Clearance of tropical forest for agriculture is a major source of CO_2 emissions, contributing to global warming, and also causes local air pollution. This satellite photo shows vegetation burning near an oil palm plantation in eastern Sumatra.

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CHAPTER 7

Mobilizing Global Interests for Forest Conservation

Two rationales for forest conservation attract a large, wealthy, worldwide constituency. All forests store carbon, so preventing deforestation can mitigate global damages from climate change. In addition, some forests harbor unique biodiversity whose survival is threatened by deforestation. The challenge for international policy is to find ways to tap these global interests to finance forest conservation, using approaches acceptable to forested countries.

Forest Carbon Finance: An Ungrasped Opportunity

Chapter 4 presented a paradox. Throughout the developing world, farmers fell trees for sometimes small and ephemeral gains, creating croplands and pastures worth perhaps a couple hundred dollars a hectare. As those trees burn and rot, they release carbon dioxide (CO_2) to the atmosphere—perhaps 500 tons a hectare in dense rainforests. Meanwhile, the European Union (EU) market values CO_2 abatement at $20 a ton.[1] In other words, farmers are destroying a $10,000 asset to create one worth $200. (While the $20 price is highly volatile, the disparity would remain even if prices plummeted. And the sum doesn't include the value of biodiversity and other environmental attributes.)

There seems to be a great opportunity for arbitrage here. Industrial countries could pay the poor farmers for forest conservation, at some amount between $200 and $10,000 a hectare, and both parties would gain. That would be a good deal for the farmers even if industrial countries' willingness to pay were at the modest price of

$2.70 a ton suggested by Yohe, Andronova, and Schlesinger (2004) as a target for global policy. Yet this opportunity remains ungrasped. Why? What are the obstacles? And can they be overcome?

Why Carbon Finance Makes Sense for Climate

The United Nations Framework Convention on Climate Change, signed by 189 countries, aims to stabilize the amount of greenhouse gases (GHGs) in the atmosphere. Greenhouse gases are increasing largely because people are burning more fuel. Thus stabilization requires a long-term shift to cleaner energy. Halting all deforestation, even if possible, would not by itself achieve the convention's goal.

But no single line of action will be sufficient to achieve that goal. Pacala and Socolow (2004) outline 15 options for reducing CO_2 emissions over the next half-century. Each option would cut emissions by about 25 billion tons during this period. Seven to ten activities of this magnitude would be required to stabilize GHGs in the atmosphere (that is, hold atmospheric concentrations of CO_2 to 500 parts per million). Reduced deforestation and increased reforestation are one option. So while containing forest carbon is no panacea for climate change, it could be part of the solution.

And it could be an important part if it is cheap. Cheapness is a virtue. We don't know how much it will cost to mitigate climate change. And we don't know how much mitigation is needed. More stringent targets for atmospheric CO_2 concentrations provide better insurance against catastrophic climate changes, but each part per million reduction will cost more than the last. Because the risks are difficult to quantify, it is hard to achieve global agreement on how much to spend and how to split the bill. Thus anything that reduces the cost of a global mitigation strategy will increase the chance that the strategy is embraced.

Why Carbon Finance Makes Sense for Forests and Rural Development

Forests may play a relatively small role in mitigating climate change, but climate change mitigation could play a large role in financing forest maintenance. Among the potential environmental services of forests, carbon sequestration has the widest applicability. That is because any action that keeps a ton of carbon out of the atmosphere has the same climatic impact no matter where it occurs. In contrast,

many of the environmental services enumerated by the Millennium Ecosystem Assessment are location-specific and idiosyncratic: ecotourism, hydrological regulation, or maintenance of globally significant biodiversity.

Carbon payments might provide significant benefits to tropical countries. Sathaye and others (forthcoming) find that over 40 years, paying $10 per ton of carbon (rising with the interest rate) would have a net present value of $150 billion in payments to developing countries for avoided deforestation. Containing forest carbon would also provide local and global benefits that would otherwise be difficult to finance—including conservation of globally significant biodiversity and of forests with spiritual or other values that are difficult to monetize. Forest carbon control might also help finance agroforestry and agricultural intensification in unforested areas.

Financing Avoided Deforestation: Problems and Solutions

The UN Framework Convention on Climate Change is responding to a submission by Costa Rica and Papua New Guinea to examine options for providing countries with incentives to avoid deforestation through forest carbon. To gain acceptance, these options will have to address, in practical ways, the objections that kept deforestation out of the Kyoto Protocol. This section lists the main concerns—and ways to deal with them. (The discussion here draws on and expands Chomitz 2002.)

"Forest Carbon Makes Mitigation Too Cheap"

Problem: At first glance this objection is hard to understand. Cheapness, as noted, is a virtue. Getting people, firms, and countries to take actions for global benefit is easier if those actions are cheaper. What drives this objection is a fear that introducing forest carbon into the Kyoto Protocol would swamp the emerging carbon market—driving prices toward zero and reducing industrial countries' incentives to shift to clean energy.

But that outcome would arise not from overly cheap mitigation. Rather, it would be the result of a timid, ineffective mitigation goal. The Kyoto Protocol currently places only moderate limits on greenhouse gas emissions from participating industrial countries. The limits for 2008–12 are perhaps a billion tons a year (CO_2 equivalent) less than would be emitted in the absence of the agreement.

Countries can try to reduce their emissions by this amount, or they can buy offsetting emission reductions abroad. Either way, the total Kyoto limit is still met. Developing countries can reduce CO_2 emissions, for instance, by switching from coal to wind power—then sell the reductions. This approach creates a market for emission reductions. The Kyoto emission limits determine the demand for these reductions, and opportunities for switching fuels and increasing efficiency in the developing world largely determine the supply.

The Kyoto Protocol doesn't allow developing countries to create emission reductions from avoided deforestation. But suppose it did and that countries could instantly create the institutions needed to reduce deforestation and that the protocol did not change its limits on total CO_2 emissions. In this unlikely set of contingencies, the supply of emission reductions would increase and their price would fall. The Kyoto emission limits would still be satisfied, and the cost of meeting them would be reduced. But the resulting low prices for CO_2 reductions would provide little benefit to developing countries and little stimulus for energy research and development.

But because the Kyoto limits are so slack, this scenario is not very relevant to policy. As it stands, Kyoto is just a pilot program. If all industrial countries (currently participating or not) met the negotiated Kyoto limits, it would merely delay the buildup of greenhouse gases by a few years. To limit CO_2 buildup to prudent levels, reductions of tens of billions of tons a year are needed by mid-century. To attempt meaningful mitigation of climate change, the protocol would have to drastically limit emission allowances. But doing so might drive the price of compliance so high that countries would refuse to sign on.

Solution: This is where cheapness comes in. By incorporating avoided deforestation into the global climate strategy, the world could afford to set a more ambitious goal for reducing CO_2 buildup. In the Kyoto context that would mean tightening emission allowances while allowing avoided deforestation as a source of emission reductions. By increasing both demand and supply, the price can stay around acceptable levels for all parties, but the climate impact is greater.

"Deforestation Avoidance Has to Be Permanent to Be Useful—but It Is Impossible to Secure Permanence"

Problem: Buyers of forest carbon want permanent agreements, while sellers want temporary ones. For buyers the problem is this. Because mitigating climate change requires stabilizing CO_2 concentrations,

many people assume that every project to reduce CO_2 emissions must have a permanent effect.

Many energy projects do have permanent effects. Replacing a diesel generator with a windmill today means that less fuel will be burned this year. Even if the windmill breaks and the generator is put back in service next year, CO_2 emissions will have been reduced—the atmosphere is a little cleaner than it would have been without the windmill. But forest conservation is riskier. Forests can burn. Climate change may imperil tropical forests if temperatures rise and rainfall decreases. And drastic changes in politics or markets may lead the heirs of today's forest owners to repudiate decades-old conservation commitments. Given these risks, buyers worry that it is impossible to sign an agreement today that securely guarantees carbon sequestration into the distant future. And without such a guarantee, they see no benefit from sequestration or reduced deforestation.

Sellers, on the other hand, may not want to sign such an agreement precisely because it closes off future options. Agricultural technologies and markets change rapidly, and expanded transport networks can transform development possibilities for once remote regions. So forest owners may not want to commit to conservation forever.

Solution: Recognize that avoided deforestation is valuable even without a guarantee of permanence. Carbon sequestration doesn't have to be permanent to be part of a climate change mitigation program. There are three ways that temporary commitments to carbon sequestration buy time to act on climate change:

- Temporary sequestration buys insurance against catastrophe in the face of uncertainty. The climate system is unstable. Small changes can trigger large and irreversible impacts, such as those that apparently shifted the Sahara from being heavily vegetated to desert (Foley and others 2003; Schneider 2004). There's a fear that too much CO_2 in the atmosphere, or too rapid a rise in CO_2, could have the same kind of catastrophic effect. But we don't know the thresholds beyond which such a catastrophe could occur. In the face of such ignorance, it is prudent to buy insurance—that is, to try to keep CO_2 levels low and rising slowly.

  Gitz, Hourcade, and Ciais (2006) show that forest carbon could be a crucial, cost-effective part of a

long-term climate change mitigation program. In their model, inexpensive forest carbon offers insurance over the next few decades—after which the world may be better able to assess the risk of catastrophe. If a dangerous threshold is then imminent, the world could continue to rely on forests as a carbon sink, or step up investments in geological carbon sequestration.

- Temporary sequestration could be a bridge to a clean energy future. Under Kyoto rules, industrial countries need to meet limits on total carbon emissions. They can park their carbon in trees temporarily, but when their storage contracts are up, they need to put that carbon someplace else—or reduce emissions someplace else. This strategy will work nicely if, at the end of the contract term, there are new, cheaper opportunities for storing carbon or reducing emissions.

  Translated from the project to global scale, this suggests that a temporary, renewable decision to protect forests could buy time for technological advance. The strategy would be to protect threatened forests with low opportunity costs. Over time those costs might rise if there is pressure for agricultural expansion. Development of emissions-reducing technologies would then allow the option of substituting emission reductions for continued forest maintenance. (But, as the next section suggests, forestholders at that time might choose not to exercise that option.)

  For the global community it makes sense to approach climate change mitigation through a program that uses not-necessarily-permanent avoidance of deforestation as one way to buy time for more effective investments in energy research and development. There is no need to tie the two approaches at a project level, but rather to move toward simultaneous global implementation of avoided deforestation and more vigorous research and development. The faster that cheap emissions-reducing technologies are developed, the less time has to be bought through temporary sequestration—potentially allowing forest owners to exercise their option of forest conversion.

- Temporary sequestration could become permanent. However, the history of the forest transition suggests that "temporary" sequestration could bridge the trough of the transition and end up being permanent. Many places face temporary pressures to convert forests for small gains. A 20- to 40-year effort to halt deforestation would not involve large opportunity costs, so equitable compensation could be arranged. At the end of that period, rising wages and appreciation of biodiversity values could prompt a reevaluation of the desirability of forest conversion. The forest owner and the host country may not want to exercise their option for conversion at that time. Thus temporary efforts to avoid deforestation provide a valuable climatic service and may end up being permanent.

"If You Protect One Forest, Someone Will Just Cut Down Another"

Problem: Does it really do any good to protect a forest plot from conversion to agriculture, or to reforest a working pasture? Won't market pressures just push someone else to deforest some other plot, to meet demands for food and employment?

This problem is called leakage or slippage, and it occurs in many contexts where a project acts locally but has distant repercussions. It's a concern in policies that seek to retire farmland to in order to prevent erosion or shore up commodity prices—do the farmers retire one field and open another? It also occurs in projects intended to reduce energy use and associated carbon emissions: switching a city from coal to wind power nudges down the price of coal slightly. Elsewhere, millions of people respond by increasing their coal consumption a bit. Such effects can add up to a large proportional diminution of the putative gains at the project site.

Solution: Leakage from forest protection isn't necessarily hectare for hectare (Chomitz 2002), as a naïve view would suggest. Suppose that a forested property is about to be converted to pasture, but is protected instead. The immediate effect is to drive up the price of beef a scintilla and to send a small amount of capital and a smaller amount of labor looking for other opportunities. One possibility is that the cowboys and ranchers move to an adjacent forest plot and set up a ranch there. But it is also possible that another ranch, possibly a distant one, intensifies a bit, adding a few animals and farm-

hands. This is especially likely if the protected forest would have been used for low-intensity grazing. In addition, the slight upward pressure on beef prices may nudge some consumers toward chicken. In sum, leakage will be smaller if other parts of the economy can intensify production and absorb the freed capital and labor; and if consumers are sensitive to the price of beef (or whatever commodity is affected by the forest project).

Leakage can be moderate even without any effort to control it. The U.S. Conservation Reserve Program pays farmers to revegetate erosion-prone land. Wu (2000) found leakage of about 20 percent in terms of area and 9–14 percent for erosion prevention. In other words, for every 5 hectares of land put into the program, 1 hectare of forest was converted to agriculture outside it. But the newly converted land was less erosion-prone than the protected land.

Murray, McCarl, and Lee (2004) simulate the impacts of a hypothetical U.S. program that would protect forestland from agricultural conversion, putting it under sustainable timber management instead. Depending on where the program was implemented, carbon leakage ranged from –4 percent (implying a gain in carbon sequestration outside the program) to 73 percent. The different outcomes could be due to differences in whether the system responds through extensification (land conversion) or intensification (higher productivity).

The solution to leakage, then, is to neutralize it by encouraging sustainable agricultural intensification in nonforest areas—intensification that soaks up the workers, commodity supply, and capital diverted by forest protection. And of course it is important to seek intensified systems that do not produce environmental burdens such as agrotoxic or nitrogen emissions.

"It's Too Expensive to Monitor Carbon"

Problem: It takes a fair amount of effort to measure the amount of carbon in a tree, let alone on a farm. Measuring changes over time makes things even more complex. Is it affordable to gauge the impact of carbon sequestration efforts?

Solution: Measuring forest carbon, in a district or a nation, involves two steps (to oversimplify a bit). The first is estimating how much carbon there is in a tree of a given size, based on its volume and characteristics. The second involves counting the number of trees of different sizes and multiplying by the amount of carbon in each tree. The second step could be done by tallying every tree—difficult even in a small forest. But technology is making this

approach cheaper. For instance, it is possible to take aerial pictures and have computers recognize trees and estimate their volumes. Still, the cost per tree or hectare is significant, as the airplane must cover the countryside in many low-altitude swaths.

Statistical techniques offer potentially huge economies of scale in carbon measurement (Chomitz 2002). Statistics can be used to estimate the number or volume of trees based on a sample. And statistical methods have a remarkable property, familiar from household surveys: the accuracy of an estimate depends on the size and representativeness of the sample, not the size of the population being sampled. With 2,000 interviews it is possible to accurately assess mean household income—for a city, province, or nation. Hence there are huge economies of scale, in costs per ton, of measuring changes in carbon stocks at a national rather than project level. Although the statistical issues in drawing appropriate samples can get complicated, the principle is clear: enlisting a few statisticians can drastically reduce the number of fieldworkers or aircraft needed to measure carbon.

Implementing Incentives for Avoided Deforestation

The solutions to these concerns about forest carbon are mutually supportive. They strongly suggest working at a national level, to incorporate leakage-neutralizing policies and drastically cut the costs of carbon monitoring. Potential steps toward avoiding deforestation in developing countries include:

- Agreement by some industrial countries to provide incentive payments for developing countries to reduce deforestation.
- Development of national systems for forest and carbon monitoring, including win-win steps to reduce excessive deforestation.
- Elaboration of the forest carbon infrastructure into national programs for deforestation avoidance. These programs would use the international incentive payments to fund deforestation reduction activities.
- Emphasis on neutralizing emissions though sustainable agricultural development.
- Incentive payments would be “pay as you go”—based on annual reductions against a reference level.

Fostering Sources of Global Finance for Avoided Deforestation and Supporting Research and Development on Emissions

Programs for avoided deforestation in developing countries will require global finance. There are different ways to provide it. One is within a Kyoto framework: some countries accept a cap on emissions but can meet that cap by purchasing emission reductions abroad, including from averted deforestation. This approach could lead to a market for emission reductions based on forest carbon, with pricing based on supply and demand.

Developing National Forest Carbon Infrastructure

To manage and use incentive payments, investments must first be made in building capacity and creating needed physical and institutional infrastructure. These investments, supported by donor financing, would include win-win investments that reduce deforestation pressure in any case.

At the core of the system are institutions and hardware for monitoring forest cover, forest and land fires, and carbon. Initially the system could track land cover—providing rapid, indicative measures of change. Later it could become a more comprehensive and accurate carbon monitoring system, combining new remote sensing technologies (such as MODIS) with ground-based observations.

Such a system can do far more than provide the carbon readings needed for incentive payments. It could aid in land use planning, forest fire prevention, and forest law enforcement. To facilitate this, the monitoring system would map the boundaries of protected areas, forest concessions, indigenous areas, and large private properties. Authorities could then use this information to help enforce forest laws and improve management of public forestlands. Public disclosure of these data would raise awareness of the issues and might help build constituencies for enforcement of laws against illegal forest conversion and logging.

Creating National Programs to Reduce Deforestation

The next step is to develop a blueprint for a program of domestic institutions, policies, and initiatives to reduce emissions from deforestation and, probably, increase carbon storage in agricultural and forest landscapes. This program would translate international incentive payments for reduced deforestation into incentives for forest owners to contribute to the achievement of these reductions.

One approach would be through direct pass-through of incentive payments to individual property owners. But this approach has disadvantages. It doesn't address illegal deforestation or deforestation on public land. It doesn't facilitate government policies that can affect entire landscapes. It fails to recognize the contribution of agricultural intensification in reducing leakage and facilitating emission reductions. And measurement, monitoring, and transactions costs are prohibitively high at the property level, especially for small properties.

An alternative is to delink incentives to the nation from incentives to individuals and firms. The national government can use incentive payments to fund diverse interventions in different sectors and locations. These interventions might cover the range of options discussed earlier in this report, such as:

- Paying communities for reduced deforestation or natural regeneration.
- Funding fire prevention programs.
- Improving tenure security.
- Enforcing regulations against illegal deforestation and logging.
- Setting up taxation of large-scale land clearance.
- Promoting off-farm employment.
- Intensifying agriculture in favorable areas to attract or divert workers from marginal lands at the forest fringe.
- Implementing strategic planning of road improvements.
- Supporting community forestry where it deters conversion to agriculture.

These programs might then be certified for participation in a globally financed incentive program. Certification could facilitate grants or loans from donors or international financial institutions to invest in the programs. To be certified, programs would have to meet some basic criteria. For instance, the monitoring system would have to eliminate any perverse incentives to replace natural forests with planted ones.

There are strong benefits to combining forest protection programs with agricultural and silvicultural intensification programs.

First, the latter neutralize leakage. For instance, road improvements in less-forested areas can lead to agricultural intensification and increased demand for labor, reducing migration to the forest frontier. Second, the combination creates a broad constituency of beneficiaries who can support program implementation.

How Should National Incentives Be Set?

Funders and recipients of incentive payments will be keenly interested in how prices and quantities are set. The framework envisions a negotiated reference level (*RL*) of emissions or net emissions. Incentives would be offered for reductions below that level. (This is different from offering an incentive based on total forest area.) The key terms to be negotiated are how to set the reference level, how much to reward reductions below it, and whether and how to discourage emissions above it.

First, if the reference level is set above the unobservable baseline (business as usual) of emissions, the country will receive rents—pure transfers unrelated to emission reductions. If these rents are too large, funders may decline to participate. But if the reference level is set too far below the baseline, deforesting countries may decline to participate. Reference levels could be set at historical emission levels, but these may be difficult to assess if data are lacking, or may reflect market conditions that no longer exist. Setting reference levels at current emission levels would introduce moral hazard because countries might be tempted to increase deforestation to obtain a higher target.

An alternative is to compute a normative reference level. The normative estimate would be based on a standardized estimate of the rate of increase in agricultural production, adjusted for an estimate of the rate of increase in agricultural productivity as well as the mean carbon content of forestland at the agricultural margin. Separate estimates could be made for logging-related emissions and the rate of abandonment of current lands. A normative reference level would tend to reward countries already trying to reduce deforestation, without introducing perverse incentives to increase deforestation to get more credits.

Second, what is the reward for reducing emissions below the reference level, and should the temporary nature of the reductions be dealt with? For simplicity, suppose that the reductions result from national incentives and are not tied to the Kyoto Protocol's carbon market or a successor. In that case funders and recipients could

negotiate a payment amount per period per ton-year. The calculations would be made as follows. Reductions in year t would be calculated as:

$$R_t = RL - E_t,$$

where E_t is measured net emissions. R could be positive (meaning a reduction relative to the reference level) or negative (implying emissions above the reference level). The payment at time T would be:

$$\max(0, P\sum_{t=1}^{T} R_t),$$

where P is the price per ton-year and $t = 1$ marks the beginning of the program. This formula is cumulative because it focuses attention on carbon storage. Each year, the country is rewarded if its actual carbon storage is greater than the baseline implied by the emissions scenario. The price P can be thought of as a storage fee, paid per ton per year. Suppose the country protects two hectares from deforestation in year 1, and an additional hectare in year 2, and suppose that each hectare would release 100 tons of CO_2 if deforested. Then $R_1 = 200$, $R_2 = 100$; the country would receive $200P$ in year 1, and $300P$ in year 2. Suppose however, that in year 2, no additional hectares were protected, and in fact one of the previous year's protected hectares was deforested, so that $R_2 = -100$. Then only $100P$ would be paid in year 2.

How should the price P be set? Ton-years have value because delaying emissions is valuable and because there is a significant chance of unintended permanence. But these values, while real, are difficult to compute on the basis of available information. So P would have to be decided by negotiation. A natural reference point would be the current interest rate times the market or normative price of a carbon allowance. This is the rental value of a permanent allowance. For example, under the EU Emissions Trading Scheme (ETS) a ton of CO_2 abatement is currently priced at about $20. At 6 percent annual interest, this implies a payment of $1.20 a ton per year. At that rate, averting deforestation of a hectare of moist rainforest might return a few hundred dollars a year. But even a price based on 6 percent of $3 per ton of CO_2 might still return an amount comparable to the annual payment rate in Costa Rica's payment for environmental services program (see chapter 6).

This approach could be made Kyoto-compatible by setting an exchange rate between ton-years and permanent tons. There is a

long, inconclusive history of discussion on the proper exchange rate for ton-years. Again, setting it at, say, 6 percent of a permanent reduction might be a starting point for discussion.

Though the obstacles to setting up avoided deforestation programs are considerable, so are the potential benefits. Moreover, solutions to those obstacles might be self-reinforcing (table 7.1).

The policies discussed here require fairly sophisticated institutional capabilities and so may not be immediately applicable to all forested countries. But countries could proceed in steps—starting by creating forest carbon infrastructure and proceeding to pilot tests of national-to-individual incentives. These early stages might be rewarding to participating countries and beneficial to the global climate, while providing information that would improve the design of international incentives.

Table 7.1 Policies to Reward Avoided Deforestation Can Have Synergistic Effects

Policy	Permanence/ contribution to long-run climate mitigation	Acceptability to host country	Leakage	Monitoring
Bundle with commitment to research and development	X			
Invest in agricultural intensification	X	X	X	
Set national baselines			X	X
Secure temporary commitments from host country		X		
Focus on marginal areas with ephemeral pressure or risk of irreversibility	X	X		
Catalyze technology diffusions	X	X		

Related Opportunities for Biodiversity Conservation

The emergence of global carbon markets may blaze a trail for new approaches to global biodiversity finance. A precondition would be mobilization of significant funding. This might be achieved through biodiversity offset requirements (ten Kate, Bishop, and Bayon 2004). For instance, large mines might be encouraged or required to offset any nonmitigatable habitat destruction by buying offsets—protection of areas elsewhere of equivalent or greater biodiversity or environmental importance.

Offsets could be done by putting an equivalent domestic area under protection or by contributing to a fund for conservation of globally significant biodiversity. Such funds could solicit contracts with landholding individuals, communities, and local or national governments. Would-be participants could submit bids specifying the services to be provided and the compensation requested, and the bids could be ranked by cost-effectiveness—as in the U.S. Conservation Reserve Program and Australia's BushTender. Geographic criteria might include the combination of temporary threat and likely irreversible degradation in the absence of action. A side benefit of this approach is that it might stimulate investments in better surveying the condition and geographic distribution of biodiversity, using new technologies such as genetic bar coding. That in turn could catalyze renewed, more sophisticated, and more productive markets for bioprospecting from which developing countries and communities could benefit.

Summary

Carbon storage and biodiversity conservation are forest services that benefit large but diffuse global constituencies. Mobilizing those constituencies to finance forest maintenance and negotiating and implementing agreements with forestholders pose institutional challenges of planetary magnitude. Still, the potential gains to all parties are big enough to motivate such efforts.

Endnote

1. Based on pointcarbon.com, August 31, 2006.