

## The importance of controlling carbon not emissions or mpg\*

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In management of carbon dioxide concentrations in the atmosphere, the authors argue that it is far superior to control upstream where the carbon leaves the ground in a limited number of places than further downstream as carbon dioxide is released in a myriad of locations. The authors note that none of the proposals being discussed politically assure this, and they control sector by sector, allowing undesirable room for special interests to be excluded from control. *Toxicology and Industrial Health* 2008; **24**: 573–580.

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### Introduction

The recent agreement in California in 2006 to seek a 30% reduction in *emission* of greenhouse gases by major industries raises the issue of whether this is the most effective procedure to address carbon dioxide concentrations. First attempts at reducing carbon dioxide emissions in Europe have done little and the recent collapse of carbon prices on the European Carbon Exchange have raised doubts about the viability of the cap and trade approaches. The list of proposed European controls in the Stern report of October 2006 (Stern, 2006) also concentrates on emissions of carbon in particular segments of the economy.

Even more indirect is the regulation of mileage standards for automobile standards in the United States. Although each of these will have an effect

on reducing overall CO<sub>2</sub> emissions, they are in stark contrast to a much simpler and flexible scheme that, if adopted *without exceptions*, has the potential of controlling carbon emissions with a minimum of financial cost and risk.

As noted further below, there is today, in 2007 and 2008, major interest in the US Congress and in other countries to address the issue in a more comprehensive way than the city by city or state by state systems now being proposed. Although it would be better if a comprehensive world wide system could be immediately adopted, a National US system and a similar national EU system would be a great improvement and enable simplifications and efficiencies that we discuss further.

Instead of holding many diverse emitters of *carbon dioxide* to many arbitrary baselines, we have proposed to limit the net transfer of carbon, *in any chemical or physical form*, from fossil deposits and other permanent reservoirs into the mobile surface pool, which includes the atmosphere, the biosphere and the upper layers of the oceans. By focusing on the extraction of fossil carbon from the ground, the number of control points is greatly reduced, thereby simplifying carbon management.

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By eliminating baselines, the system is unambiguous and fair. One of us (RW) discussed this as early as 1973, but we only wrote a more detailed, quotable, paper 25 years later (Lackner, *et al.*, 1999).

Two scientific and technical facts make this simplification possible. First, most oil and coal brought to the surface are burnt within months or years creating carbon dioxide which is emitted to the atmosphere. Second, carbon once brought to the surface will distribute itself throughout the mobile carbon pool. Over 20–25 years, carbon dioxide levels are determined by the total carbon input rather than the specific form in which it was brought to the surface. In the last 10 years, several economists have proposed that carbon be controlled as it leaves the ground, calling it “upstream” regulation. In particular, we note a forthcoming report by Robert Stavins, who is well known as a principal advocate of the tradable permit system for sulfur and particle emissions (Joseph and Robert, 2007; Robert, 2007).

Although we agree with most of what Stavins says, we have a different emphasis. Stavins has constantly emphasized cap and trade systems and compares them with carbon taxes. Whereas a cap and trade system for carbon may well be better than a carbon tax, we believe the important point is the possibility of upstream control. The system should take advantage of the difference between sulfate and particulate control, where a more upstream location for control does not exist, and carbon control where the upstream location of the oil well, coal mine and gas field does exist and is already documented on a national (US) or multinational (EU) basis. The same friendly criticism applies also to the proposal by Bluestein (2005). The failure to put the major emphasis on the scientific facts that make upstream regulation at the oil well possible may be a contributory reason that the governmental proposals so far are all further down the energy chain. We are more particularly concerned that the IPCC fails to make this emphasis (Intergovernmental Panel on Climate Change: Climate Change 2007). Worse still, a major website emphasizing a carbon tax (<http://www.carbontax.org/>) talks about taxing carbon *emissions* and does not even mention the possibility of taxing further upstream as we have, do and will, propose.

Of course in advocating this simple procedure, we make a major assumption that the “free market system” is an efficient financial way of optimization of actions and encouraging innovation. There are problems with this. We are well aware that this has been the subset of major world discussions and disagreements at least since Karl Marx. We do not forget the fact that in many cases people will save money by being more efficient in energy use. Unfortunately people have not always decided to save money in this way and violate the economists’ principle that “all free lunches should be eaten.” As we all know, Arthur Rosenfeld has been highly successful in California by mandating efficient appliances.

Arthur’s procedure is an important, perhaps crucial, correction to a free market policy, but it should not be a substitute for the free market. In 1972, when environmentalists began talking about energy efficiency (originally energy conservation), I (RW) asked everyone to calculate the amount of energy he or she was using; both directly and indirectly in the goods and services provided for them. I showed them how to do so by calculating the energy use of myself and family. We had six children at home, and only one car, at that time, and the energy per capita was 20% less than the US average. Almost all my critics were using more than the average. Now that I have no children at home, and the denominator is therefore 2 instead of 8, my energy use per capita is now well over the US average! I have taken few steps to bring it down although I have taken most free lunches. Moreover, cost is not the only criterion. Public health and warmth cannot easily be included. I jest that my wife believes in global warming. She turns up the thermostat for comfort, and opens all the windows for healthy ventilation! It is our view that the reasons that people fail to take advantage of their free lunches, and the ways of encouraging them to do so, deserves intensive study on its own. However, that is a separate subject.

### **Possible details of carbon control**

In Lackner, *et al.* (1999), we proposed a Carbon Board that issues permits for the transfer of carbon from permanent reservoirs to the surface pool and

also the inverse: to issue certificates of sequestration for the return of carbon from the mobile pool to the sequestered pool. A permit would allow introduction of a specified mass of carbon into the surface pool, or in the absence of international agreements – the import of an equal amount of fossil carbon. By charging at these points in the fuel cycle rather than at myriad points of emission, one minimizes the regulatory process. Because these transactions are already well monitored, accounting would not add significant new burdens. The control of carbon would be achieved by the carbon board steadily reducing the number of permits issued.

Stabilizing greenhouse gas *concentrations* will require more than a slowdown in emissions. Merely controlling emissions, or improving efficiency, can therefore only be a first step to meet that desirable goal. Removal of excess carbon from the surface pool (*sequestration*) will be necessary as well. Direct control of carbon accommodates this through *certificates* of carbon sequestration. A method of sequestration, certified by the Carbon Board, should do more than what would occur naturally and must be quantifiable. Less than permanent storage, for example in forestry, could be accommodated by treating these storage sites as a new class of carbon emitters that remobilize sequestered carbon. The problem of physical leakage is solved by making the owner of the site, who entered into carbon accounting voluntarily, responsible for the long-term carbon budget of the site.

There are several options for implementing a permit system. Simply assigning *permits* to current polluters, like in sulfur dioxide emission trading, skews the playing field in favor of entrenched interests. Politically, this may be hard to avoid, but nevertheless we propose a level playing field: all parties, large or small, new or old, weak or strong, must purchase permits for all net carbon transferred into the surface pool. The money collected could support research and development in alternative energy, energy efficiency, carbon sequestration and verification and quantification of carbon sequestration. If governments simultaneously reduce other general taxes, the result would be revenue neutral and stimulating to the economy (Jorgensen and Wilcox, 1992).

The immediate goal of the Carbon Board would be to limit excessive influx of carbon into the

mobile carbon pool. Over time, the board would have to state the desired stabilization point. The Carbon Board would also need to dampen price fluctuation by adjusting the permit supply to demand. If the board adjusts supply of permits to keep the price constant, the procedure acts like a carbon tax. If the Carbon Board were to set a fixed supply of permits, as now done in Europe, it would be extremely difficult to achieve price stability. The Carbon Board, like the Federal Reserve Board, would need a certain amount of independence to achieve flexibility, but it should be guided by general government and international policy to achieve stabilization of CO<sub>2</sub> concentration in the atmosphere at a generally acceptable level.

In the first year, permits might be issued for 100% of anticipated demand to allow all players to get used to the scheme. In subsequent years, the number of permits would be gradually reduced. This would give incentives for construction of new plants that eliminate carbon dioxide emissions, whereas avoiding costly retrofits or abandonment of existing infrastructure. Without a flexible response of a Carbon Board, a balanced strategy would be impossible to implement. Focusing on carbon rather than a plethora of greenhouse gases allows the marketplace to make a large number of decisions that otherwise would need regulation. Consider for example, the questions that arise in waste incineration. For a baseline, should one consider the plant to replace a natural gas combined cycle plant or a coal plant? Should one treat the carbon dioxide derived from wood residues differently than those from petroleum-based plastics? How does one keep track of the different types of carbon present in the waste? Carbon permits neither require a baseline with which to compare nor need they distinguish between different forms of carbon in the waste. It is all part of the mobile pool. Because no further fee is levied, the waste-to-energy plant enjoys a competitive edge. By capturing its own carbon, it could also generate certificates of sequestration, resulting in a separate revenue stream.

International agreement about *certificates of sequestration* would be relatively easy to achieve. More challenging is the internationalization of permit systems. Each country would be allocated an amount of permits on an equal *per capita* basis.

Developing nations could benefit by exporting carbon allocations and certificates of carbon sequestration. Many of the technical opportunities for emissions reductions arise in the developing nations, whereas the responsibility for reductions is largest in the developed world. An international transfer of permits among carbon boards could provide the means of deploying technology in developing nations early and turn their carbon liability into a development asset.

Stavins, Bluestein, and others fall short of suggesting a carbon board. They discuss in some detail the relative advantages of a carbon tax or a cap and trade system for carbon. They note that the cap and trade system for carbon addresses more directly the total amount of carbon brought up from the subsurface, whereas the carbon tax would have to be adjusted as the willingness to pay for carbon, presently unknown, becomes apparent and changes. We take no firm position on this, but note that we do not now know what level of carbon the world will, in due course, accept. It seems to us that a board to address this question and make adjustment as the years pass by will be necessary and should be established from the beginning.

### **Control by societal segment is inefficient**

Control of carbon emissions by electricity generating plants, or by improving gas mileage, can produce gross inequities. Everyone wants the burden to fall on someone else. A city dweller in New York, who commutes by subway, can argue that an Arizona resident should limit the number of miles he travels. An Arizona resident can complain about the excessive fuel consumption to heat buildings in the northern parts of the country. Who should resolve such disagreements? How are they to be resolved? We argue that no one in the world, no scientist, no ardent environmentalist, and certainly no politician knows the best way of reducing the carbon emissions to meet societal goals. However, there is a simple procedure for deciding such questions, the "free market system". If properly set up, the marketplace can provide the myriad of incentives, and the myriad of decisions to optimize the reduction of carbon. However, it cannot do it effectively unless it can reallocate resources among societal segments. A cap and

trade on carbon emissions from power plants is ineffective to stop unnecessary driving. However, a cap and trade on carbon coming into the surface pool can do so readily. It is well known that much energy and probably carbon emissions are used to make equipment, to make fertilizers, and, for example, to grow corn (McElroy, 2006). It is uncertain exactly how much energy and this leads to dispute, see Figure 2. Rather than a lengthy contentious procedure whereby the "government" decides how much, and where, to reduce carbon emissions in growing corn, would it not be better for that to be left to the market place?

We can get a rough idea of how inefficient sector by sector regulation might be. In the USSR and communist nations generally before 1990, governments fixed prices and allocated such resources as electricity. How well did they do? We suggest that a rough idea can be found by looking at the ratio of energy use to gross domestic product (GDP), and comparing that figure with other nations with a similar GDP per capita (Figure 1). Graphs of energy/GDP as a function of GDP/capita are frequent. All show that this ratio for centrally planned economies was two to three times as high as the ratio for countries with a free market system (Figure 3). We suggest that a similar figure would be the case here. We repeat the argument in other language. If the best of the procedures in the Stern report were adopted to reduce carbon emissions, it would be two to three times as expensive, for the same total reduction, as a coherent policy of direct carbon control.

### **No exceptions**

We argue very strongly that there should be no exceptions in this policy of monitoring carbon. No industry should be grand fathered. No industry should be favored or rejected. Diesel fuel for trucks and buses, gasoline for cars, and jet fuel for airplanes should all have the same carbon tax. Once exceptions are made for special interests, they will be hard to control.

A report on the future of nuclear power from MIT, chaired by two professors who had worked in Washington, Dr Deutsch and Dr Moniz, stated: "We recommend that incremental nuclear power be

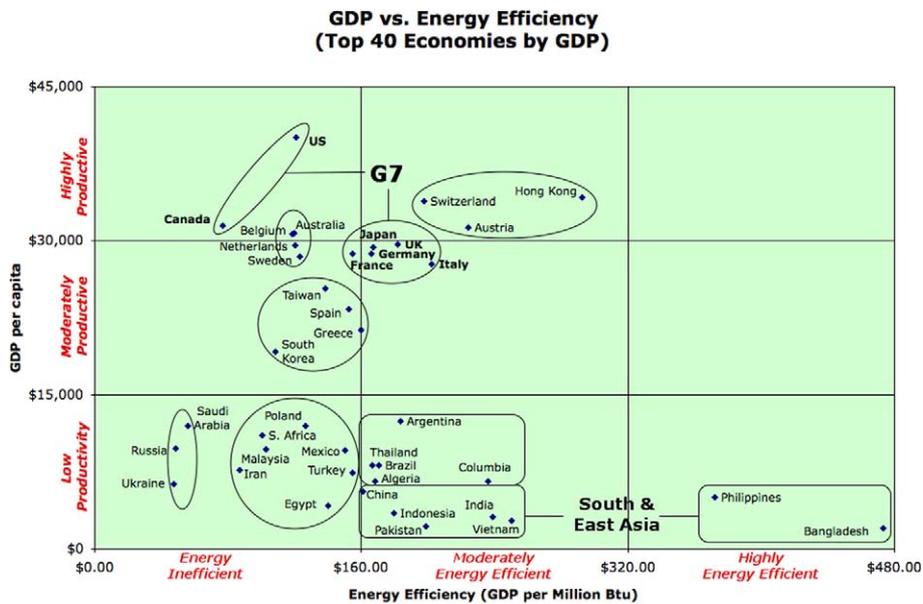


Figure 1 Data quoted in Wikipedia, showing the ratio of GDP and energy use and the relationship with GDP per capita.

eligible for all “carbon free” federal portfolio standard programs” (Deutsch and Moniz, 2003).

The Atlantic Council of the United States stated inter alia: “In implementing international emission trading programs, credit should be given to nuclear power facilities for their contribution to reduction of greenhouse gas emissions” (An Appropriate Role for Nuclear Power in meeting Global Energy Needs, 1999).

The Permanent Energy Monitoring Panel of the World Federation Scientists was more consistent and careful and stated in 2004 after careful deliber-

ation: “Therefore we recommend that governments and international agencies treat all non-carbon energy technologies *on a par with each other* with access to similar subsidies and benefits of removal of financial market barriers, so that improved versions of all these technologies can rapidly be utilized for achieving stabilization of greenhouse gas emissions while meeting energy demand.”<sup>13</sup> Presented to the Plenary Session of the 32nd seminar on Planetary Emergencies in Erice, Sicily on August 23rd 2004 and circulated to many government representatives.

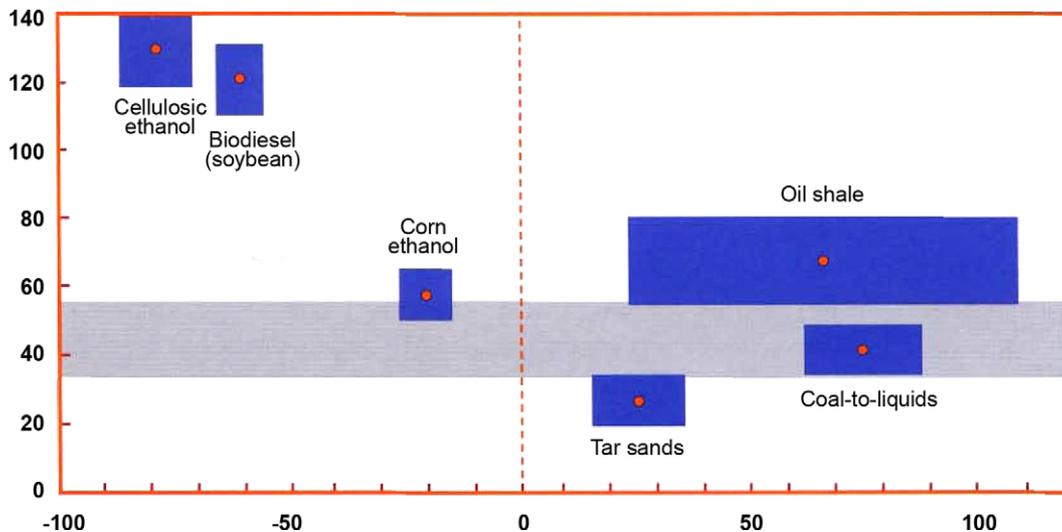


Figure 2 Shows the small effect, if any, of making ethanol from corn, but the larger effect of making ethanol from cellulose.

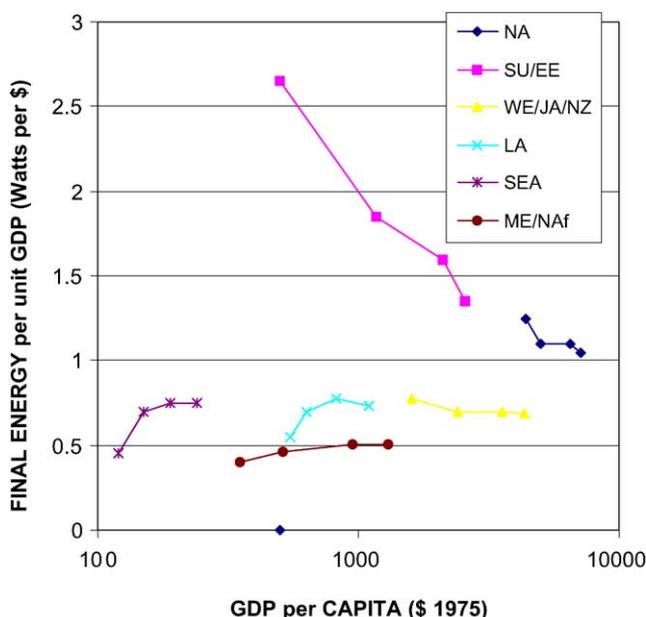


Figure 3 Shows the 1984 IASA comparisons of centrally planned and market economies for energy intensity.

This simple recommendation seems to have gotten nowhere. One possibility is that people dislike nuclear power. If nuclear power were more expensive than alternates, we would need no especial provision to keep it out of the energy mix. If, as we believe, it is cheaper in many situations, keeping it out of the mix is an inefficient way of coping with climate change. We consider two possibilities; either that no one heard the recommendations, or that a special interests favor one fuel over another and fail to put climate change at the top of the agenda. It must be realized that this modest proposal only addressed one sector; basically electricity generation, which is between 1/4 and 1/3 of the total.

### Legitimate special interests

We do not argue that special interests do not exist or that some of them are legitimate in the sense that accommodating them is in the best interests of society as a whole. We do argue that they should be kept separate from discussions of addressing climate change. For example, we can legitimately argue that a decentralized energy system has some advantages over a centralized one with its large capacity power stations.

Some people would prefer to leave out nuclear powers a potential part of a country's energy mix for any of the well-known aspects. Rather than leaving it out of any proposed control structure, we believe that the anti-nuclear concerns should be specially singled out and addressed separately.

Others are very worried about the effects of air pollution on health. This has been addressed in many places, but in only one major study on the "Externalities of Energy" (ExternE, 2005) sponsored by the European Commission, has any attempt been made to put the damage in economic terms. However, no jurisdiction has yet "internalized the externalities" by putting an appropriate charge for burning coal in a dirty manner. Countries prefer to rely on emission controls, rather than more directly on financial incentives for reduction in pollutant concentration or better still on human exposure.

It is much harder to see why carbon sequestration is left out of the European incentives for carbon-free electricity. Without some incentive, such as would occur automatically with our simple proposal, there will be little carbon sequestration.

### The early warnings

Here's one popular vision for saving the planet: Roll out from under the sumptuous hemp-fiber sheets on you bed and pull on a pair of \$245 organic cotton Levi's and an Armani biodegradable knit shirt. Stroll from the bedroom in you eco-McMansion, with its photovoltaic solar panels, into the kitchen remodeled with reclaimed lumber. Enter the three-car garage lighted by energy-sipping fluorescent bulbs and slip behind the wheel of your \$104,000 Lexus hybrid. Drive to the airport, where you settle for an \$8,000 -mile flight - careful to buy carbon offsets beforehand and spend a week driving gold balls made from compacted fish food at an eco-resort in the Maldives (Alex Williams, 2007).

Alas, this parody is far nearer the truth than most of us would like to admit. Unfortunately, the parody appears to be an attempt to ridicule those calling for action, however small, in order to attract attention to a worldwide emerging problem. We hope that the small, city wide, or state wide, or industry wide approaches will be replaced

by the superior, upstream, federal regulation. However, their time and their initial approaches, by city, or by state, are not wasted. As gasoline prices inevitably increase somewhat, car drivers will be thankful that automobile manufactures will already have more fuel efficient cars available as a result of their efforts. Utility companies and their customers will be delighted that the plants have already been built with reduction in carbon burning in mind. As scientists, we should discuss the proposed actions and put them in perspective. The energy use per capita in the USA, and with it in a loose correlation the carbon emissions per capita, is twice that of western Europe, three times that of China, and nearly 10 times that of countries such as India. It is an American "ideal" that all countries should be taught to have the same standard of living as the USA by embracing democracy. That should involve bringing their energy use per capita up to the US level, or *the USA bringing their energy use per capita down to the level of the rest of the world.*

We do not suggest that America should abandon this "dream" of helping the rest of the world attain our living standards, far from it. However, we do suggest, even insist, that we recognize that this is one of the many American "dreams" that is not now fulfilled in practice, and the difficulties and expense of fulfilling it. The rest of the world knows the problem, perhaps better than many Americans, and is rightly concerned. To some extent, Europeans have a similar problem. To many, this leads to tokenism and ineffectual partial solutions. We argue that now is a good time to change this with national, rather than state wide solutions, and upstream regulation. Unless this is addressed, we risk spending more money and effort on partial solutions to excessive carbon concentrations than on a more direct solution, and end up not only with more expense but also with more global climate change than possible. Unless we, as scientists, speak loudly and often about this problem, and discuss sensible ways of addressing it, we are not part of the solution. We are part of the problem.

## Summary and hope

We believe that the world would be well served by an emphasis on withdrawal of carbon from the subterranean carbon pool rather than by the myr-

riad of places where it is burned. We believe that this is simple, practical, and "merely" needs the political will to implement it.

In 2007, two suggestions in the right direction have come from the US congress. First, Representative John Dingell, Chairman of the House Energy and Commerce Committee, has taken the bull by the horns and proposed carbon taxes, although when the legislation was enacted in December 2007, he emphasized a tax on carbon emissions and had not yet realized the importance of taxes further upstream (Dingell, 2008). In a bipartisan move in the US Senate, Senators Bingaman and Spector have proposed a tax on carbon emissions, of \$12 a ton of carbon in 2012 rising 5% a year above inflation each year (<http://bingaman.senate.gov/news/record.cfm?id=278733>).

We believe the time is ripe, and the occasion may not again arrive, when a scientific emphasis on upstream control, whether by taxes or cap and trade, should be brought to the attention of all governments by all scientists.

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