td>
</tr>
</tbody>
</table>

Fear of the outcome in quadrant II leads governments to resist accepting major quantitative cut commitments, and generally impels them to seek an unambitious international arrangement if the arrangement uses quantitative commitments. In quadrant IV, it is seen that lower than expected costs under a system of quantitative commitments leave carbon reduction gains “on the table.” This is what happened in the sulfur reduction trading system under the U.S. Clean Air Act Amendments of 1990. Higher than expected costs hurt only the first round climate protection results in quadrant I, and lower than expected costs permit full harvesting of windfall de-carbonization gains. The less risky and preferable system is price regulation.

Moreover, imagine you are an observer looking over the shoulder of the regulator as he chooses between price and quantity signals. If you believe that the costs will be lower than the estimated costs, which environmentalists generally do believe, you will want price regulation because under it you will get more carbon reduction. If you are a pessimist, and believe that costs will be high, you still don’t want quantitative regulation, which is likely to produce a painful outcome which will discredit international climate protection arrangements significantly into the future.

End Box-within-Box

The second question at the head of this box was, “How do we set the level of an internationally harmonized carbon tax, after an initial level has served to get it going?”

It was noted above that in choosing between quantity and price as means of carbon regulation, if a ceiling existed at which catastrophic environmental effects would begin, then the regulatory system should be quantitatively based, and should assure that that ceiling is not approached or breached. Such a ceiling is
not known with regard to greenhouse emissions. But, interestingly, there may be a potential for economic disaster if a certain cost ceiling is exceeded. This ceiling exists at the point where raising the costs of energy engenders not just effects in the energy sector (conservation, substitution, etc.), but has effects in the economy as a whole (inflation, recession and unemployment). Such effects were felt from the energy revaluations of the 1970s, and perhaps in the 1990s as well. For every political leader, such damage to the general economy is a nightmare to be avoided at all costs.

There is no need to pay the price of a depression, or even recession, to decarbonize the world economy. Therefore, if a control mechanism, prices, is chosen which permits economic authorities to navigate cautiously with regard to this frontier of disaster, it is a far safer course for the durability of the whole climate protection effort. It seems likely that an initial tax level of $25 tC is well and safely short of this frontier. Thereafter, it can be imagined that at the national or world level, a body comparable to the Federal Reserve or IMF would advise on setting carbon taxes at their maximum level that would avoid negative macro-economic effects. This could prove to be one of the basic measures of how fast the climate protection effort could proceed.

End Box One.

Box Two: Material Decarbonization

In a material, engineering sense, how are we to go off carbon energy?

Nakicenovic et al of IIASA, in their “Global Energy Perspectives,” make the point that with ongoing economic development and population growth, world demand will inevitably increase for both larger quantities and higher qualities of energy services. This imperative demand, I think, basically cannot be denied or wished away. My sense is that if adequate decarbonization technologies and policies do not emerge and find acceptance, in the now opening 21st century humans will take their fossil energy and see the environment suffer, rather than abstain from greenhouse energy use to preserve the atmosphere.

Within the overall picture of growth in energy use, there are also trends in the other direction. Such more favorable trends include increasing awareness and practice of energy efficiency, perhaps some move toward actual energy conservation (giving up of energy services) in the rich societies, and the general tapering off of energy demand found in the higher parts of the development curve, where services replace industry as the core of the economy and national energy intensities (energy use per dollar of national product) diminish.

There is also another trend: more and more energy is used in the form of electricity. Electricity is high quality energy in the Second Law sense, and is also high quality energy for its flexibility, transportability and cleanliness. Some remember stoking home furnaces with coal many years ago; that is a direct, low-quality use of primary energy, as is cooking over firewood in a Nepali peasant household. Where

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electricity is available, such practices do not persist. Electric power’s share of energy consumed will likely continue to increase worldwide, with a potential to go to the point of being virtually the only form of energy use. We have already seen major shifts from direct fuel use to electric power, for example from coal-fueled open hearth steelmaking to electric arc steel production.

The major segment of the energy market which does not use electricity now is transportation, notably automobiles and trucks, burning refined petroleum in internal combustion engines. But it is likely that this huge and growing transportation sector (half of all energy use in California, according to the Union of Concerned Scientists) will be significantly converted to electric propulsion in the two-decade scale future. There is no technical difficulty in converting railroads from diesel to electric propulsion. The power trains of automobiles and trucks will be electrified, as they are in today’s hybrid vehicles, and will receive their energy from batteries fed by off-peak power from the normal grid, and from fuel cells. Drawing power from the grid during off-peak consumption hours avoids the need to build new generating capacity proportional to the large amounts of energy that the electrified transportation sector will use. Fuel cells will progressively come to use on-board stored hydrogen rather than on-board conversion (reforming) of fossil or bio-mass energy to hydrogen for the use of the fuel cell. If the vehicle uses pure hydrogen (or even hydrogen from a bio-fuel, such as ethanol) as its source of energy to the fuel cell, the vehicle as a whole is truly and fully non-CO₂ emitting.

We will leave aside the other major non-electrified energy function remaining, space heating in northern climates (noting that the cooling side of temperature management (air conditioning), is already handled by electricity, and that electricity-based heat pump/mini-geothermal approaches may also provide house heating).

So, in the future, we are likely to see our energy coming (and being billed) under a new set of labels:

1. Direct, concentrated electricity, largely generated in large plants for centralized grids, under which there will be two categories, peak and off peak. Life in America now is heavily urban or metropolitan, and this is the metropolitan form of electricity.

2. Spatially dispersed, or decentralized, electricity, meaning power that is non-urban and is generated and used off the grid. While the core grids mentioned above are likely to become more “concentrated,” providing power to densely settled and heavy users, at the same time more power will be produced off-grid on a de-centralized basis, perhaps even for the suburbs, or at least the outer ring of the suburbs.

3. Stored electricity, under several sub-categories, which include storage for mobility, as in electricity converted to the storage medium of hydrogen for use in a fuel-cell powered car, and storage for time. The latter includes nighttime power stored after being produced by photovoltaic systems, or power from wind turbines, stored for
availability on windless days.

4. Special forms of energy, such as long-distance aviation gas, high seas bunker fuel, and ultra-pure, non-interruptible electricity for computer and similar applications.

Thus, the core problem of decarbonizing world energy supply is likely to be decarbonizing electric power generation. Relatively dispersed, low-volume electricity consumption may well be able to be handled by renewable technologies, including rooftop PV, wind, and geothermal collectors, with associated storage devices as needed. These resources and others such as mini-hydro and existing large-scale hydro dams can be substantially stretched not only by energy efficiency policies and technologies, but by a capable and “intelligent” national grid which can rapidly shift power over distances to handle local demand peaks, shortfalls and emergencies by applying surpluses from other localities.

But the creation of marketable, economically usable energy is at its heart a process of concentrating energy, which is abundant but useless in its many dispersed and unharnessed forms, most famously the 240 watts per square meter of sunlight available “everywhere.” So the problem of replacing highly concentrated fossil energy becomes most acute where the energy demand is high volume and highly concentrated, classically perhaps in an industrial situation like a steel mill, but more typically and generally, in a large city. The world population, of course, is urbanizing even faster than it is growing. Energy use follows wealth, and in a world perspective, cities are where the money, or the “effective demand” for electricity is. A very large proportion of the total demand for energy is very specifically urban (that is, geographically concentrated) demand for electricity. This is the world of coal: more than half of United States electricity is still generated from coal, and a much higher proportion comes from coal in China, which sees few alternatives at present to continuing an overwhelming dependence on coal as its power consumption expands.

End of Box Two.

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