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Climate: Making Sense *and* Making Money

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On 19 May 1997, the chief executive of British Petroleum said: "[T]here is now an effective consensus among the world's leading scientists and serious and well informed people outside the scientific community that there is a discernible human influence on the climate, and a link between the concentration of carbon dioxide and the increase in temperature." He continued: "[W]e must now focus on what can and what should be done, not because we can be certain climate change is happening, but because the possibility can't be ignored."

The prospect of having to reduce carbon emissions has aroused dismay, foreboding, and resistance among many in the business community who fear it would hurt profits and growth. That is unfortunate, especially because their reaction stems from one unexamined assumption—which is incorrect.

Predictions of dire consequences from those on all sides—climate-protectors and cost-avoiders, interventionists and laissez-fairers, those concerned about their grandchildren and about their shareholders—freeze stakeholders into seemingly opposed positions. Their preoccupation with defending those positions masks vast opportunities for mutual gain. It might be more productive for all sides to acknowledge the hopes they share. All of us want to be safe, prudent, profitable, productive, and competitive. All want flexibility, entrepreneurship, and markets doing what they do best. All want the poor, at home and abroad, to have a fair chance to live better. And nearly all can get what they want, simultaneously and without compromise—a stable climate *and* a vibrant economy—if practical business experience is allowed to replace theoretical assumptions.

Economist Robert J. Samuelson, in the 14 July 1997 *Newsweek*, concluded: "It would be political suicide to do anything serious about [climate]....So shrewd politicians are learning to dance around the dilemma." Climate policy is in this rut because such influential economists *assume* that protecting the climate will be costly: in Samuelson's widely held view, saving a ton of carbon emissions would happen only under a roughly \$100 tax, a level he thinks might only cut 2010 emissions back to 1990 levels. Thus "Without a breakthrough in alternative energy—nuclear, solar, something—no one knows how to lower emissions adequately without crushing the world economy." Congress "won't impose pain on voters for no obvious gain to solve a hypothetical problem. And if the United States won't, neither will anyone else."

This eminent economist holds that belief because it's the conclusion reached by many economic computer models. He may not realize, however, that the models find carbon abatement to be costly *because that's what they assume*. This assumption masquerading as a fact has been so widely repeated as the input and hence the output of supposedly authoritative models that it's often deemed infallible.

Yet an enormous body of overlooked empiricism, including government-sponsored studies [e.g., ICF 1990, NAS *Pol Implns of Grnhs Wrng*, D J Evans ed, 1992, & E S Rubin et al., "Realistic Mitigation Options for Global Warming," *Sci* 257:148ff, 10 July 1992, Okken et al. 1991, Krause, MDLevine&MABrown *Scenarios for U.S. Carbon Reduction* LBNL-40533 9/97] and worldwide business practice, shows that the breakthrough Samuelson seeks has already happened. Protecting the climate can be *not costly but profitable*—just as many industries are al-

ready turning the costs of environmental compliance into the profits from pollution prevention.¹ To prove that, this paper will:

- show how firms are starting to capture these profit opportunities, and can greatly broaden and intensify that success even on a national and global scale;
- examine how eight kinds of practical obstacles that have retarded implementation can be turned into lucrative business opportunities;
- explain how climate/economic models ignore those opportunities and wrongly assume that rapid adoption requires high energy prices;
- clarify how least-cost climate solutions can foster vibrant competitiveness and employment; and
- demonstrate that the climate issue represents a largely unexploited and underrecognized business bonanza.

Consider a few examples. Southwire, the top independent U.S. maker of rod, wire, and cable (a very energy-intensive business), cut its electricity use per pound of product by 40%, gas by 60%, during 1981–87—then kept on saving even more energy and money, still within two-year paybacks. The resulting savings created nearly all the company's profits in a tough period when competitors were going under. The two engineers who led the effort may have saved four thousand jobs at ten plants in six states. The lead engineer, Jim Clarkson, says the technologies are all simple and available; their effective use takes only "an act of management will and design mentality, consistently applied." Indeed, Southwire found that such dramatic energy savings both require and facilitate better management and production systems that are vital anyhow for competitiveness, so the energy savings—sufficient "to cut American industrial energy use in half," as Southwire did—tag along almost for free.

In 1981, Dow Chemical's 2,400-worker Louisiana division started prospecting for overlooked savings. Engineer Ken Nelson quietly set up a shop-floor-level contest for energy-saving ideas. Proposals had to offer at least 50% annual return on investment. The first year's 27 projects averaged 173% ROI. Startled at this unexpected bounty, though expecting it to peter out quickly, Nelson persevered. The next year, 32 projects averaged 340% ROI. Twelve years and almost 900 implemented projects later, the workers had averaged (in the 575 projects subjected to *ex post* audit) 202% predicted and 204% audited ROI. In the later years, the returns and the savings were both getting bigger, because the engineers were learning faster than they were exhausting the "negawatt" resource. In only one year did returns dip into double digits (97% annual ROI). The whole suite of projects paid Dow's shareholders \$110 million every year.

DuPont expects to save the equivalent of 18 million tons of CO₂ by 2000 through simple measures that will also save \$31 million each year. Roche Vitamins (Belvedere, NJ) has profitably cut its steam use per unit of production by more than half in five years. A new chiller and related improvements at a Kraft ice-cream plant saved 33% of its electricity and 2,500 tons of CO₂ a year; productivity rose 10% and the plant turned from a money-loser into one of the most competitive. A process innovation at Blandin Paper Company (Grand Rapids, MN) saved each year 37,000 tons of CO₂ and more than \$1.8 million.² The first two years of billion-dollar carpetmaker Interface Corporation's efficiency efforts, *The Wall Street Journal* reports [11 July 1997 p B1], have saved "a stunning \$25 million..., with another \$50 million expected the next two years." Greenville Tube Corporation's demonstration of new drivesystems under DOE's Motor Challenge program boosted productivity 15% and energy efficiency 30%, reduced scrap 15%, and saved \$77,000 a year with a five-month payback [Romm present'n]. And Southern Company's 1984–94 improvements in the thermal efficiency of its fossil-fueled power plants saved 400,000 tons of SO₂, 35 million tons of CO₂, and an annual \$108 million.

Because such examples are the exception, not yet the rule, America is confronted, as Pogo said, by insurmountable opportunities. Those opportunities can create enough practical ways to mitigate climatic concerns *and* save more money than they cost, without ascribing any value to the abatement itself, to turn climate change into an unnecessary artifact of the uneconomically wasteful use of resources. Specifically³:

- Over half⁴ of the threat to climate disappears if energy is used in a way that saves money. In general, *it's far cheaper to save fuel than to burn it*.
- Another one-fourth or so of the threat can be abated by farming and forestry practices that take carbon out of the air and put it back in the soil and plants where it belongs, in the rich tilth and diverse biota that create lasting value. Soil-conserving and -building practices are generally at least as profitable as soil-mining, chemical-dependent methods [NRC 1989, AREE], so let's call them at least a breakeven.

- The rest of the threat vanishes when we replace CFCs with the new substitutes which, thanks to industrial innovation, work the same or better and typically cost about the same or less. (They're also required by global treaty to protect the stratospheric ozone layer.)

So if the "cost" of protecting the climate ranges from strongly negative to roughly zero or irrelevant, what are we waiting for?

Assuming the conclusion

Climate policy has been held hostage to a tacit presumption that if saving a lot more energy were possible at an affordable price, it would already have been implemented. That's like not picking up a \$100 bill from the sidewalk because if it were real, someone would previously have picked it up; or like an entrepreneur who abandons a good business idea because if it were sound, it would have been done earlier.

All economists know that real markets are far from theoretical perfection. But most climate/economy models assume that almost all profitable energy savings must already have been bought—as if in a perfect market. On this basis, the modelers suppose, buying significantly bigger savings will be worthwhile only at higher energy prices. They then use big computer models to calculate how big an energy tax is needed (based on historic elasticities), how much that will depress the economy, and hence what the "cost" of protecting the climate must be.

Those models have driven policy for the past two decades. They may get the amount of money about right—but flowing in the wrong direction. A model popular in the Reagan-Bush years trumpeted the notion that meeting the Toronto carbon-reduction goals would *cost* the U.S. about \$200 billion a year; but the empirical evidence of what energy savings actually cost showed that saving that much fossil fuel would *save* the U.S. about \$200 billion a year compared with buying and burning that fuel. Ever more elaborate models, discussed further below, continue to be built on the same fundamental assumption—that saving energy isn't profitable at present prices and hence will require higher prices that will burden firms and the national economy.

Had those theorists ever run an energy-saving business, they'd know better. GE Chairman Jack Welch said of American industry [*Fortune* Cover Conversation, 11Dec95], "Our productivity is at the beginning stages. There's so much waste. There's so much more to get, it's unbelievable. And somehow or other people think all these things are finite." Practitioners often find that the more the waste that pervades industry is corrected, the more new opportunities emerge to save even *more* resources, even faster and cheaper—especially electricity, which is the costliest and most climate-affecting form of energy.⁵

Big, cheap energy savings

Consider a simple example about pumping—the biggest use of electric motors. Leading American carpet-maker Interface was recently building a factory in Shanghai. One of its processes required 14 pumps. The top Western specialist firm sized them to total 95 horsepower. But a fresh look by Interface/Holland's engineer Jan Schilham, applying methods learned from Singapore expert Eng Lock Lee, cut the design's pumping power to only 7 hp—a 92% or 12-fold energy saving. It also *reduced* the system's capital cost, and made it easier to build and maintain and more reliable and controllable.

These astonishing results required two changes in design. First, Schilham chose big pipes and small pumps instead of small pipes and big pumps: friction falls as nearly the fifth power of pipe diameter. Second, he laid out the pipes first, then installed the equipment, not the reverse: the pipes are therefore short and straight, with far less friction, requiring still smaller and cheaper pumps, motors, inverters, and electricals. The straighter pipes also allowed him to add more insulation, saving 70 kilowatts of heat loss with a two-month payback.

Schilham marveled at how he and his colleagues could have overlooked such simple opportunities for decades. His redesign required, as inventor Edwin Land used to say, not so much having a new idea as stopping having an old idea; not rocket science but rather correcting a common error in engineering economics. The original specification used a rule-of-thumb that balanced the extra capital cost of fatter pipe only against the saved *operating* cost of reduced pumping energy. The new design instead optimized for lifecycle savings in pumping energy *plus* capital cost—not just of the pipes but the *whole system*. The extra cost of the slightly bigger pipes was far smaller than the cost reduction for the dramatically smaller pumps and drivesystems. Such whole-system lifecycle costing is widely

used in principle but rarely in practice. Optimizing energy-using components in isolation tends to pessimize the whole system and hence the bottom line.

Such opportunities exist in more than just pumping. Major energy savings are available in valves, ducts, dampers, fans, motors, wires, heat exchangers, insulation, and most other technical design elements, in most technical systems that use energy, in most applications, in all sectors. Virtually all energy uses are designed using rules-of-thumb that are wrong by about three- to tenfold. Substituting economically rational design would therefore save much of the energy used by industry, while *reducing* capital costs. Many of those savings can also be profitably retrofitted into existing plants, either immediately or as part of routine renovations and expansions.

Similar rethinking of building design has lately yielded, among hundreds of examples,

- houses that are comfortable with no heating or cooling equipment in climates ranging from -47°F in the Colorado Rockies [H1] to $+115^{\circ}\text{F}$ in central California [ACT² refs, TM-93-5], yet cost less to build;
- air-conditioning savings ranging from 90% in a new Bangkok house, at no extra cost [Suntoorn], to 97% in a cost-effective California office retrofit design [F4];
- total energy savings from over 50% to nearly 90% in cost-effective U.S. house and small-office retrofits [F4, ACT² Sunset/ENSAR]; and
- a retrofit design to save 75% of the energy in a typical 20-year-old Chicago curtainwall office tower [ASHRAE J], providing far greater comfort and a simple payback of -5 to $+9$ months.⁶

A particularly effective retrofit strategy, illustrated by the last example, is to coordinate energy efficiency with renovations needed anyhow, such as replacing aging glazings and mechanical systems. New superwindows can insulate fourfold better and let in six times as much daylight but a tenth less unwanted heat. That can trigger further savings, notably in lighting, that can cut air-conditioning needs fourfold. Then the mechanical system can be replaced with a redesigned version four times smaller, four times as efficient, and cheaper than renovating the old one. That saves about enough money to pay for the extra costs of the superwindows and other improvements. Every city in America has such buildings ripe for similar treatment—100,000 of them nationwide.

Careful scrutiny of actual market prices for equipment (“In God we trust; all others bring data”) reveals that even at the single-component level, many technical devices—motors, valves, pumps, rooftop chillers, etc.—show no correlation whatever between efficiency and price. A 100-hp American motor, for example, can be cheaper at 95.8% efficiency than an otherwise identical 91.7%-efficient model. But if you don’t know that—if you assume, as economic theory predicts, that more efficient models always cost more—then you probably won’t shop for it. And that can be costly. If the motor runs continuously, then each one-percentage-point gain adds about \$50 per horsepower to the bottom line, so not choosing the most efficient 100-hp motor can slash present-valued profits by \$20,000.

Again, the key is not so much adopting new technologies, though they’re important, as using proper recipes for combining the best available technologies in the optimal manner, sequence, and proportions. Some of the recipes are embarrassingly obvious. In hot cities, heat-reflecting roofs can save nearly 70% of cooling energy. Up to 40%—90% for houses—can be saved by combining light-colored paints and pavement with revegetation to help bounce solar heat away. An urban tree keeps about 10–14 times as much carbon out of the air as the same tree planted in a forest where it can’t also save air-conditioning energy by keeping people and buildings cooled and shaded. Such effects multiply: traditional passive cooling methods formerly provided summer comfort even in steamy Bangkok, and can do so again if superefficient cars and buildings are gradually introduced so the waste heat from cars’ engines and air conditioners stops making the city too hot.⁷

Proven examples abound in every kind of business:

- Properly choosing office equipment and commercial and household appliances has saved over two-thirds of their energy use with the same or better service and comparable or lower cost [Shepard et al. 1990]. (Such choices cut our household electric bill to \$5 a month with a 10-month payback using 1983 technology.)
- Skilled retrofits have saved 70–90% of office and retail lighting energy, yet the light quality is more attractive and the occupants can see better. In many cases, the better lighting equipment more than pays for itself by costing less to maintain [Lovins & Sardinsky 1988, Piette et al. 1989].
- Motors use three-fourths of industrial electricity, three-fifths of all electricity, and more primary energy than highway vehicles. This use is highly concentrated: about half of all motor electricity is used in the million larg-

est motors, three-fourths in the three million largest. Since big motors use their own capital cost's worth of electricity every few *weeks*, switching to more efficient motors can pay back quickly. This plus retrofitting the rest of the motor system saves about half its energy and pays back in around 16 months [Lovins et al. 1989, Fickett et al. 1990]. Doing this right requires integrating up to 35 kinds of improvements to the motors, controls, electrical supply, and drivetrains, but the resulting saving is twice as big, yet one-fifth as costly, as conventional retrofits that use only two kinds of improvements.

- The chemical industry saved half its energy per unit of product during 1973–90 by plugging steam leaks, installing insulation, and recovering lost heat. Now it's discovered that better catalysts and matching heat to the required temperature can often save 70% or so of what's left, yet pay back within two years.⁸ Next-generation industrial plant design, now moving from the chemical industry into semiconductors, is uncovering 50–75% savings with lower capital cost, faster construction, and better performance. Early adopters will prosper.

Many of these examples illustrate a new design concept: that whole-system engineering can often make it cheaper to save a large than a small fraction of energy use. This “tunneling through the cost barrier” typically comes from integrating the design of an entire package of measures so they do multiple duty (such as saving on both energy *and* equipment costs), or piggyback on renovations being done anyway for other reasons, or both. Good engineers think this is fun. Most economic theorists assume it's impossible.

Moreover, the cornucopia of efficiency opportunities keeps expanding far into the future:

- Just selling “waste” heat to other users could cost-effectively save up to about 30% of U.S. and 45% of Japanese industrial energy. (America's power stations waste more heat than Japan's total energy use.)
- Still largely unexploited are new kinds of heat exchangers and motors, membrane separators and smart materials, sensors and controls, rapid prototyping and ultraprecision fabrication, and radically more frugal processes using enzymes, bacteria, and biological design principles.
- Saving materials also saves the energy needed to produce, process, transport, and dispose of them. Product longevity, minimum-materials design and manufacturing, recovery of any scrap not designed out, repair, reuse, remanufacturing, and recycling together present a formidable menu of business opportunities that also save energy, pollution, mining, and landfilling. Japan cut its materials intensity by 40% just during 1973–84; but far more is yet to come. Americans throw away enough aluminum to rebuild the country's commercial aircraft fleet every three months, even though recycling aluminum takes 95% less energy than making it from scratch. Smart manufacturers now take their products back for profitable remanufacturing, as IBM just did with computers in Japan and Xerox does with photocopiers worldwide. Interface, the world's top carpet-tile maker, reckons to cut its materials flow by about tenfold, ultimately by a hundredfold, by leasing floor-covering services instead of selling carpet, remanufacturing old carpet, and ultimately mining nylon from landfilled carpet.
- Innovative new approaches also seem about to solve the most intractable part of the climate problem—road vehicles.⁹ Ultralight, ultralow-drag, hybrid-electric “hypercars” [refs] with 70–90% fuel savings, better performance in all respects¹⁰, and competitive costs have attracted about \$2.5 billion of private investment by 25-plus firms worldwide, half of them new market entrants. GM has announced it's developing cars with half the weight, half the drag, and hybrid drive (hypercars in all but name). In autumn 1997, Ford will test a dozen 40%-lighter 6-passenger cars (including two kinds with hybrid drive), meeting essentially the goals of the government's tripled-efficiency car program but 3–6 years early, while Toyota will mass-market in Japan a hybrid Corolla-class car with doubled efficiency, tenfold lower emissions, and only \$4,000 higher initial price. Daimler-Benz has pledged to be making 100,000 fuel-cell cars a year by 2005. With such progress being *announced*, imagine what's going on behind closed doors. Ultimately hypercars will save, probably at a handsome profit, as much oil worldwide as OPEC now sells.
- Many energy savings reduce climatic threats from more gases than just CO₂. Advanced refrigerators, using vacuum insulation and helium-engine coolers, can save over 90% of standard refrigerators' energy, thus avoid burning enough coal to fill the refrigerator every year. This also eliminates climate- and ozone-disrupting CFCs from insulation and refrigerant. Landfill and coal-mine gas recovery turns heat-trapping and hazardous methane emissions into a valuable fuel while making electricity that displaces coal-burning. Recycling paper (the average person in a rich country uses as much wood for paper, mostly wasted, as the average person in a poor country uses for fuel) saves it from turning cellulose's carbon into landfill methane, and also saves fossil-fueled manufacturing and transportation. Superefficient cars simultaneously reduce at least eight classes of heat-trapping gases. These and scores more examples represent business opportunities with multiple profit streams.

Providing the energy that a severalfold larger global population, many of them desperately poor, will need for a decent life mainly requires much more efficient use. This offers about threefold greater relative scope, and meets an even more urgent developmental need, in the South than in the North. But it will also require energy production. Where will that energy come from if not fossil fuels?

Such firms as British Petroleum and Enron are investing heavily in renewables—for good reason [Romm & Curtis *Atl* 4/96 “Mideast Oil Forever?”]. London’s Delphi Group advised its institutional investors in 1995 that alternative energy industries not only help “offset the risks of climate change,” but also offer “greater growth prospects than the carbon fuel industry” [Mansley rpt on Gelbspan 87]. In 1990, five U.S. National Laboratories reported that either fair competition plus restored research priority¹¹, or proper counting of environmental benefits, could cost-effectively expand renewables to a level equivalent to three-fifths as much energy as the United States uses today; renewable electricity supply could be one-fifth *more* than present usage [SERI 1990]. In 1997, a new five-Labs study [Levine & Brown 97] found that efficiency, renewables, and other low-carbon options could profitably or very cheaply hold 2010 U.S. carbon emissions at about the 1990 level—reducing the carbon intensity of the economy at a 1997–2010 average rate of 2.3–2.5% per year.¹² Just in the buildings sector, reducing the 1990–2010 carbon increase from 26% to 4% would save about \$22 billion a year more (1995 \$ in 2010) than it would cost [*id.* 3.6].

Best of all, sunlight is most abundant where most of the world’s poorest people live. In every part of the world between the polar circles, freely distributed and efficiently used renewable energy is adequate to support a good life continuously, indefinitely, and economically using present technologies [Sørensen 1979, Reddy & Goldemberg 1988, Lovins et al. 1981, Johansson et al. 1989, 1992]. And this potential, once considered visionary, is starting to be validated in the marketplace. The world’s fastest-growing energy source, outpacing even energy savings, is now...windpower, up 26% during 1995–1996, and led by Germany (which just overtook American installed capacity), India, Denmark, and Spain. Double-digit annual growth in solar cell shipments is bringing costs steadily down, and counting some of the dozens of kinds of “distributed benefits” can make those cells cost-effective right now in many uses [Lovins & Lehmann 1997]. (The Sacramento utility even found it’s cheaper to hook alley lights to solar cells than to the existing wires.) Adding other advanced renewables can cut utilities’ carbon emissions by as much as 97% with unchanged reliability and essentially the same cost [Johansson et al. *rens. bk.* 1992 pp 23ff].

Meanwhile, doubled-efficiency combined-cycle gas turbines, with only one-fourth the carbon-intensity of coal-fired power plants, have quietly grabbed more than half the market. The new dark horse is low-temperature polymer fuel cells: equally efficient but silent, clean, reliable, scaleable from large to computer-battery-sized, and likely to transform global power markets. Indeed, converting wellhead natural gas to hydrogen for fuel cells could offer a new option. That separation is already cost-justified by the fuel cell’s high efficiency, so its free byproduct—CO₂—can be reinjected into a depleted gasfield. This cheaply sequesters all the carbon—up to about twice as much as the field’s natural gas originally contained—and is nearly paid for by the extra gas recovered by repressurizing the field [Williams 1996].

In contrast, the products of socialized costs and central planning have not fared well. The world’s slowest-growing energy source is nuclear power—under 1% in 1996, with no prospect of improvement. Despite strenuous effort, its global capacity in 2000 will be a tenth, and its ordering rate is now only a hundredth, of the lowest official forecasts made a quarter-century ago. In America, civilian nuclear technology ate \$1 trillion, yet delivers less energy than wood. It died of an incurable attack of market forces. The only question is whether, as many analysts believe, a third or more of U.S. nuclear plants will retire early because their operating and repair bills are unaffordable. The writing is on the wall: worldwide, around 90 nuclear plants have already retired after serving fewer than 17 years. Even in France, nuclear expansion was far outpaced by its poor cousin—unheralded, unnoticed, unsupported, but more cost-effective energy efficiency.

The collapse of nuclear power—once the great hope for displacing coal-burning—might at first appear to be bad for climate. But since nuclear power is the costliest way to displace fossil fuels, every dollar spent on it displaces less climatic risk than would have been avoided by spending that same dollar on the best buys first. This opportunity cost is why nuclear power actually makes climatic threats worse rather than better.

Whole countries, especially heavily industrialized ones, can achieve big energy savings, and alternative supplies, just by adding up individual ones. During 1979–86, in the wake of second oil shock, America got nearly five times as much new energy from savings as from all net expansions of supply, and 14% more energy from sun, wind, water, and wood but 10% less from oil, gas, coal, and uranium. By 1986, CO₂ emissions were one-third lower than they would have been at 1973 efficiency levels. The average new car burned half the fuel (4% of that gain came from making cars smaller, 96% from making them smarter) and emitted almost a ton less carbon per year. Annual energy bills fell by ~\$150 billion. Annual oil-and-gas savings grew to become three-fifths as large as OPEC's capacity [Rosenfeld et al. 1990a in AREE]. In those seven years, GDP rose 19% but energy use shrank 6%. No problem.

All that effort in the '80s only scratched the surface. In 1989, the Swedish State Power Board (Vattenfall) published—without, by order of its CEO, the usual disclaimer saying it didn't represent official policy—a thorough and conservative technical study of Sweden's further potential to save electricity and heat (which are often made jointly, or "cogenerated") [ref]. The team found that fully using mid-1980s technologies could save half of Sweden's electricity, 78% more cheaply than making more. That plus switching to less carbon-intensive fuels and relying most on the least carbon-intensive power stations could enable Sweden simultaneously to

- achieve the forecast 54% GDP growth during 1987–2010,
- complete the voter-mandated phaseout of the nuclear half of the nation's power supply,
- reduce the utilities' carbon releases by one-third, and
- reduce the private internal cost of electrical services by nearly \$1 billion per year.

If this is possible in a country that's full of energy-intensive heavy industry, cold, cloudy, very far north, and among the most energy-efficient in the world to start with, then countries not so handicapped must have important opportunities too. A year later, a study for the Indian state of Karnataka found that even a limited menu—several simple efficiency improvements, small hydro, cogeneration from sugarcane waste, biogas, a small amount of natural gas, and solar water heaters—would achieve far greater and earlier development progress than the fossil-fueled plan of the state utility, with two-fifths less electricity, two-thirds lower cost, and 95% less fossil-fuel CO₂ (Reddy & Goldemberg 1990).¹³ These two analyses spanned essentially the full global range of energy intensity and efficiency, technology, climate, wealth, income distribution disparities, and social conditions. Yet they both found that efficiency plus renewables yielded a highly profitable carbon-reducing investment package.

That Karnataka study exposes the twin canards that climate is the North's problem and that reducing the South's carbon emissions would inequitably cripple development. Precisely because energy waste hobbles economic progress, some governments in the South and East have lately been quietly cutting subsidies to energy-intensive industries and even to fossil fuels themselves—the latter more than twice as fast in the South as in the North. Reformers are also opening up the energy sector to greater competition, innovation, and efficiency. Such policies have achieved better overall economic efficiency *and*, as a free byproduct, much lower carbon emissions. Such countries are saving carbon about twice as fast as OECD countries have committed to do, and they're probably saving more carbon in absolute terms than OECD countries actually will do, while boosting their own economic growth. In short, they're saving energy for *economic* reasons and reaping the incidental environmental benefits. Among the strongest economic advantages is that building superwindow and efficient-lamp factories instead of power stations and transmission lines can use a thousandfold less capital [Gadgil] and recover it ten times as fast for reinvestment—thus liberating for other development needs the one-fourth of global development capital now consumed by the power sector [Asian paper].

China has three times the energy intensity of Japan (which itself has surprisingly big efficiency opportunities still untapped). But China is improving rapidly. Spurred by energy shortages that idle an estimated 25–30% of its manufacturing capacity, China now gets a quarter of its total primary energy from renewables and over an eighth of its electricity from cogeneration. It's converting all large industrial boilers to cogeneration. It's cut its coal subsidies from 37% to 29% (1984–95) and its oil subsidies from 55% to 2% (1990–95). These and other policy initiatives reduced the 1980–90 growth in China's carbon emissions by 40%. Now, encouraged by internal rates of return on recent manufacturing energy efficiency projects all exceeding 12% and usually exceeding 20%, China is tackling a further savings potential which the World Bank last year estimated would reach in 2020 a level greater than China's entire 1990 energy consumption [Reid & Goldemberg 1997]: in steelmaking alone, best practice could reduce the typical 1990 energy per ton by 64% promptly and 82% ultimately [UNDP 1997 p 72].

Similar conclusions have been found at scales ranging from New England (Krause et al. 1991a) and California (Calwell et al. 1990) to the five largest western European economies (Krause et al. 1991) to the world (LCE, Goldemberg et al. 1988). Studies for the governments of Canada (DPA Group 1989) and Australia (Greene 1990) confirmed that ~20% CO₂ cuts would be highly profitable. In Australia, for example, a 36% energy and 19% CO₂ reduction from projected 2005 levels would save \$6.5 billion (Australian) of private costs per year by 2005, because each \$5 invested in efficiency would save \$15 worth of fuel purchases *and* 1 ton of CO₂. A new U.S. study [E Innovns 6/97] similarly found that saving 26% of carbon emissions and 15% of primary energy by 2010 would also save 13% of national energy costs—\$85 billion a year, or \$205 per ton of avoided carbon emissions, or \$530 per household per year—and create nearly 800,000 net jobs. Investments in more efficient energy-using devices to 2010 would average \$29 billion a year, but direct monetary savings would average \$48 billion a year, excluding any value of stabler climate and cleaner air.

Such profitably efficient energy futures are simply a logical extension of past achievements. Energy savings since 1973 have cut this country's energy bill by \$150–200 billion a year¹⁴ *and* carbon emissions by one-fourth. We did all that quietly, easily, and profitably—but now we know how to do far better: America, and the world, have barely begun to capture the energy efficiency that's available and worth buying. Modern cars, after a century of devoted engineering refinement, use only 1% of their fuel energy to move the driver. An ordinary light-bulb converts only 3% of the power-plant fuel into light. The entire U.S. economy is only about 2% energy-efficient compared with what the laws of physics permit. National materials efficiency is even worse: only about 1% of all mobilized materials are actually put into and remain in the average product six weeks after its sale. Thus despite impressive achievements so far, America still wastes upwards of \$300 billion a year worth of energy: more than the entire military budget, far more than the federal budget deficit, and enough to increase personal wealth by more than \$1,000 per American per year. That waste begs to be turned into profits.

Marketplace energy savings: turning obstacles into opportunities

So if such big savings are both feasible and profitable, why haven't they all been done? Because the free market, effective though it is, is burdened by subtle imperfections that inhibit the efficient allocation and use of resources. It is necessary at the outset, writes Professor Stephen DeCanio, Senior Staff Economist for President Reagan's Council of Economic Advisers [sp sic][cite JGM],

...to discard the baggage carried by most economists (the author confesses membership of that much-maligned group) that immersion in a market environment guarantees efficient behavior by the market participants. Much of modern economic theory practically *defines* efficiency as the outcome of competitive market exchanges. But the bloodless "competition" of mathematical general equilibrium models bears only a partial relationship to the actual experience of real firms.

This is tacitly conceded whenever market economists, as a senior government official recently wrote, "are unpersuaded that just because an act seems to make good economic sense it will happen." That is true—precisely because of real-world obstacles and complexities that aren't reflected in the perfect-market economic models relied upon for the conventional conclusion that saving much energy will require much higher energy prices. In fact, those barriers block economically optimal investment in efficient use of energy in at least eight main ways. The good news is that *each of these obstacles represents a business opportunity* [F4Pt2]. Some examples of how they match up:

Obstacles

Opportunities

Capital misallocation

Energy is only 1–2% of most industries' costs, and most managers pay little attention to seemingly small line-items, even though small savings can look big on the bottom line. Surprisingly many executives focus on the top line and forget where saved overheads go; and without their attention, nothing happens. In addition, manufacturing firms tend to be biased toward investments that increase output or market share and away from those that cut operating costs [Levine & Brown 1997 p. 2.2].

A few years ago, one of us was able to tell the CEO of a Fortune 100 company that one of his sites had an outstanding energy manager who was saving \$3.50 per square foot-year. The CEO said, "That's nice—it's a million-square-foot facility, isn't it? So that guy must be adding \$3.5 million a year to our bottom line." He got that right—until he added in his next breath, "I can't really get excited about energy, though—it's only a few percent of my cost of doing business." He had to be

shown the arithmetic to realize that similar results, if hypothetically achieved in his 90-odd million square feet of facilities worldwide, would boost his corporation's net earnings that year by 56%. The energy manager was quickly promoted so he could spread his practices across the company.

About four-fifths of firms don't assess potential energy savings using discounted-cashflow criteria, as sound business practice requires; instead, they require a simple payback whose median is 1.9 years [DeCanio JGM]. At (say) a 36% total marginal tax rate, a 1.9-year payback means a 71% real aftertax rate of return, or around six times the marginal cost of capital. (For example, before state and then federal standards required them, high-efficiency magnetic ballasts, with a 60% real internal rate of return, won only a 9% market share [Levine et al AREE '95]. Many capital-constrained industries use even more absurd hurdle rates: in some, the energy managers can't buy anything beyond a six-month payback.

Many supposedly sophisticated firms count lifecycle cost only for big items and make routine "small" purchases based on first cost alone. Thus 90% of the 1.5 million electric distribution transformers bought every year, including the ones on utility poles, are bought for low first cost—passing up an aftertax ROI of at least 14% a year and many operational advantages, and misallocating \$1 billion a year.¹⁵

If you invest to save energy in your business or home, you probably want your money back within a couple of years, whereas utilities are content to recover their power-plant investments in 20–30 years—about ten times as long. Thus both managers and householders typically require about tenfold higher returns for saving energy than for producing it.¹⁶ This is equivalent to a tenfold price distortion. It makes us buy far too much energy and too little efficiency. Not fairly comparing ways to save with ways to supply energy means not choosing the best buys first, hence grossly misallocating capital—lots of capital. Until the late '80s, the U.S. wasted on uneconomic power plants and their subsidies (each roughly \$30 billion a year) about as much as it invested in all durable-goods manufacturing industries. This misallocation badly crimped the nation's competitiveness.

High consumer discount rates are especially tough: folks used to paying fifty cents for an incandescent light-bulb are often unwilling or unable to pay \$15–20 for a compact fluorescent lamp which, over its life (about 13 times that of the incandescent lamp), keeps nearly a ton of CO₂ out of the air and saves tens of dollars more in power-plant fuel, replacement lamps, and installation labor than it costs. It's a good deal, but sounds like too much

Top finance firms have joined the U.S. Department of Energy in an International Performance Measurement and Verification Protocol [IPMVP, DOE/EE-0081(97), 9/97, www.ipmvp.org]. This industry-consensus approach, like FHA mortgage rules, standardizes streams of energy-cost savings so they can be aggregated and securitized. That's creating a booming market in which loans to finance energy and water savings can be originated as fast as they can be sold into the new secondary market. Achieving the savings therefore no longer requires one's own capital, can be affordably financed, and needn't compete with other internal investment needs.

A new generation of building is overcoming the psychological barrier of supposedly higher capital cost. A hundred case-studies [GDS bk] demonstrate that energy savings of 75% or more can come with superior comfort, amenity, and real-estate market and financial performance—yet *identical or lower* capital cost, because integrated design creates synergies that drastically cut equipment and infrastructure costs. Major developers are starting to move such buildings into mainstream practice.

Arbitrageurs make fortunes from spreads of a tenth of a percentage point. The spread between the discount rates used in buying energy savings and supply are often hundreds of times bigger than that—surely big enough to overcome the transaction costs of marketing and delivering lots of small savings.¹⁷ (Scores of utilities proved this in well-designed '80s and early '90s programs that delivered efficiency improvements at total costs far cheaper than just *operating* existing thermal power stations [Nadel, ABL/Joskow].) This is the basis of the Energy Service Company concept, where entrepreneurs offer to help cut your energy bills for nothing up front—just a share of the savings. Skilled firms of this type are flourishing worldwide, although the domestic ESCO industry is still in its shakeout phase.

Southern California Edison Company gave away more than a million compact fluorescent lamps because that cost less than running power stations. SCE then cut the lamps' retail price by about 70% via a temporary subsidy paid not to buyers but to lamp manufacturers, thus leveraging all the markups. Some other utilities *lease* the lamps for, say, \$0.20 per lamp per month, with free replacements; customers can thus pay over time, just as

money.

Most international vehicles for investing in national or utility-level electric power systems consider only supply-side, not demand-side, options and have no way to compare them. The resulting misallocation is like the recipe for Elephant and Rabbit Stew—one elephant, one rabbit—and it's the wrong way around.¹⁸

Organizational failures

Old habits die hard. A famous company that hasn't needed steam for years still runs a big boiler plant, with round-the-clock licensed operators, simply to heat distribution pipes (many uninsulated and leaking) lest they fail from thermal cycling; nobody has gotten around to shutting the system down. Why rock the boat to make someone else look good? Why stick your neck out when the status quo seems to work and nobody's squawking?

Schedules conquer sensible design. One of us once called the chief engineer of a huge firm to introduce opportunities like a cleanroom that uses a small fraction of the energy he was used to, performs better, costs less, and builds faster. His reply: "Sounds great, but I pay a \$100,000-an-hour penalty if I don't have the drawings for our next plant done by Wednesday noon, so I can't talk to you. Sorry. Bye." The result is "infectious repetitiveness"—like the semiconductor plant where a pipe took an inexplicable jog in mid-air as if it were going around some invisible obstacle. The piping design had been copied from another plant that did have a structural pillar in that location. In short, intense schedule pressures combine with design professionals' poor compensation and prestige, overspecialized training, and utterly disintegrated processes to yield commoditized and pervasively poor technical design.

Few firms carefully measure how their buildings and processes actually work. Their design assumptions are therefore untested and often incorrect. Their design process is linear—require, design, build, repeat—rather than cyclic—require, design, build, measure, analyze, improve, repeat. No measurement, no improvement. And no discoveries—like the plant that for decades had been unwittingly running a 40-kilowatt electric heater year-round under its parking lot to melt snow. Nobody remembered or noticed until measurement found the books didn't balance, and the wiring was traced to track down the discrepancy.

Departments often don't or can't cooperate. A noted firm calculated that its proposed new office building should get all-new, superefficient office equipment, because the

they now pay for power stations, but the lamps are cheaper.

Rapidly growing new investment funds, partly funded by the climate-risk-averse insurance industry, are bypassing utilities altogether and investing directly in developing-countries' house-level "leapfrog" efficiency-plus-solar power systems. Those often cost less than villagers typically pay now for lighting kerosene and radio batteries, and represent a new market of two billion people.

Columbia University had entrenched practices too. When a tough new energy manager, Lindsay Audin, was told to cut 10% off its \$10-million-a-year energy bill, with uncompromised service and no upfront capital, authorizations were painfully slow—until he showed they were costing \$3,000 a day in lost savings, more than the delayers' monthly paychecks. Five years later he was saving \$2.8 million a year, 60% of it just in lighting; had won 9 awards and \$3 million in grants and rebates; and had brought 16 new efficiency products to market [CS-94-1].

Both such designers and their clients can get away with this, and probably won't notice it, so long as their competitors use the same methods, consultants, and vendors. But once such striking improvements are introduced to a given market segment, the laggards must adopt them or lose market share. Thus competitive forces can do automatically much of the marketing and outreach normally required. Rocky Mountain Institute, having successfully promoted superefficient buildings and cars by this method, is now helping with a new initiative to overhaul the semiconductor industry, which has \$100 billion worth of fabrication plants on the drawing boards worldwide, all inefficient. The opportunity for clean-sheet redesign is intriguing industry leaders who now understand that they cannot compete without leapfrogging over old methods.

The late economist Kenneth Boulding said hierarchies are "an ordered arrangement of wastebaskets, designed to prevent information from reaching the executive." But letting viscous information flow freely to those who need it stimulates intelligence, curiosity, and profits. At a large hard-disk factory, the cleanroom operator started saving lots of money once the gauge that showed when to change dirty filters was marked not just in green and red zones but in "cents per drive" and "thousand dollars' profit per year." In another plant, just labeling the light-switches, so everyone could see which switches controlled which lights, saved \$30,000 in the first year.

Electric utilities traditionally dis-integrate their operations too. But Canada's giant Ontario Hydro inverted its culture to make end-use efficiency and distribution plan-

extra cost of buying it early (rather than waiting for normal turnover) would be less than the up-front savings from smaller cooling equipment. No deal: the chiller was in one budget, office equipment in another. Similarly, Federal buildings are bought from one budget, then operated by a different organization from another; in some cases, they're prohibited from sharing investments so as to reduce taxpayers' total costs.

If you save, the beancounters simply cut your budget some more. Institutional or personal rewards for cutting energy costs are rare, even in the private sector.

Corporate turmoil spoils continuity. Many firms, assuming they'd already done all the worthwhile energy savings, downsized their energy managers right out of a job, stuffed the task onto other overloaded agendas, and watched it slip to an invisible priority. How many economists does it take to screw in a compact fluorescent lamp? None, goes the joke—the free market will do it. But we all know that somebody actually has to get the lamp from shelf to socket; otherwise the wealth isn't created. In many firms, that somebody doesn't exist.

Companies full of smart, competent, rational, and profit-oriented people often fail to optimize because of even deeper kinds of inherent organizational failures well described in the economic literature.¹⁹

Regulatory failures

All but a handful of states and nations reward regulated utilities for selling more energy²⁰ and penalize them for cutting your bill, so shareholders and customers have opposite goals—with predictable results. Many proposed restructuring efforts would enshrine the same perverse incentive in new commodity-based market rules—rewarding the sale of as many kilowatt-hours as possible at the lowest possible price, rather than rewarding better service at lower cost [Negawatts: 12 Transitions].

In some (though increasingly rare) cases, obsolete codes, standards (as for cement composition [Levine & Brown 97 4.41]), specifications (including those for corporate and military procurement), and laws actually prohibit sound and efficient practices. Far more often, standards meant to set a floor—like “meets code” (euphemism for “the worst building you can put up without being put in jail”), or the British expression “CATNAP” (Cheapest Available Technology Narrowly Avoiding Prosecution)—are misinterpreted as a ceiling or as an economic optimum.

ning its primary focus and generation an afterthought. Its first three experiments in meeting customers' needs by the cheapest means—typically demand-side investments plus better wires management—rather than reflexively building transmission and generating capacity cut its investment needs by up to 90%, saving US\$600 million. Such achievements can motivate deep structural and cultural reforms.

Washington State routinely shares the savings between their achievers, the General Fund, and an account reserved for reinvestment in more savings.

After Ken Nelson, the sparkplug of the remarkable Dow/Louisiana savings, retired in 1993, a reorganization disbanded his organizing committee, tracking ceased, and it became impossible to evaluate how much progress, if any, continued without him. (Lacking a champion, the neighboring Texas division reportedly never undertook a comparable effort in the first place.) But now Mr. Nelson, like Southwire's Mr. Clarkson, is an independent consultant, sharing his skills with more firms.

Proper measurement and incentives help: a utility that started paying its efficiency marketing staff a dollar for every measured kilowatt they saved quickly found that verified savings got bigger and cheaper—both by an order of magnitude.

Simple accounting innovations in a few states decouple utilities' profits from their sales volumes, and let utilities keep as extra profit part of whatever they save off their customers' bills. The nation's largest investor-owned utility, PG&E, thus added over \$40 million of riskless return to its 1992 bottom line while saving customers nine times that much. In California alone, Governor Wilson's PUC found that efficiency investments rewarded and motivated by this incentive system's emulation of efficient market outcomes, just during 1990–93, had saved customers a net present value of nearly \$2 billion. Thoughtful utility restructuring can do the same.

To encourage developers to exceed the minimal energy-saving requirements of building codes, Santa Barbara County entitled overcompliers (by 15–45+%) to jump the queue for approvals—a valuable reward at no cost. Elsewhere, some builders of superinsulated homes that leapfrogged far beyond code requirements have won credibility, and dominant market share, by offering to pay any heating bills over, say, \$100 a year, or all utility bills for the first five years' ownership.

The transportation sector is the fastest-growing and seemingly most intractable source of carbon emissions precisely because it is the most socialized, subsidized²¹, and centrally planned sector of the U.S. economy—at least for favored modes like road transport and aviation. It has the least true competition among modes, and the most untruthful prices, with hidden costs of hundreds of billions of dollars per year per year for U.S. road vehicles alone [refs]. These distortions leverage more billions into otherwise uneconomic infrastructure and locational decisions.

The dispersion of uses that causes so much excessive driving is mandated by obsolete single-use zoning rules meant to segregate noxious industries that scarcely exist today. Congestion is specifically caused by non-pricing or underpricing of the road resource: most roads are supported by taxes, not users, so they look free to drivers who behave much as Soviet customers did in demanding a great deal of energy when it looked free. Congestion is further exacerbated by building more subsidized roads that elicit even more traffic, and by requiring developers to provide as much parking as people use when they pay nothing for it. Future generations will marvel that the incredible social costs of these policies—costs deeply intertwined with many inner-city ills—went so long unremarked and uncorrected.

Thailand loses a sixth of its GDP to Bangkok traffic jams, so it's building Los Angeles-style freeways that will create more traffic.

Informational failures

The extremely high returns implicitly required for buying efficiency often reflect a paucity of accurate and up-to-date information. Do you know where to get everything you would need to optimize your own energy use, how to shop for it, how to get it properly installed, who would stand behind it? If any of the preceding examples of big, cheap savings surprised you, you've just observed a market barrier: if you didn't know something is possible, you can't choose to do it.

Strong evidence is emerging that co-locating where people live, play, shop, and work creates such desirable, friendly, low-crime, walking-and-biking-dominated neighborhoods that they yield exceptional market performance. Such co-location, and land-use policies that integrate housing and jobs with transit, can be further encouraged by "locationally efficient mortgages"—the subject of a \$1-billion Fannie Mae experiment—that effectively let homebuyers capitalize the avoided costs of a car they no longer need in order to get to work.

Employers can profit from "cashing out" employee parking spaces—charging fair market value for each space, and paying each employee a "commuting allowance" of equal aftertax value. By monetizing competition between all means of getting to work (or, through telecommuting, of not needing to), this will typically reduce demand for parking spaces, which often cost \$10–30,000 apiece, by more than it enriches the Treasury through the newly taxable perk.

Real-estate developers can profit from annuitizing perpetual transit passes rather than providing a \$25,000 parking place with each housing unit (which yields less but costlier housing). Allowing residents to rent out their daytime parking spaces can pay their home property tax [Shoup 1997].

Singapore is almost congestion-free because it charges drivers their true social cost and invests the proceeds in effective public transit and coordinated land-use.

Labeling tells buyers how competing models compare. Some voluntary labeling systems (as of a quarter-million San Francisco houses in 1978–80) have swept the market because buyers quickly became suspicious of any house that *wasn't* labeled. EPA's voluntary Energy Star standard for office equipment did the same, now embracing over 2,000 products by more than 400 manufacturers, because the efficient machines worked better, cost the same or less, and were therefore mandated for federal purchasing. They're saving a half-billion dollars a year, and promise a profitable ten-million-ton-a-year carbon saving by 2005. Other voluntary programs that provide informational, technical, and trade-ally support, like EPA's Green Lights [www.epa.gov/appdstar/green/glb-home.html], are succeeding because they create competitive advantage. Involving more than 2,300 organizations, Green Lights' retrofits save over half the lighting energy with 30% ROI and unchanged or improved lighting quality. The national potential for this effort alone is a \$16-billion annual saving, plus a 12% reduction in utilities' carbon and other emissions.

"Hassle factor" and transaction costs prevent efficient microdecisions in day-to-day life. For example, how much do you pay at home for a kilowatt-hour of electricity, and how many kilowatt-hours does your refrigerator—typically the biggest single user in the household unless you have electric space or water heating—use each year? If you don't know, because you're too busy living to delve into such minutiae, then you're part of another market barrier. And if you do know, then there's probably another barrier, because for the same price, you could have bought a seemingly identical refrigerator 2–3-fold more efficient, or nearer 20-fold with advanced techniques not yet brought to the mass market.

Risks to manufacturers and distributors

Industry lacks information too—about what customers really want and whether they'll put their money where their mouths are. Manufacturers often hesitate to take the risk of developing and making new energy-saving products, because of limited confidence that they'll sell in the face of all the obstacles listed here.

Efficient equipment often isn't available when and where it's needed—as anyone knows who's tried to replace a burned-out water-heater, furnace, refrigerator, etc. on short notice. Yet distributors, aware of the slow uptake of efficient devices, don't want to take the risk of carrying inventory that may sell slowly or not at all. Thus British Columbia Hydro found that the huge motors in that Province's mining and pulp-and-paper mills were virtually all inefficient, simply because that's what local vendors customarily stocked; anything else took too long to order, and the mills couldn't afford to wait.

Perverse incentives

Compensation to architects and engineers worldwide is based directly or indirectly on a percentage of the *cost* of the building or equipment specified. Designers who work harder to eliminate costly equipment therefore end up with lower fees, or at best with the same fees for more work. Such backwards incentives have led the U.S. to misallocate about \$1 trillion to air-conditioning equipment (and utility systems to power them) that wouldn't have been bought if the same buildings had been optimally designed to produce the same or better comfort at least cost [SOA:SC or ?SCTA or SIP2].

The real-estate value chain is full of incentives so perverse that each of the 25 or so parties in a typical large

It's precisely to make such decisions hassle-free—and because most appliances are bought not by billpayers but by landlords, homebuilders, and public housing authorities—that Congress almost unanimously approved mandatory efficiency standards for household appliances. They merit further extension to commercial and industrial devices. Such standards knock the worst equipment off the market and reward manufacturers for continuous improvement. That's largely why careless shopping for a same-priced refrigerator can sacrifice only 2–3-fold efficiency gains in America, vs. 6-fold in Europe. Smart utilities also reinforce standards by rewarding customers for beating them.

Swedish official Hans Nilsson pioneered contests for bringing efficient devices into the mass market. A major public-sector purchasing office issues a Request for Proposal guaranteeing to buy a large number of devices, bid from certain prices, if they meet certain technical specifications, including energy savings highly cost-effective to the user. This explicit expression of market demand has already elicited many important innovations giving a strong advantage to Swedish industry in both home and export markets. A "golden carrot" devised by Dr. David Goldstein of the Natural Resources Defense Council followed suit with improved U.S. refrigerators.

BC Hydro paid a small, temporary subsidy to stock only efficient models, so vendors' extra carrying cost was covered. In three years, premium-efficiency motors' market share soared from 3% to 60%. The subsidy was then phased out, supported by a modest backup standard. Similarly, PG&E found in the '80s that rather than paying customers a rebate for buying efficient refrigerators, it could improve refrigerator efficiencies faster, at less than a third the cost, by paying retailers a small bonus for each efficient model stocked, but nothing for stocking inefficient ones. The inefficient models quickly vanished from the shops, so when you wanted the next unit the dealer could put on the truck, it'd be efficient, because that's all they'd have.

Pilot projects launched by RMI are now testing how much more efficient buildings become if their designers are rewarded for what they save, not what they spend, by letting them keep several years' measured energy savings as extra profit. Early results are highly encouraging. The German and Swiss architectural associations are pursuing similar reforms.

Careful case-studies are revealing that in well-designed, highly efficient buildings, the better visual, acoustic, and

deal is systematically rewarded for inefficiency and penalized for efficiency [SIP2]. The 75% energy saving designed for the Chicago office tower mentioned earlier, with instant payback, wasn't bought: the property was controlled by a local leasing office, incentivized on dealflow, that didn't want to delay its commissions a few months by retrofitting before leasing up the building. The building then proved unmarketably costly and disagreeable, so it had to be sold off to a bottom-feeder. Yet the owner wasn't unsophisticated—it was one of the world's largest fiduciaries.

Split incentives—one party selecting the technology, another paying its energy costs—limit ultimate consumers' choices by substituting intermediaries who don't bear the cost of their poor decisions [DOE '96 @ 5L 2.2]. This issue is ubiquitous. Why should you fix up your rented premises if you don't own them? Why should the landlord do it if you pay the energy bills? Alternatively, if you *don't* pay the bills, why use energy thoughtfully (for example, why maintain or efficiently drive a company car whose costs are paid for you)? In the Shanghai pumping example above, the pipefitters don't mind putting in lots of extra bends, because they're paid by the hour and they won't pay the equipment or electricity bills.

Similar split incentives apply to the makers and users of all kinds of equipment used in buildings and factories. Such equipment is almost always inefficient, optimized on first cost alone, since those who sell it won't pay the operating costs and most buyers won't shop carefully. (Indeed, for most kinds of equipment, efficient equipment simply isn't available—until a big customer demands better, as Wal-Mart successfully did for day-lighting and air-conditioning equipment.)

In one respect the market works all too well: wasteful old equipment often gets salvaged for resale in the secondary market—mainly to poor people who can least afford the high running costs that motivated the scrapping in the first place. Such “negative technology transfer” can cripple development efforts [Asian paper].

False or absent price signals

Energy prices are often badly distorted by subsidies and by uncounted external (larcenous) costs not internalized by the Clean Air Act's laudable trading system. The U.S. still subsidizes energy supply by about \$21–36 billion per year [Koplow ASE93 for '89; EIA92 omits many terms], mostly for the least competitive options and essentially all for supply—implying significant costless reductions in carbon emissions just by removing subsidies [Shelby et al. 1995]. And that doesn't count an even

thermal comfort enables people to do about 6–16% more and better work. In a typical office, where people cost 100 times as much as energy, that boost in labor productivity is about 6–16 times as valuable to the bottom line as eliminating the entire energy bill! Analogous benefits, big enough to create decisive competitive advantage, are also being found in retail sales and manufacturing. These results may help to explain why firms participating in EPA's voluntary Green Lights lighting-efficiency programs showed stronger earnings growth than nonparticipants [cite DeCanio in Feldman bk]. Increasingly educated tenants will not long tolerate buildings that don't contribute to their success.

Lease riders can fairly share savings between landlords and tenants so both have an incentive to achieve them. Energy utilities could also (as some water/wastewater utilities already do) apply “feebates” to new building hookups: you pay a fee or get a rebate to connect to the system, but which and how big depends on how efficient you are, and each year the fees pay for the rebates. Unlike building codes and appliance standards—which are better than nothing, but become instantly obsolete and offer no incentive to do better—such a revenue-neutral economic instrument drives continuous improvement. It also signals lifecycle costs up front when long-lived investments are being made.

The world's largest maker of air conditioners, Carrier Corporation, is leasing comfort services—much as elevator-maker Schindler leases vertical transportation services and Dow leases solvent services. This improves not only resource efficiency but also incentives: the *more* efficient, durable, and flexible Carrier's air-conditioning systems become, the *greater* its profits, and the better the service it provides at lower cost to more customers. Service leasing aligns the providers' incentive with its customers' objective.

Some big California utilities buy up inefficient old motors, refrigerators, and other devices in order to scrap them before they enter the second-hand market: they're worth far more dead than alive. Unocal even bought and scrapped polluting old cars in order to gain pollution credits for its refinery near Los Angeles.

Subsidies are under increasing pressure by a more skeptical Congress and a better-informed public. Utility regulators in about 30 of the United States also take account of some externalities in considering utilities' proposed resource acquisition decisions. Some proposals for industry restructuring would worsen but others would help to correct these longstanding distortions.

bigger item: subsidies to security of supply that make the true cost over \$100 per barrel²² for Persian Gulf oil, all of it unnecessary.²³ (Yes, more was at stake in the Gulf War than just oil, but we'd hardly have sent a half-million troops there if Kuwait just grew broccoli.)

Energy price signals are diluted by other costs. For example, U.S. gasoline, cheaper than bottled water, is only an eighth of the total cost of driving, even though the car is cheaper per pound than a Big Mac. Why buy a 50- instead of a 20-mpg car when both cost about the same per mile to own and run?

Few firms track energy costs as a line-item for which profit centers are accountable. Firms in rented space may have energy bills prorated rather than submetered. Most billing systems give no end-use information that lets customers link costs to specific devices. Many firms, especially chains and franchises, never even see their energy bills, which are sent directly to a remote accounting department for payment. Some large firms still assume that utility bills are a fixed cost not worth examining.

Appraisers rarely credit efficient buildings for their actual energy savings, so efficiency's value isn't capitalized. Most leasing brokers base pro forma financials on average assumed operating costs, not actual ones. Few buildings have efficiency labels. Few renters have access to past energy bills.

Tax asymmetries further distort energy choices. For example, energy purchases are deductible business expenses, but investments to save energy get capitalized.

Market prices don't include many environmental costs and risks: the Clean Air Act, for example, creates a cap-and-trade regime for sulfur but not for carbon emissions.

Incomplete markets and property rights

There is no market in saved energy: "negawatts" aren't yet a fungible commodity subject to competitive bidding, arbitrage, secondary markets, derivatives, and all the other mechanisms that make real markets in copper, wheat, and sowbellies. You can't yet go bounty-hunting for wasted energy, trade negawatt futures and options (or bid them in a spot market against megawatts), or even, in general, bid them fairly against expansions of energy supply. You can seldom sell reduced demand or reduced uncertainty of demand; yet both are valuable resources that deserve markets. Property rights in most forms of depletion and pollution are incomplete or absent and hence cannot be traded.

Feebates (above) can reward turning over big capital stocks like car fleets more quickly, so we get the worst ones off the road soonest. This offers a huge new market opportunity—especially if the rebate for your efficient new car depends on the *difference* in efficiency between the new one you buy and the old one you scrap.

New bill-paying and -minimizing service companies are springing up to meet exactly this need. Many provide submetering and two-way communications to pinpoint opportunities for improvement. Such simple efforts as ensuring that each meter generating a bill is actually on the customer's premises often generate big savings.

Some jurisdictions have right-to-know laws; others get similar results by training renters and buyers to be assertively inquisitive. Smart leasing brokers are distinguishing their services by offering valuable advice on minimizing occupancy costs. Home and commercial-building energy rating systems are rapidly emerging.

Some countries do better. When the Japanese government wanted to clean up sulfur emissions from power plants, it allowed them to be expensed the same year.

Natural Resources Defense Council published an index of relative exposure to carbon-tax risks for all U.S. utilities and let capital markets adjust ratings accordingly.

When Morro Bay, California, ran short of water, it simply required any developer wanting a building permit to save, somewhere else in town, twice as much water as the new building would use. Many creative transactions occurred as developers discovered what saved water is worth. Two-fifths of the houses were retrofitted with efficient fixtures in the first four years. A more comprehensive market transformation effort enabled Goleta, California, to cut per-capital residential water use by over 50%, and total water use by over 30%, in one year and with no loss of service quality—thereby deferring indefinitely a multi-million-dollar wastewater-treatment-plant expansion.

Critics of climate protection often cast doubt on the elaborate computer models that simulate the physical processes of the earth's climate. But those models, which now closely fit the climate data, are far more detailed and realistic than the climate-economics models used to claim that climate protection is too costly. The pervasive barriers to buying energy efficiency make the economic models' perfect-market assumption as otherworldly as if the physical climate models omitted atmosphere, clouds, and oceans, and relied instead on a theoretical assumption based on a simple historical regression linking CO₂ levels to global average temperatures.

Compare the "actually existing market" in the left column above with the requirements of a *theoretical* free market: perfect information about the future, perfectly accurate and complete price signals, perfect competition, no monopoly or monopsony (sole buyer), no unemployment or underemployment of any resource, no transaction cost, no subsidy, and so forth. It's a different universe. Ignoring those real-world distinctions leaves most of the climate-economics models riddled with flaws: for example,

- The economic models all forget that renewable sources get cheaper as you produce them in higher volumes, as they've done for decades—leading Royal Dutch/Shell Group Planning to consider it plausible that over the next half-century, renewables could grow to supply more than half the world's energy [Sustained Growth scenario, Kassler 1994, from UNDP 1997 p 110].
- The economic models also don't let technologies improve as price incentives increase, even though rising prices are well known to spur innovation [Newell et al 1996, Grubb et al 1995, Goulder & Schneider 1996].
- Most models quietly assume that carbon-tax or -permit-auction revenues are simply rebated (which lowers GDP) instead of being used to displace the distorting taxes that discourage savings, work, or investment (which would raise GDP) [WRI pp 23-26].
- The relatively few models that allow international trading of emissions and reductions assume that all countries have essentially perfect market economies—even those, like the former USSR and China, that don't have economies at all, but only giant machines for eating resources (and hence the biggest opportunities for improvement).
- Most economic models are very sensitive to how fast, if at all, energy efficiency is assumed to improve by itself at present prices: one model, for instance, found that as this rate was increased from 0.5 to 1.5% per year (it actually averaged 1.54% per year during 1973–95²⁴), the calculated cost of cutting carbon emissions to 20% below 1990 levels fell from \$1 trillion nearly to zero [Manne & Richels 1990s; see WRI p 19].
- Very few of the models take any explicit account of efficiency technologies, and those that do (like the government studies that show ways to save 20–25% of the carbon at negative cost, with much further potential at low cost [IPCC 1996b, NAS 1991, OTA 1991, Levine & Brown 1997,...]) are ultraconservative: they use outmoded, costly, incremental, component-based technologies rather than reflecting the modern whole-system approach.

A lucid guide to 162 predictions by the 16 top climate/economy models [WRI] found that seven underlying assumptions explained 80% of the differences in their results. Does a model assume there's any "backstop" energy source, such as renewables or nuclear, that can be widely adopted if fossil-fuel prices get high enough? Does it assume the economy responds efficiently to price signals and can make significant substitutions between fuels and between products? Can different countries trade their savings opportunities? Are revenues recycled efficiently? Does the model count the value of avoiding climate change (perhaps a relatively minor term, but enough, with efficient revenue recycling, to improve economic welfare [Nordhaus & Young 1996, Jorgensen et al 1995, Nordhaus 1994, 1993])? Does it count the benefit of abating associated forms of conventional air pollution as a free byproduct of burning less fossil fuel—benefits large enough to offset 30–100% [IPCC 1996b] or more [Ekins 1995, Jorgenson et al 1995, Boyd Krutilla & Viscusi 1995] of the assumed cost of carbon abatement?²⁵ For (say) a 60% carbon reduction in 2020, *these seven assumptions can predetermine whether the model shows by then a 7% reduction or a 5% increase in GDP* [WRI 1997].²⁶ That noted economists should find such wildly divergent results underscores not only their lack of unanimity on whether climate protection is disastrous or beneficial for the economy, but also that the difference arises from divergent model structures and assumptions.

In sum, most economic models—especially the extreme ones publicized by fossil-fuel companies' \$30-million ad campaign—calculate large costs because they assume rigid, constrained, and unintelligent responses to economic signals. The few models that show economic *benefit* from protecting climate, even if they assume outmoded energy-

efficiency techniques and impute no value to reducing carbon or other pollution, merely assume that people and firms behave with the ordinary sagacity and flexibility that market mechanisms offer.

Even cheap energy can be saved quickly

Energy efficiency can be implemented very rapidly, by either or both of two quite different methods. One method, demonstrated in the 1970s and '80s, is to have high or rising energy prices and a sense of urgency:

- During roughly 1975–85, most new U.S. energy-using devices—cars, buildings, refrigerators, lighting systems, etc.—*doubled* their efficiency, improving at an annual rate averaging around 7%.
- If all Americans saved electricity as quickly and cheaply as ten million people served by Southern California Edison Company did during 1983–85, then each year they'd decrease the forecast need for power supplies a decade hence by about 7%, at a cost to the utility around one-tenth that of today's cheapest new power stations [Lovins 1985 pp 180–83, Fickett et al. 1990].
- In the 1980s, skillful utilities captured ~70–90+% of particular efficiency micromarkets, mainly difficult ones like retrofitting house shells, in just one or two years.
- Speed can extend to renewables as well as efficiency. Maine used auctions and other competitive processes to raise its private share of power generation from 2% in 1984 to 20% in 1989 to 36% in 1995—and more than two-thirds of that new production was renewable.

Of course, a lot has changed since the '80s. At first, U.S. primary energy consumption “froze at about 74 quads” (quadrillion BTU per year) during 1973–86 “while the GNP grew by 35%” [Levine & Brown 1997 p x]. Those huge energy savings largely caused the mid-1980s crash in energy prices. This in turn retarded further savings: “Starting in 1986, [real] energy prices began their descent...that has continued to the present. As a result, energy demand grew from 74 quads in 1986 to 91 quads in 1995”—a 22% increase, while GDP grew 23%. With more fuel being burned, “carbon emissions have been increasing at a similar pace” [Levine & Brown 1997 p x].

This history makes it natural for economists to suppose that resuming rapid energy savings will require a return to the costlier energy that propelled rapid savings before. But lower and still-declining fuel prices don't bar us from regaining that decade-old momentum. Today's better technologies and smarter delivery methods can far outweigh the lower energy prices and the used-up initial opportunities, achieving quick savings even *without* the spur of high prices:

- During 1990–96, utility facilitation enabled electric customers in Seattle—with the cheapest electricity of any major U.S. city—to save electric load nearly 12 times as fast as those in Chicago, and electric energy more than 3,600 times as fast, even though Seattle electricity prices are about half of Chicago's.²⁷ This conclusively shows that making an informed, effective, and efficient market in energy-saving devices and practices—as Seattle City Light's efforts helped to do—can fully substitute for a bare price signal, and indeed can influence energy-saving choices even more than can price alone. That is, *people can save energy faster if they have extensive ability to respond to a weak price signal than if they have little ability to respond to a strong one.*²⁸
- Investor-owned utilities, when rewarded for cutting bills, sold efficiency ever faster and more skillfully despite falling electricity prices. In 1990, New England Electric System captured 90% of a small-commercial pilot retrofit market in two months. Pacific Gas and Electric Company captured 25% of its entire new-commercial-construction market—150% of the year's target—in three months, so it raised its 1991 target...and captured all of it in the first nine days of January.

Higher energy prices do not automatically yield substantial energy savings, as can be seen simply by comparing the virtually identical electricity-using devices found in U.S. cities that pay severalfold different electric rates. Nor, as the Seattle/Chicago comparison shows, do low energy prices preclude rapid energy savings where policy encourages and support them. Thus higher energy prices do help spur savings and reflect true social costs. But high energy prices are neither a necessary nor a sufficient condition for economically and technically efficient use of energy: not necessary because vast savings are already worthwhile at present prices but blocked by the barriers described earlier, and not sufficient because the same obstacles, if not deliberately removed, would persist even at higher prices.

Honest energy prices do increase economic efficiency: if we don't know what energy really costs, we won't know how much is enough. Combining desubsidized and internalized energy prices with policy “trimtabs” that reduce the barriers would yield the fastest possible savings. The most balanced approach to price, however, is not to focus spe-

cifically on *energy* prices, but to shift taxation from jobs and income to *all* forms of resource depletion and pollution—just as the British, Danes, Dutch, Finns, and Swedes are starting to use revenues from environmental taxes to cut taxes on labor. Today's outmoded U.S. tax system penalizes work and employment while often subsidizing depletion and pollution. The present system rewards, and therefore gets, just the opposite of what we want. In a 21st-century world of more abundant people and scarcer natural capital, it makes good theoretical and practical business sense to rebalance factor inputs by correctly signaling their relative scarcities.²⁹

Energy prices and national competitiveness

If for whatever reason the price of emitting CO₂ into the atmosphere were raised above its current value of zero, Americans need not fear damage to national competitiveness. After all, the nations that have traditionally been the toughest competitors, like Japan and Germany, have long had energy prices two to three times those of the U.S. This simply made them use the energy about twice as efficiently. Learning how to do this drove their industrial innovation on a broad front, further widening the competitive gap against a cheap-fuel America. Similar flexibility, and more, exists in our own economy—as Americans have already proved by invisibly cutting the nation's annual energy bill by some \$150–200 billion compared with 1973 levels of inefficiency. And there's a hidden bonus: just as energy efficiency created the conditions that crashed world oil prices in 1986 and have made them decline ever since, triggering a durable boom [Schwartz 1997], so repeating and accelerating that success can continue to suppress OPEC's cartel power and dampen oil prices. This would cut America's oil trade deficit (\$61 billion in 1996 alone) while not causing material adverse trade shifts of other kinds [WRI p 9].

Nor need we fear that costlier energy in industrial countries would make American jobs (and carbon emissions) flee to an untaxed South—akin to the “pollution haven” notion which analysts have searched for in the data but not yet found [DeCanio new MS cite]. Electricity prices would be the most sensitive to any carbon tax or emissions trading; yet 1994 electricity bills averaged only 1.3% of the value shipped by average U.S. manufacturing firms, 3.4% for the most electricity-intensive sector (pulp and paper) [EEI Stat Yrbk 1995, p. 82].³⁰ If electricity is too small a factor cost to worry about saving, it's hardly big enough to justify moving one's factory overseas. Conversely, if its price rises enough to motivate moving abroad, it's certainly a strong enough reason to save most of that electricity, at a profit, and stay at home.

After all, a small saving in such a tiny factor cost is far less important to industrial competitiveness than the many-fold saving that's *already* available in the biggest factor cost—labor. Yet most American jobs have remained here: firms that haven't already exported jobs in search of cheap labor have generally concluded that other countries don't have the infrastructure, skills, local markets, laws, tax rules, or other conditions they need. Differences in energy price would be a much weaker incentive to migrate—as we can infer from American firms' failure to move to the few countries, like Venezuela and Saudi Arabia, that have long had even cheaper energy than we do. Another thought-experiment reveals the absurdity of this notion that energy prices are the sole or main determinant of industrial location. If this were true, then Japan and Europe would long ago have transplanted all their factories to America to take advantage of our severalfold lower energy prices. They didn't.

Those who prefer pricing to obstacle-busting policy instruments for climatic protection contemplate price increases far smaller than the differences that already exist: for example, a 1–2¢/kWh rise in electricity price—less than the differences that already exist between different parts of the United States, or even between some adjacent utilities, without triggering industrial mass migrations. Japanese industry pays about 10¢/kWh more than its American counterparts, but as Japan long ago discovered, even such a threefold difference in energy price can be offset by more productive energy use. That's the durable source of competitive advantage; and it's far easier to sustain amidst the rich infrastructure and skill base of the North than of the South, so migrating Southwards would generally lose advantage, not gain it.

Almost everyone wins

Using energy far more efficiently does mean that less fossil fuel would be sold than if we continued to waste it so profligately. Lower physical volumes may not mean lower profits, but vendors fear that they would make less profit than expected if demand grew more slowly, or stabilized, or even declined—as it would have done eventually from depletion. (For example, a standard model of stabilizing emissions at 1990 levels through a carbon tax [Jorgenson et al. 1992] shows U.S. coal output 25% below the rapid growth in its baseline projection—but output would still grow.) Where is it written, however, that coal companies or OPEC countries have an inalienable right to sell ever

more of their product—or, as their mouthpieces³¹ now urge, to be compensated for lost profits if their hoped-for demand growth slackens or reverses?

This nation has never been good at helping workers or industries in transition, and now would be a good time to get better at it. Much of the Rust Belt is now recovering, but little thanks to outside help. In today's climate-induced shifts, a similar failure to help coal miners, depressed communities, and even disappointed shareholders will encourage them to oppose measures that benefit society. But those measures are also profitable enough that society can afford to ease their difficulties. The total payroll of all U.S. coal-miners is about \$5 billion, or 1% of the nation's energy bills—less than spontaneous gains in energy efficiency save in any typical year. Climate policies threaten miners' jobs much less than do the coal companies, which since 1980 have eliminated more than half of the miners' jobs for which they profess such concern.

As for the shareholders, hard-nosed free-marketeers might say they should have foreseen that climate would become an issue, so they should have invested in natural gas, efficiency, or renewables instead of coal, or in gas pipelines instead of coal-hauling railways. If efficient energy use costs less than coal, then coal will lose in fair competition, and no friend of a thriving economy should wish otherwise. But the best outcome, especially for the workers, would be to structure the incentives so that the companies at risk in the transition will start selling a more profitable mixture of less fuel *and* more efficiency in using it—as a few oil companies and hundreds of electric and gas utilities are already successfully doing to improve both customer service and their own profits. That's the same logic that has already led the likes of BP, DuPont, Ford, Tokyo Electric, Norsk Hydro, and ABB to fund both internal and consortium research to protect the climate while advancing their own business interests [ChrSciMon editorial "21st Century Weather," 6Aug97p20].

Time to dump the myths

With this understanding of how modern technologies and creatively used markets can profitably protect the climate *and* the economy, we can see the aridity and irrelevance of the myths underlying the conventional climate debate:

- *It's about climate science.* No; it doesn't matter what the climate science says, or even whether it's right, because we ought to be purchasing energy efficiency anyway just to save money.
- *It's about decision-making under uncertainty.* The uncertainty doesn't matter, because the robust economic benefits depend only on private internal costs and benefits, not on any imputed environmental values or risks.
- *It's about carbon taxes.* No; they may be helpful and appropriate, especially as part of a general tax shift from people to resource depletion and from production to consumption, but present prices are ample to elicit all the energy savings we need—if we just get serious about vaulting the barriers that inhibit people from buying energy efficiency.
- *It's about command-and-control.* Wrong; it's about helping markets to work properly—and then letting them do their job.
- *It's about who should bear the costs.* What costs? The interesting question is who should get the *profits*. That's a good thing to compete about in the marketplace, but it shouldn't require difficult negotiations.³² The "polluter pays principle"—OECD doctrine since 1974—remains valid, but this time the polluter can profit.
- *It's about sharing sacrifices for the common good.* On the contrary, it's about helping individuals, firms, and nations behave in their economic self-interest.
- *It's about changing to a lifestyle of privation and discomfort*—as the Chairman of Chrysler Corporation recently put it, "dimming the lights, turning off the air conditioning, sacrificing some of our industrial competitiveness and curtailing economic growth" [WPost 7/17/97 p A19]. No; it's about living even better with less, by using smarter technologies that yield the same or better service. The showers will be as hot and tingly as now, the beer as cold, the rooms as well-lit, the homes as cozy in winter and as cool in summer, the cars as peppy, safe, and comfortable; but we'll have substituted brains for therms and design for dollars.
- *It's about keeping the poor down.* Quite the opposite; if equitably provided as the cornerstone of the development process [Asian paper], energy efficiency could be a boost for those most burdened with the least efficient buildings and equipment, and least able to afford such waste. Even if the price of fossil fuels did rise, that's not very regressive, because poor people spend more of their income directly on energy but less indirectly (embodied in goods and services). Any disproportionate harm to the poor could be corrected by straightforward adjustments elsewhere in the tax or welfare systems [WRI, p 8, pp 32–33]. Equity issues merit careful attention, but are no reason to keep on subsidizing energy for the rich.

- *It's about consuming too much in the North and not enough in the South.* That's a real issue, and we in the North have to start thinking hard about what we want, how much is enough, how to meet nonmaterial needs by nonmaterial means, what will make us better human beings, and the difference between a good life and what scripture calls "vanity." But the resource-efficiency revolution described in two new books³³ can buy much time by simultaneously sustaining or enhancing Northern *and* greatly improving Southern living standards while dramatically reducing the use of energy and materials.

Protecting the climate for fun and profit

A proper grasp of the practical engineering economics of energy efficiency (and of other climate-stabilizing opportunities) can thus give nearly all the parties to the climate debate what they want. Those who worry about climate can see it stabilized. Those who don't will still make more money. Those who worry about costs and burdens will see them replaced by profits. Those who want improved jobs, productivity, competitiveness, quality of life, public and environmental health, and individual choice and liberty will get those things too. Two emphases—energy efficiency, and climate-protecting farming and forestry practices that treat nature as model and mentor—can deal profitably not only with climate but with about 90% of EPA's pollution concerns. These actions are therefore not inimical but vital to a vigorous economy, a healthful environment, sustainable development, social justice, and a livable world. As an eminent group of economists supported by more than 2,000 of their colleagues recently concluded, in short, "policy options exist that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run" [Arrow et al. 1997].

The true pragmatists in this debate are those who suggest that we have at hand—and should elevate to the central role in climate policy—the tools we need to turn climate into a business opportunity, at home and worldwide. This can, but need not, involve changing energy prices. Innovative, market-oriented public policies, especially at a state and local level, can focus chiefly on barrier-busting to help markets work properly and reward the economically efficient use of fuel and money. This requires much *less* intervention in the market than we now have with regulatory rules and standards: it properly assumes that the role of government is to steer, not row, and that market actors guided by clear and simple rules can best figure out what will make sense and make money. But we need to steer in the right direction—the line of least resistance and least cost—guided by a detailed and exact understanding of the barriers that now block energy efficiency, and thereby damage global development and national security [Nitze W Post A22 2 July 1997].

A bizarre irony lurks beneath the climate debate. Why do the same people who favor competitive markets in other contexts seem to have the least faith in their efficacy for saving fossil fuels? Let's recall what happened the last time this gloom-and-doom attitude overcame these people's better instincts. Just before Congress approved in 1990 the cap-and-trade system for reducing sulfur dioxide emissions, environmentalists predicted that reductions would cost about \$350 a ton, or ultimately (said the optimists) perhaps \$250. Government economic models predicted \$500–750; the higher figure was the most widely cited. Industry models upped the ante to about \$1,000–1,500. In fact, the sulfur-allowance market opened in 1992 at about \$250 a ton; in 1995, it cleared at \$130 a ton; in 1996, at \$66.³⁴ Moreover, national sulfur emissions have fallen 37% in just the past decade—and 38% faster than the Clean Air Act envisaged, because of simple incentives to reward early achievers. Much the same thing is happening with CFCs.

The genius of private enterprise and advanced technologies found a way billions of dollars cheaper than command-and-control regulation. It would do so again if we competed to save the most carbon in the cheapest ways. In fact, a double bonus would emerge: we'd automatically and profitably meet most of the stringent new ozone and fine-particle standards too, via the same reduced combustion that helps the climate and cuts our energy bills; and we could easily use similar incentives for doing so early.

In the past half-century, global carbon emissions have quadrupled. But in the next half-century, the climate problem could become as faded a memory as the energy crises of the '70s are now³⁵—because it's not an inevitable result of normal economic activity, but an artifact of energizing that activity in extraordinarily inefficient ways.

Let's vault the barriers, use energy in a way that saves money, and put enterprise where it belongs: in the vanguard of sound solutions. Climatic change is a problem we can't afford, don't need—and can avoid at a resounding profit.

* * *

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Notes [references to be added]

¹ That switch saves \$8 billion in the pulp and paper industry alone [*Agenda 2020*, Am. Forest & Paper Assn., 11/94, ref'd by Romm present'n]; similar findings of a DOE/industry process include 20% energy savings in glass, 50% in aluminum, and 15% in chemicals.

² These case-studies are from the USDOE ClimateWise Case Study Compendium, Report 1, DOE/GO-10096-217.

³ For detailed documentation on each of these matters, omitting only the newest developments such as hypercars, please see our survey paper “Least-Cost Climatic Stabilization,” *Ann. Rev. En. Envt.* 16:433–531 (1991).

⁴ The exact percentages don't matter because such big and profitable savings are available in each gas, source, and sector [*id.*].

⁵ Average U.S. industrial electricity in 1996 cost the heat-equivalent of oil at about \$79 per barrel, over three times the world crude-oil price. Commercial and residential electricity prices averaged respectively 75% and 83% higher yet. Electricity is therefore the most lucrative form of energy to save. It is also the form whose savings yield the greatest climatic leverage: each unit saved saves 3–4 units—in developing and socialist economies, more like 5–6 units—of power-plant fuel, and that fuel is mainly the most carbon-intensive kind—coal. (U.S. electricity is 52% coal-fired, and 88% of U.S. coal makes electricity.) For these reasons, our case-studies focus on new ways to save electricity, although similarly large savings are profitable for most directly used fuels too [AREE].

⁶ The negative figure means the building would have saved a capital investment equivalent to five months' worth of operating cost before you even turn it on.

⁷ The engines are especially inefficient when running air conditioners in cars stuck in traffic (*i.e.*, most cars most of the time), and all of the 5–6 GW of electricity brought into the city ends up as heat. Dr. Suntoorn [ref] notes that together, these heat sources add nearly as much artificial heat per square meter as is delivered by all the sunlight striking the city. In the nearby countryside, ingenious ventilative and radiative passive designs still work fine.

⁸ Just the temperature optimization typically saves 50% in new plants, and pays back in six months in retrofits [Levine & Brown 97 4.20].

⁹ Hypercar-like heavy road vehicles look attractive too, and new uses of information technology to smooth or displace the flow of goods can make much freight traffic unnecessary. Major savings are also available in other transport modes. Ships and passenger aircraft doubled their efficiency in the 1970s and '80s and can do it again: the National Research Council has called for 40% less fuel per seat by 2010–15 [Levine & Brown 97 5.31]. As one hint of what's possible, a 1996 Lockheed-Martin Skunkworks fighter-plane design, made of 95% carbon-fiber and the like, cut weight 35% and cost 65%. Other new vehicles are starting to enter the market, from tenfold lighter and cheaper trains to convertible road-rail vehicles (like GM's Roadrailer) and Lufthansa's freight dirigible to hybrid-electric bikes.

¹⁰ A sophisticated model perhaps a decade or two from now could combine Lexus comfort and refinement, Mercedes solidity and stiffness, Volvo safety, Porsche acceleration, roughly Taurus price, 100–200 miles per gallon-equivalent (the upper range using hydrogen fuel cells), and zero or equivalent-zero emissions. All the technologies needed to do this exist today.

¹¹ Costing only one reactor's worth (\$3 billion) spread over 20 years. Federal renewable-energy R&D was slashed 89% in real terms during 1979–89, and remains under continual attack. In consequence, American industry must already import many renewable energy technologies that were invented here, then left to wither on the vine. Effi-

ciency R&D has a similar history, with drastic cuts, slow rebuilding interrupted by continual sniping, and little attention to the \$28 billion energy saving achieved through 1996 from just five of the numerous technologies developed or demonstrated with DOE's \$28-billion efficiency RD&D budget during 1975–95 [Levine & Brown 97 p 2.5].

¹² This potential is economically consistent with the National Academy of Sciences' 1992 findings (*Policy Implications of Greenhouse Warming*) but about one-fourth to one-third as large, because the Academy examined long-term potential without regard to timing, while the five-Labs study explicitly counted retrofit and replacement dynamics.

¹³ This is possible because efficiency is abysmal to start with—so low that when an Indian village switched from kerosene to fluorescent lamps, illumination rose 19-fold, energy input decreased ninefold, and household lighting expenditure fell by half [Reddy 1994 cited at UNDP 1997 p 70].

¹⁴ This range [Levine & Brown 1997, p x] depends on what fraction of the 1973–96 reduction in primary-energy/GDP ratio is due to improved technical efficiency; with most authorities, we estimate upwards of two-thirds, the DOE estimate for 1973–86 [*id.*, p. 2.1]. The rest is due to shifts in composition of economic output and to minor behavioral changes.

¹⁵ Bill Howe, "Distribution Transformers: A Growing Energy Savings Opportunity," E SOURCE TU-93-10, 12/93; dominant models are ~96–98.5% efficient, the best amorphous-iron model 99.33%, but it costs \$680 instead of \$320, so its market share is only 10%. Compared with the best standard model, it yields a 14%/y aftertax ROI, a 20-year saving more than twice its marginal cost, a longer life, and far greater service flexibility. This analysis assumes 25-kVA oil-filled units, 0.50 load factor, 0.95 power factor, 6¢/kWh, 5%/y real discount rate, 36% marginal tax rate. The misallocation is assessed as the present value, over a 20-y minimum life, of avoided generation at 2¢/kWh and generation-plus-transmission at \$700/kW (busbar) with 3% transmission loss; each 10,000 transformers sold at 98.44% instead of 99.33% waste 2.5 peak MW and ~22 GWh/y (*id.*). One-third are bought by nonutilities; 35 million units are U.S. service; and virtually all electricity flows through similar transformers.

¹⁶ Implicit real discount rates for buying efficiency typically range upwards from 60% a year [refs], while big energy supply firms have traditionally been content with 5–6%.

¹⁷ Some theorists argue that "transaction costs"—the supposedly prohibitive cost and hassle of searching out every little source of energy inefficiency and negotiating with its owner to correct it—will eat up any profits and make further energy savings impractical. Nonsense. Transaction costs in some poorly designed early utility programs were up to tens of percent of total costs—which were still severalfold smaller than the savings they achieved. But more mature programs cut those transaction costs by tenfold, to just a few percent overhead, making the net profits even juicier [AREE p 3n/SCE pri ref].

¹⁸ Most of the misallocation is driven also by the enormous personal profits for dealmakers. Those transactional rewards drive many investments with unsound fundamentals (like most recent Asian project-financed power plants), just as they propelled the '80s real-estate bubble and S&L fiasco. Those tens of billions of dollars per year get tied up for a decade or more and can't be invested instead in cheaper efficiency. But efficiency doesn't offer fat commissions.

¹⁹ Firms are not individuals and are not of a single mind—hence often experience [DeCanio Epol p 907...] the "divergence between goals and actions" familiar in all bureaucracies. Indeed, economic theory correctly states that in general, "rational, self-interested individuals will not act to achieve their common or group interests." Corporate inefficiency may be invisible if profits are positive and competitors use similarly inefficient practices. As Nobel economist Herbert Simon convincingly describes, firms do not in fact fully maximize profits but rather resort to "satisficing" because of the inherent complexities of their environment and the limits of their processes for making and executing decisions. Shareholders hold diversified asset portfolios, but managers whose careers ride on the success of specific projects are far more risk-averse, so they go only for extremely high-return investments—and so on down the hierarchical chain of control, where subordinates bear the personal risks of failure while superiors see the results and know which projects were chosen but not why. This leads to systematic suboptimization—to second-best solutions perceived as less risky individually, but less profitable overall than they should be. In summary, the reasons for corporate (or for that matter government) underinvestment in energy efficiency are described by economists as bounded rationality, principal-agent problems, and "moral hazard" (an old insurance term for situations where behavior can take advantage of and thereby change actuarial odds or prices, as where people are more likely to abuse a rental car than one they own, forcing the rental firm to raise its price). Overlaid on these is widespread myopia—hurdle rates for capital budgeting generally (not just to save energy) well above investors' required returns. The complex reasons for this relate mainly to takeover and investment-analyst pressures.

²⁰ When regulators convert revenue requirements for a fair return on and of capital into a schedule of tariffs (cents charged per kWh used by various customers), they must assume how much energy will be sold. If the utility then sells more energy than assumed, its profits go up; if less, its profits go down. The solution is to decouple profits

from sales volumes via a simple balancing account, so the utility is no longer rewarded for selling more energy nor penalized for selling less. This also eliminates the incentive to game the forecast (lowball forecast sells so you can sell more), and does not make utilities' profits depend on things they cannot control such as weather [EPoI].

²¹ Developing countries subsidize their energy by an estimated \$111 billion per year, but America subsidizes just its car drivers by more than that (the gap between their public direct costs and their fee and tax payments) [Worldwatch ref: Vital Signs '97?]. We pay to create the problem and we pay to deal with it. It would be cheaper and smarter to pay no subsidy and thus avoid the problem.

²² The military costs of forces whose primary mission is intervention in the Persian Gulf totaled at least \$73 billion in 1994—plausibly 3+ times that [Cavallo 1996]. Allocating that cost generously to all, not just Gulf, oil use is equivalent to a hidden shift of about \$2–7 per million BTU, or \$13–37 per barrel, from energy bills to tax bills.

²³ The U.S. wouldn't have needed a drop of oil from the Gulf if it had kept on saving oil as fast after 1986 as it did for the previous nine years. During 1975–87, the U.S. had boosted its oil productivity four-fifths faster than it had to in order to match both economic growth and declining domestic oil output. By 1986, the annual energy savings, chiefly in oil and gas, were providing two-fifths more energy than the entire domestic oil industry, which had taken a century to build; by 1995 the savings had surpassed *all* oil use. But after doubling, new-car efficiency stagnated for a decade and is now declining again under the weight of inefficient light trucks, vans, and sport-utilities.

²⁴ But with localized spurts, like New England's 6%/y gains during 1978–80 (the period of the second oil shock). To be sure, national improvements were much faster before the 1986 price crash than since, but if a lower-than-historic rate is to be assumed because greater energy efficiency will continue to lower energy prices, then the stimulative effect of that cheaper energy must also be considered.

²⁵ EPA's 1994 *Emission Trends Report* states that conventional energy use causes 95% of U.S. CO₂ and NO_x emissions, 73% of volatile organic compounds, and 70% of CO, so as *The Economist* remarked in June 1990, "Using energy in today's ways leads to more environmental damage than any other peaceful human activity."

²⁶ Such a long-term change is quite small in annual terms: a review of nearly 100 modeling studies showed that holding long-term CO₂ emissions at about current levels (much more stringent than current proposals for stabilizing emissions) "may if carried out in an efficient manner be expected to reduce...average GNP growth rates over the period [to the mid-21st century] by less than 0.02–0.03% per year" [M. Grubb *et al.*, "The Costs of Limiting Fossil Fuel CO₂ Emissions: A Survey and Analysis," *Ann. Rev. En. Env't.* 18:397–478 (1993) at 472].

²⁷ Seattle City Light's measured savings achieved through 1990–96 investments in demand-side management, emphasizing energy rather than peak-load savings, were 313 GWh/y or 38 average MW—3.2% of 1996 energy sales and average load (J. Todd, personal communication, 7 August 1997, documented in annual *EMSD Accomplishment Reports*). By 1996, but nearly all during 1995–96, the nearly tenfold larger Chicago utility Commonwealth Edison saved 51 peak MW (0.27% of its 19-GW peak load), or an 11.8-fold smaller fraction of load. ComEd made essentially no effort to save electrical energy, yielding savings of only 800 MWh/y, or 0.00088% of its sales [M. Brandt, personal communications, 13 and 21 August 1997]—a 3,640-fold smaller fraction than in Seattle. The ComEd figures are not corrected for any offsetting sales increases resulting from promotional tariffs and practices. Big customers in Seattle in 1996 paid 1.9 times less and small customers paid 2.3–2.4 times less per kilowatt-hour than in Chicago.

²⁸ This is not surprising, since "nonprice measures have an important role in improving economic efficiency....All markets in open societies and in all sectors of economic activity...function within a framework of laws,...standards and public and private information services designed to improve the clarity and integrity of economic transactions and in so doing improve economic efficiency....[P]ure market transactions, in which prices, along with other economic variables such as income and wealth are the sole variables, are rare" [D. Anderson, World Bank, AREE '95, pp 563–4].

²⁹ Environmental taxes certainly work: as *The Economist* [28 June 1997] summarizes, "the OECD says that in Sweden, where dirtier automotive diesel has been taxed relatively heavily since 1991, almost all diesel is now of the cleanest type and sulfur emissions from diesel vehicles have fallen by 75%. In Norway, the carbon-dioxide tax has prompted a switch away from fossil fuels, cutting emissions from power stations and factories by one-fifth since 1991." Making "labor taxes less damaging...is worthwhile anyway." Tax-shifting simply combines both benefits. Phased-in, revenue-neutral tax shifts [Jeff Hammond, Peggy Duxbury, Alan Sanstad, & Stephen DeCanio, *Tax Waste, Not Work*, Redefining Progress, SFO, 1997] offer rich potential for strengthening the public and private economy and for avoiding many social costs whose remediation now increases the total burden of taxation. Tax-shifting would signal managers to fire the unproductive tons, gallons, and kilowatt-hours, and thereby help them to keep the people, who'd then have more and better work to do. There is an intimate link between the waste of people, resources, and money—and the solutions to all three problems are also intertwined [NatCap/MJ].

³⁰ Moreover, less than half the price of electricity is fuel, and under a mere \$20–40/ton carbon tax, coal-fired electricity would be quickly displaced by modern gas-fired plants that emit only one-fourth as much CO₂ per kWh and are hence only one-fourth as sensitive to the tax—or even by competitive renewable sources.

³¹ Including some leading non-oil-exporting Southern diplomats whom OPEC has coöpted for this purpose.

³² As chief U.S. negotiator Tim Wirth put it [Intl Envtl Reporter 2 Oct 1996], “probably the most complicated scientific, environmental, economic and political challenge in history.”

³³ *Factor Four: Doubling Wealth, Halving Resource Use* [cite] and the forthcoming book *Natural Capitalism: The Worthy Employment of People and Resources* [cite]. The European Union, German, and Dutch Environment Ministers have endorsed the Factor Four approach as a new basis for sustainable development—the only dissent coming from Sweden which, farsighted as ever, prefers a Factor Ten goal, as do the OECD Environment Ministers. Fair enough: the latest technical findings described in *Natural Capitalism* do make that a realistic goal. But four is on the way to ten and is much better than zero.

³⁴ See Bohi & Burtraw, *El J* Aug/Sept 97 pp 67–75. The price subsequently spiked up to \$115 in spring 1997 as Enron and other traders bought the cheap allowances. By mid-1997 it had fallen back to \$90. One could well conclude [Ackerman & Moomaw, *El J* Aug/Sept 97 pp 61–66] that “If pollution reduction is so cheap, perhaps society should buy more of it.”

³⁵ In the 1970s, experts were nearly unanimous that energy use and GDP must forever march in lockstep. The Chairman of Chrysler Corporation still holds this view and more: although his 17 July 1997 *Washington Post* op-ed “Global Warming: Industry’s Reponse” [p A19] acknowledges that “new technology will allow us to continue to grow our economy while managing the level of CO₂ output,” he also states that curtailing fossil-fuel use “in the next dozen years by more than 20 percent” by obliging ourselves to “heavily tax or somehow rigidly ration our own energy use” would have the “certain consequence” of “a decline in the country’s economic growth by a similar amount,” so without sustaining historically high levels of energy use, the U.S. is “not likely to remain” a developed country. Of course, GDP and energy have long since parted ways—we now produce 44% more GDP per unit of energy than we did in 1970—and that’s only the beginning. Even those who wonder how much further such progress can persist should be happy to try the experiment; both economically and politically, they have nothing to lose but their waste.

Articles

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Energy Security in the Asia Pacific Region

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Energy Security in the Asia Pacific Region

By Daniel Yergin, Dennis Eklof and Jefferson Edwards¹

Underlying the dramatic economic growth experienced by the majority of East and Southeast Asian countries over the past three decades has been a less readily apparent second “Asian miracle” -- rapid growth with severely limited energy resource endowments. Japan, South Korea, Taiwan, and Hong Kong all built powerful, dynamic economies without significant hydrocarbon resources. These countries achieved this impressive performance through a broad portfolio of strategies -- and by earning their way in the world economy.²

Some countries in the region, blessed with an abundance of natural resources, avoided the hardships of resource dependency in the past. In the coming years, however, virtually all of the countries in the region are or will become net importers of crude oil. All of them will experience rapid growth in energy demand. And for all, ensuring adequate supplies is essential to facilitating and protecting economic growth. How key players react to the inevitability of the region's increased dependence and the market pressures that go with it constitutes one of the major security questions for the region.

The uncertainty surrounding the resolution of this question makes energy security a particularly urgent question for the Asian countries themselves, for the countries that supply them -- and for the countries that participate with them in the marketplace. The issue, however, is not only a matter of tangible facts and future projections. It is also a question of perception -- of how countries view the problem and act upon it. Is the “second miracle” -- rapid growth with limited energy resources -- at risk?

The key signpost toward the emergence of energy security as a key issue in Asia appeared in 1993. That was the year that China moved from being an exporter of oil to being an importer. This represents a fundamental change in Asia's energy balance. Since then, it has been recognized that not only is Asia the locus of growth for the world's energy industries, but that the rapid demand growth and the attendant stresses and potential rivalries define a new calculus for energy security. Certainly, those familiar with global energy supply and demand issues during the past two decades will find themselves perplexed when reviewing Asia's energy supply situation in this decade's closing years and into the twenty-first century. On the one hand we see a mix of old imperatives -- diversification of supply,

¹ The authors would like to thank James C. Clad and Joseph A. Stanislaw for their contribution to this paper.

² On the impact of Asia's export orientation, see Jose Edgardo Campos and Hilton Root, *The Key to the Asian Economic Miracle: Making Shared Growth Credible* (Washington D.C., Brookings Institution, 1996) and The World Bank, *The East Asian Miracle* (Washington D.C., The World Bank and Oxford University Press, 1993).

development of strategic reserves; on the other hand we detect the interplay of new impulses and approaches. Consider Asia's perennial supply constraints but also the innovative commercial approaches that are emerging to overcome them. Consider also how the passage of time has actually increased some dependencies, the region being more dependent than ever on Middle Eastern petroleum. Yet consider as well how Asia's range of energy supplies has advanced over the intervening years.

This mix of old and new becomes especially perplexing when the position of some countries, notably China, comes under scrutiny. Analysts sometimes take as both starting and ending point the outlook of China's future energy demand. That country's needs are growing so rapidly that many analyses describe Beijing's policy options in ways that come perilously close to the 'shortage-equals-security-challenge' scenarios of the 1970s.³ But security planning follows closely on the heels of these assessments, and thus we need to think very clearly about the likely effects of the evolving energy picture to avoid creating misunderstandings, controversies, and conflicts that can be avoided. Certainly one area, the South China Sea, does stand out as a potential arena for competition and confrontation. And there are scenarios and sketches that point to a security clash and a struggle over resources that could shake the entire region.

However, this paper offers a contrasting view, one based upon cooperation, integration, and cross-border investment. It is one in which the issues and stresses can be resolved not through military power and blue water navies, but rather through markets and investment within the ever-denser web of international commerce. Interdependence and mutual benefit win out over confrontation. Let us leave no doubt; this is an optimistic view. But it rests upon the proposition that the end of the Cold War and technological change have accelerated the move towards a truly global economy. As we put it, the shift can be understood as a move from an era in which states sought to dominate the "commanding heights" of their economies to a world in which the ideas of markets, commercialization, deregulation, and privatization have captured the "commanding heights" of world economic thinking.⁴ One observes, in the post-Cold War world, a sharp split and indeed to some extent a mutual incomprehension between the perspective of the security specialist and that of the businessman. Our perspective in this paper tries to bring these perspectives together and heal the breach.

³ See Kent E. Calder (1996), *Pacific Defense: Arms, Energy and America's Future in Asia* (New York: William Morrow and Company, Inc.).

⁴ See Daniel Yergin and Joseph Stanislaw, *The Commanding Heights: the Battle Between Government and Marketplace That is Remaking the Modern World*, forthcoming, Simon & Schuster, December 1997.

Our view on Asian energy is being profoundly shaped by the learning that is coming out of the year-long study that Cambridge Energy Research Associates is undertaking - together with a number of international and regional energy companies and governments in the region - on the future development of Southeast Asian gas markets.⁵ It is becoming clear that the potential for new gas resources and for gas markets is much greater than has been anticipated up to now. If, however, that potential is to be achieved, there will have to be much more extensive infrastructure development. That, in turn, requires a new level of international cooperation among nations and a new level of confidence on the part of the private capital investors whose involvement will be essential if maximum use is to be made of this gas. In other words, cooperation and integration -- along with flexibility -- are the keys to bringing additional supplies to market, not elbow-jabbing neo-mercantilist rivalry.

With all this as context, let us offer a series of key observations and conclusions:

- Energy security is a major issue because of rapid growth - both in terms of the broader economies and the energy consumption that underpins that economic growth -- matched up against limited regional supplies, particularly of oil. Nothing so dramatizes the issue as the anticipated growth in Asian oil demand of more than 12 million barrels per day between 1996 and 2010 -- almost equivalent to the entire current output of Saudi Arabia, the United Arab Emirates, and Kuwait combined.
- The environment is becoming a new dimension of security, both on a national and regional base. Countries want to reduce air pollution in their own countries, and they want to be protected from pollution carried from other countries. The Kyoto climate change conference in December of this year could well push national energy supply decisions into the arena of international contention.
- Markets and market-based strategies will ease traditional energy supply concerns and allow the diversification of risk.
- Some countries are moving away from the traditional security strategies of the 1970s and 1980s and looking instead to privatization, competition, and open markets to supply the energy they need and the capital necessary to develop infrastructure sufficient to meet those needs. This is taking place partly out of conviction and experience -- and partly out of necessity.
- While markets will resolve more and more energy security issues, there are some areas in which diplomatic efforts are still urgently needed.

⁵ *Natural Gas in Southeast Asia: Scenarios for the Future of Gas Investment, Infrastructure Investment, and the Competitive Dynamics of the Energy Marketplace* (Cambridge Energy Research Associates, 1997).

- Governments can enhance their national energy security by taking steps to encourage market development rather than imposing policy solutions that disregard economic fundamentals.
- In many cases, the urgent security issue is not supply, but the securing of the infrastructure to transport and distribute supplies.
- Natural gas can play a larger role in regional energy supply than is generally recognized and, in so doing, will encourage cooperative, cross-border solutions.

It is appropriate to consider Asia's energy security at the IISS meeting in Singapore, the regional energy hub and a crucial location for refining product, for transshipping it, and for pricing it. In Singapore, the contractual instruments so prominent in our era--forwards, futures, and swaps--play an everyday role in getting product to markets. Singapore's role demonstrates the importance of market pricing; it underlines the fact that a mismatch between demand and supply points *not* to threat scenarios or to tense scrambles for resources, but rather to a *continuing diversification of supply risk* whether by Asian consumers, companies, importers, or governments. This diversification comes through many modes.

Such diversification most often results from an array of market responses scarcely imaginable twenty, or even ten years ago, responses that include the privatization of single-supplier firms or of various publicly owned "national patrimony" corporations intent upon *dirigiste* solutions within closed-off national markets; the development of regional markets; the reduction in international tension and the lowering of borders; and the emergence of entrepreneurial international developers -- whether from the oil, natural gas, or power business -- competing to provide solutions to nations' energy problems. . The choice of open markets reflects many pressures--fiscal imperatives; efficiency strictures, and (not least) a reordering of economic priorities. Multiplying commercial opportunities for energy supply can result from very urgent needs, such as relief of pressure on the public accounts or the need for immediate alleviation of electricity shortages. But with the need comes a growing conviction that an increasingly diversified regional and global energy marketplace can provide enough leeway even for smaller players and purchasers.

Whatever the primary or secondary motivations may be, an increasingly clear objective lies in the attainment of flexibility as a device to assure the security of supply via the marketplace. After surveying below the trends that characterize Asia's energy security situation, one cannot conclude that the marketplace itself has all the answers. We must, however, observe how powerfully markets have responded to resolve what seemed to be intractable energy security issues in the 1980s -- whether through the stimulus to conservation, new oil development and diversification, fuel switching -- or

through technological innovations that have married advanced computer technologies to the search for and production of hydrocarbons. In questions that turn on the exploration of resources, old-fashioned anxieties such as, 'who is sovereign over a particular piece of real estate or seabed floor?' guarantee the persistence of old-fashioned diplomacy resting, ultimately, on a balance of power. A wise approach to coping with Asia's steady demand growth and its comparatively static supply picture embraces a set of commercial *and* government policies. In the present era, 'energy security' does not mean a preparation for conflict, but rather a preparation for competition, an approach that fastens on achieving security of trade and financial flows across borders by competitive liberalization.

The starting point for the entire discussion, however, must be the fundamentals of the marketplace.

Asian Energy: Supply & Demand.

Despite a slowdown in energy demand growth across East Asia as economic growth slows, Asian energy demand itself will continue to be the single strongest impetus in world energy demand overall. Asia's export-driven growth, its dramatic shift to hydro-carbon powered transportation (a by-product of personal income growth overall), its rapid urbanization, and its politically central electricity programs all seem set to climb at a rate of between 4 to 5 percent per annum to the year 2010, in contrast to global demand rising by about two percent per annum. (Global, non-OECD demand will reach between 5.5 to 7% per year, with the higher values bunching in the first years of this projection as stagnant economies revive.) Our estimate is somewhat higher than others; for instance, Japan's Ministry of International Trade and Industry puts the growth at 4 percent.

Excluding Japan, Korea, Singapore, and Taiwan, already highly developed economies, CERA expects energy demand to rise by as much as ten percent each year in some areas, notably within the ASEAN countries. That is a huge number, but a realistic one. Between now and the year 2010, Asia will account for 56% of the global increase in oil demand, an annual growth of 4 percent each year, even though oil's share of the region's primary energy demand will be falling slightly, from 40% to just under 38%. Once again, we expect Asian oil demand to routinely reach six percent per annum, both in the ASEAN countries as well as in China. Transportation fuels will rise even more quickly.

In electricity demand, we expect Asian growth to measure 6.5 to 7% per annum, while the total non-OECD electricity demand will be higher, at ten per cent annually up to 2010. Meeting the needs for electricity -- rather than for personal transportation -- is the heart of the energy issue across Asia. The issue is not angry motorists, which is the specter that haunts politicians in the West. Rather, it is

brownouts and blackouts that disrupt hospitals, schools, and factories, and whose impact can be measured in terms of lost GDP. That is why infrastructure looms so high.

While coal remains at the heart of power strategies in China and India, much of the power demand in the region will be satisfied by as yet-unbuilt natural gas-fired generation, an outcome which will drive up demand for this fuel in Asia from its present 8.7% per annum growth rate (totaling 25 BCFD). Detailed scenarios developed by CERA's Integrated Natural Gas Study for Southeast Asia, a study in progress since 1996, show that natural gas demand in this region can grow at even higher rates given the right political and regulatory environment.⁶

Given rapid demand, from where comes the supply? The challenge is to supply the equivalent of an *increase* over 40 million mbd of oil equivalent in primary energy between 1996-2010. Analysts concerned by a perceived demand/supply gap with pressing security overtones have focused on Asian crude oil production -- and with good reason. Total liquid productive capacity (including condensate and natural gas liquids) is projected to peak at approximately 7.9 million barrels per day in the Far East during the same period. Crude oil productive capacity (excluding condensate and NGSs) is slated to peak at approximately 6.5 million barrels per day between 2000 and 2005. Outside of electricity generation, oil will remain the most important fuel. Self-sufficiency in coal and natural gas may augur important shifts in energy dependence over the longer haul, but the net difference in crude oil imports from 1996-2010 will be 12.4 mbd.

At present rates of oil demand increase -- and in the absence of major new supplies -- Indonesia, Malaysia, and possibly even Vietnam will join China as net importers of oil over the next decade. This alteration in fortune has especially significant implications for Indonesia, an OPEC member but soon to become another Asian oil importer. Jakarta now sees Indonesian fields providing approximately 20% of total Asia oil production; within as little time as five years Indonesia's current 0.6 mbd of oil exports may disappear altogether, due to rapidly increasing domestic demand and declining production.

In toto, the prospects for intra-regional oil supply in Asia look decidedly poor. By 2010, productive capacity will have declined to approximately 5.5 mbd, with new field developments proving nowhere near enough to compensate for the maturing of Indonesian, Malaysian and Australian fields. So, regardless of exploration, we see Asia as almost destined to import 23 mbd of oil by 2010. Perhaps the need will be for much more.

The tendency of security analysts, up to this point, is to stop the analysis at crude oil production. But we have also been looking closely at the effort being put into coal--into its efficiency, cleanliness,

⁶ See *Asia Pacific Energy Watch, Spring 1997* (Cambridge Energy Research Associates, 1997)

and export promotion. Both Indonesia and Australia are putting faith in coal exports. The overall result will be trade-offs between price and sulfur content. The result, however, will be much stiffer inter-fuel competition, the result of lower coal prices, especially when linked to cleaner burning technologies. Good quality, low-sulfur coal will go some way toward erasing the environmental premium. The export objectives of both Indonesian and Australian coal producers have received top-level endorsement from their respective governments.

Prospects are good for both increased production, and increased power generation utilization, of natural gas. With advances in exploration technology, more gas is being found in Southeast Asia with each passing year; with each boost to reserves, the producers have become more persuasive about long term supply and power generation prospects in the region. But getting to the natural gas end-users means a very different level of infrastructure than oil. Whether used for domestic or export, getting gas to market means building pipelines, power plants and or LNG facilities. Vast sums of capital must therefore go into non-portable infrastructure which must, to justify the investment, have very long life commitments. The implications of the growing attractiveness of natural gas, and of the particular infrastructure requirements of this resource, are discussed in the concluding section of this paper--which deals with the contemporary meaning to Asia of the words, "energy security." But natural gas could become a more flexible fuel with the technological advances that are beginning to attract attention in terms of competitive conversion of natural gas into a high quality liquid fuel.⁷

China's Energy Future

China has not yet become a "driver" of energy trends entirely in its own right, but its impact on world energy markets will only grow in the coming years. Few can argue with the proposition that China's growth rates, even if these were to be halved over the next decade, still points to an increasing dependence on imported oil and gas. Our working figure for China's primary energy demand growth is 4.5 percent per year from now to the year 2010. How is China to deal with such needs?

As should be clear from the earlier discussion, we believe that there is too much emphasis in recent writing on the ever-starker appearance of these deficits alongside Beijing's growing financial ability to purchase the sort of weapons platforms which will enable it to project military power over the horizon. The thrust of much of this recent writing is to equate China's energy insecurity to a longer-term prognosis of political insecurity for China's neighbors and, by implication, for U.S.-Japan interests.

Another dimension to China's energy situation lies in its increased reliance on indigenous energy – most notably coal but also untapped hydroelectric potential. This perspective converts energy insecurity to environmental insecurity, for the Chinese people themselves, of course, but also for countries adjacent to China (Japan's acid rain-diminished forests) and the world at large, fated to suffer large increases in greenhouse gas emissions.

The concerns raised by these analyses are not based on thin air. Natural gas demand in China may more than triple by 2010; even so, coal--which now accounts for more than 70% of China's energy - will remain the dominant fuel. In keeping with the other two of Asia's Big Three countries, India and Indonesia (which both possess large coal deposits as well), demand for coal will grow. In China we expect this demand to rise at about five percent p.a., despite improvements in combustion and conversion efficiencies.

China's breakneck growth; its transition to oil-importer; its insatiable urban demand for electricity; its disappointing oil and gas exploration results; its population densities; its environmental issues; the levels of air pollution in many of its cities -- all these point to levels of political insecurity and to environmental anxiety. The question is, what is missing from the analysis?

Our answer is that the global open market provides China with mechanisms that are already in use to mitigate the impact of its dependence on outside energy supplies. As China becomes ever more integrated into the world economy and an ever-larger exporter of manufactures, its international commercial role in world energy markets will also grow. Recent events support this view. China's two major oil companies in recent months have committed themselves to a variety of oil exploration and production ventures beyond its borders. Announced deals include:

- A planned \$4.3 billion investment to take a 60% stake in Kazakhstan's main oil company, develop fields in that country and build a 3,000 kilometer crude oil pipeline to China's Xinjiang province
- A successful \$359 million bid for the right to develop and operate two oil fields in Venezuela
- An agreement to invest \$1.2 billion to develop the Al-Ahdab oil field in southern Iraq, while discussion continues about development of two additional fields
- Agreement to form a joint venture with the National Iranian Oil Company to explore for offshore fields in Iran, China and in third countries, and to upgrade Chinese refineries in order to accommodate increased Iranian oil exports to China

⁷ Chuck Jordan, *New Developments in Gas-to-Liquids Technology: Fundamental Change or Just a Niche Role?*

- A \$750 million project to develop oil fields in southern Sudan with Malaysia's Petronas and Canada's Arakis Petroleum
- An open-ended supply agreement with Saudi Arabia to meet China's rising oil import needs (present imports stand at a modest 30,000 bpd)

In the past, large projects - such as the Kazakhstan pipeline and a proposed pipeline project designed to bring Russian natural gas to the Chinese, Korean and Japanese markets from the Russian Far East and Siberia- have been mooted as confidence building measures between neighboring states. However, the CNPC investment in a major Kazakh oil company implies a higher level of intent. There are two possible drivers behind China's upstream strategy: the corporate ambitions of China's national oil companies; and the national security concerns of China's political and military leadership. For the Kazakhs, this project with China also provides a very welcome diversification that goes to the heart of its new independence.

But the immediate problem remains: demand for oil has out paced rising (2 percent per annum) production levels in China, currently the world's seventh largest crude oil producer. Both the offshore areas and the Tarim basin have proven disappointments. The question is, what may China do to reduce dependence on imported oil and, more generally, minimize supply risk? In 1996, China imported almost 0.5 mbd; this figure could reach 1 mbd by the year 2000 and as much as 3 mbd by 2010--i.e. almost 50% of total oil demand. This must come, given the fading away of Indonesian supply, from the Middle East or from Central Asia. One early sign of China's strategy for dealing with its oil import needs is the arrangement with the Iranian National Oil Company to reconfigure Chinese refineries to received more Iranian crude.

Beyond that, China's moves to increased efficiencies in fuel consumption have begun to make some headway in reducing the energy intensity of the Chinese economy. Important in government thinking is the establishment of a strategic petroleum reserve to reduce the impact of market fluctuations. In this perspective, everything from port modernization to faster turnaround of larger and more efficient oil tankers has a place. Indeed, such modifications *must* occur if China is to liberalize, as it eventually must, its domestic pricing structure for oil products. Finally, the China National Petroleum Company (CNPC) has been moving actively to lay the foundation for a more diversified based of oil imports and, eventually, set-asides for longer term supply contracts.

These moves include the abovementioned taking of major equity stakes in Iraqi, Sudan, Iranian, Kazakhstan, and Venezuelan fields, as well as plans for a pipeline from Kazakhstan. These come in the wake of the China National Offshore Oil Company's (CNOOC) move into joint exploration and development of fields in Southeast Asia, notably a 40% stake in an Indonesian field within the strait of Malacca, but also in Thai, Malaysian, and Papua New Guinean territory. The Chinese political leadership clearly has become more amenable to suasion based on energy security rationale; hence the top-level push to import natural gas from Siberia and the Russian Far East, the long term use of which may reduce disagreements with Japan over coal-fired electricity in northeast China leading to acid-rain.

The drive by China's national oil companies to internationalize operations is a sign not only of China's desire to gain access to supplies, but also a sign of a desire to gain experience in international operations and to export their own know-how and experience. Such "commercialization" of the operations of state-owned enterprises is likely to be strongly emphasized in the upcoming the 15th party congress. In their international operations at least, Chinese oil companies could become, to borrow a phrase, international oil companies with "Chinese characteristics." Commercialization and internationalization will allow China's oil and gas companies to learn at an accelerated pace through exposure both to latest-generation exploration and production technology and to advanced financial risk management techniques. At the same time, indigenously produced Chinese technology, though perhaps not as advanced as some western technologies, is also not as expensive. In this sense, Chinese technology may in some cases be financially and technically more appropriate for developing countries – in effect creating a new export market for Chinese technology.

Beyond that, China faces another 'risk' – this one domestic in nature and the result of its economic success. For the likelihood is strong that China's citizens will be developing in the years ahead the same appetites and, on the coast at least, the same purchasing power as the burgeoning middle classes in Southeast Asia and Taiwan. Consumer-driven electricity demand, far more than increases in transportation fuel consumption, will drive energy policies and needs. Yet growth in private transportation has become associated with indicators of improved living standards in every high-growth Asian economy. Ensuring supplies within China's current infrastructure and supply constraints could amount to *the* urban challenge over the next decade.

The World Energy Supply Market

No question -- the years ahead will see a race between energy demand growth and supply development. As it is, the world oil market is operating at about 95 percent capacity utilization,

eliminating much of the “security margin” that became so familiar in the 1980s. Yet technological advances will allow for the development of resources once thought beyond reach; computers and information technology are transforming the world of oil and gas information. Indeed, it may well be correct to say that those IT advances did much to “save” the world oil industry after the 1986 price collapse.⁸

Building upon technological advances and opening borders, we expect world oil supply to grow from 78 mbd in 1997 to over 97 mbd in 2010; though production in Asia and the North Sea will drop in the early years of the next century, new production in the Middle East, Latin America, the former Soviet Union, and Canada on our present estimates will be adequate to meet global oil demand.⁹ This relatively-favorable supply situation will result, we believe, from three things: (a) technology; (b) increasingly open opportunities for firms regardless of commercial domicile; and (c) an overall shift toward a commercial mentality, from neo-mercantilist notions fixing petroleum resources as “national treasure” to the acceptance of them simply as a “tradable commodity.”

The Middle East and Asia

Within this picture of global supply adequacy and Asian demand lies an important relationship: that of Asian consumers and Middle Eastern producers. This will deepen. The share that OPEC countries have of global production will probably rise, from 36% to about 45% of world production by 2010. The Middle East, overwhelmingly predominant within OPEC, will provide not only physical supply but also spare capacity, a security margin available in times of unanticipated supply reductions--as occurred when Iraqi crude disappeared from global markets after 1990.

As noted in the introduction to this paper, this steady, ever increasing dependence on the Middle Eastern is a recurring theme in the Asian energy picture. In 1975, Asia imported 5 mbd of its 9.3 mbd oil demand; by 1995, Middle Eastern imports had risen to 6 mbd, despite having dropped away in the 1980s by nearly half in response to Northeast Asian conservation measures and deliberate diversification policies aimed at coal, LNG and even nuclear power. Only in 1991 did Middle Eastern oil import levels reach volumes seen in the 1970s, a journey taking Asian fuel dependency full circle.

⁸ *Quiet Revolution: Information Technology and the Reshaping of the Oil and Gas Business* (1996) (Cambridge: Cambridge Energy Research Associates).

⁹ Robert Esser, *The Race to Supply Oil in the New Century: Expanding Horizons III* (Cambridge Energy Research Associates, 1997).

In Northeast Asia, Middle Eastern crude now provides over 70% of throughput; in Singapore, Middle East oil provides more than eighty per cent of refinery in-put. And crude oil procurement decisions by new refineries recently coming on line elsewhere in the Asian region show a preference for supply deals favoring Middle Eastern producers. For example, in the first half of this year, imports by Thai refineries of Middle East crude rose by more than 150%, with Indonesian and Malaysian imports sliding, by comparison to the previous half-year period, by over forty per cent. When Asia's imports of refined products are considered, the degree of Middle Eastern oil dependence has risen even more than the crude net import figures would suggest.

The question is, will Middle Eastern crude continue to provide the major incremental source of Asian refinery input? While proximity may favor its use in Southeast Asian refinery capacity, other signs point to a more diversified intake in East Asia, where crude from Russia, Turkmenistan, and even Kazakhstan has made an appearance. More to the point, the simple numbers showing Asian dependence upon the Middle East overlook three elements that will drive the future of the Asia – Middle East relationship. First is the transformation of the global energy market, with prices now far less subject to government control and far more transparent at every level of the value chain. This has enabled the evolution of a much wider spot market than existed two decades ago, and the more open trading environment has made possible the arbitrage that we see today. Second, new supply sources may emerge for Asia from the Former Soviet Union to compete with Middle East producers. Finally, the producers of the Middle East will increasingly depend on Asia for volume growth.

The Former Soviet Union and Asian Energy Security

A decade ago, the then Soviet Union was the world's biggest oil producer. In the years since, its output has plummeted by a daily volume greater than the entire current daily output of the North Sea. Meanwhile, out of the turbulence of the collapse of the USSR, a series of partly privatized Russian oil majors are emerging. Russia continues to be one of the major gas exporters, and indeed the entire former Soviet Union ranks as the "Saudi Arabia of natural gas." Under an Sino-Russian agreement signed earlier this year, Russian natural gas could become a major source of supply to the Chinese, Korean and Japanese markets through a proposed network of pipelines linking Siberia with Northeast Asia.

At the same time, perhaps the hottest development "spot" in the entire world oil industry is the Caspian region -- in Azerbaijan, Kazakhstan, Turkmenistan and in the waters of the Caspian Sea itself. The Caspian region may hold oil and gas reserves second only to those of the Middle East. Conservative estimates run as high as 100 billion barrels or more -- almost ten times the reserves of Alaska, and that

amount could increase as exploration moves into deeper waters. By as early as 2010, the Caspian could produce as much oil as the North Sea does today, making it one of the world's main production centers. The Caspian region also holds the potential of becoming a major supplier of natural gas. Turkmenistan alone is estimated to have as much gas as the United States.

There is an inherent and -- if old and new rivalries do not get in the way -- almost inevitable logic to conjoining the huge supplies of the former Soviet Union to the huge and growing Asian market. Much of the focus on the Caspian to date, understandably, has been on moving its oil west into the Black Sea and then on to Europe. But we are convinced that increasing amounts of oil and gas from the former Soviet Union will move east into the Asian markets. This will require investment, great amounts of investment. The gas transport will involve some combination of long-distance pipelines, but no more difficult or complex than the pipelines that now carry Russian gas to Europe. That gas will go into electric power generation.

Already the first signs of reorientation and focus are there. Japanese companies are becoming members of Caspian consortia. China's deal with Kazakhstan is a major bellwether for the future. As it is, increasing volumes of Kazakh oil are ingeniously finding their way into Chinese markets. These are harbingers of how the pressures that accentuate the energy security issues can be relieved through commercially-based-deals that require cooperation and integration.

Continuing Controversies: The South China Sea

One issue turns back to very traditional areas of diplomacy. The maritime dispute in the South China Sea and its potential to disrupt regional confidence ranks as a front-burner issue in Southeast Asia. The focus is competing claims, which pit China against other countries in the region. To be sure, China has several ongoing maritime territorial disputes: with the Koreans and Japan in the Yellow and East China Seas; with Japan in the Senkaku Islands in the East China Sea; with Vietnam in the Gulf of Tonkin; and with Vietnam, the Philippines, Malaysia, Brunei and Taiwan in the Spratly Island region of the South China Sea. The claims in the Spratly Islands have garnered the most attention, for two reasons: the extent of the riches which some project under the disputed waters, and the broad expanse of territory covered by the Chinese claim.

How abundant are the resources of the South China Sea? Estimates range from six billion barrels of oil equivalent to over 105 billion barrels. Yet oil exploration in the region has, to date, been very disappointing, and it is currently thought that the region is largely gas-prone. If the experience in the Natuna field is a guide, gas resources in the region would be extremely difficult and expensive to

commercialize. Natuna, a huge gas field, has been under study for more than ten years and has an estimated total development cost of more than \$40 billion. The technical difficulties and huge cost of developing the field necessitated the creation of an international consortium to spread the investment risk and provide sufficient technical expertise and financial strength. Exploitation of a sizeable field in the nearby Spratly Islands would likely necessitate a similar approach involving extensive international cooperation. Such cooperation would prove difficult to marshal if jurisdictional issues are not clarified.

The Spratly Island group is the center of conflicting claims involving many nations -- China, Vietnam, Indonesia, Malaysia, and the Philippines. China's boundary claim potentially overlaps the major gas reserves of all these countries except Malaysia -- where only the source fields for the Malaysia III (Tiga) LNG project are included. The reserves contiguous to or included in the Chinese claims include many of Southeast Asia's most significant gas fields. The dominant reserve is, in fact, the undeveloped Natuna field, with an estimated 46 trillion feet (tcf) of natural gas. The South China Sea area already holds 65 tcf of natural gas with the potential to add 25 to 50 tcf more. Other reserves affected by the Chinese claim include:

- Vietnam's gas discoveries Lan Tay and Lan Do, both under development
- East Malaysia's Jintan and other fields under development to supply
- LNG along with recently issued high-potential deepwater blocks
- The Philippines' large Malampaya-Camago gas/condensate field being developed in deep water off northwest Palawan Island.

Regardless of the actual reserves underlying the waters of the South China Sea, the region will remain vitally important to Northeast Asian energy security. The disputed waters lie astride strategic sea lanes through which more than 70 percent of the crude oil and LNG supplies bound for Japan, Taiwan and South Korea transit. Equally important, manufactured goods bound outward from Northeast Asia for markets in South, Southeast Asia and West Asia also pass through these waters. Overall maritime traffic through the South China Sea is estimated to triple by 2010. The sea-lanes are also the strategic passageways for the US Navy in its transition from the Pacific to the Indian Oceans. The U.S. strategic relationship with Japan and South Korea is in no small part invested in the U.S. role as guarantor of energy security to these key Asian allies. Any country able to supplant the United States in that role would obviously gain enormous strategic leverage in the region.

Chinese officials have repeatedly asserted their willingness to jointly develop resources in the South China Sea on a bilateral basis. Despite the success of joint development programs in other

offshore areas in Southeast Asia, other claimants -- including Vietnam, Malaysia, and the Philippines -- have thus far resisted joint development, fearing that such cooperation would prove tacit acceptance of China's historically-based claims to the region. As they see it, the Chinese claim, if accepted, would extend Chinese sovereignty more than 500 miles off China's mainland coastline.

The South China Sea dispute is about energy. It is also, however, about the strategic balance in Asia and overall political relations. And it needs resolution.

Energy Sector Deregulation in Asia

A number of the factors mentioned above -- the effects of market prices, the flow of resources across borders, trade liberalization, a focus on national competitiveness, the need to attract investment dollars into the energy sector - have led to the region-wide trend towards price deregulation of national energy sectors. Japan, South Korea, the Philippines, and Thailand have begun the liberalization of the downstream oil industry, leading to market-derived prices for oil products in those countries. Several countries, including Japan, Thailand and the Philippines, have begun deregulating and privatizing their respective electric power industries as well.

The primary driver toward deregulation differs across countries, as a result of differing economic structures and stages of development. For some of these countries, the drive for international competitiveness has been the overarching motivation behind liberalization -- this is clearly the Japanese and South Korean model. For other countries, such as the Philippines, the need to attract capital has provided the impetus for deregulation.

In all of these cases, however, the move toward freer energy markets represents a move from one form of energy security -- one based upon government mandate -- to another, based upon market competition. Supported by a stable political environment and motivated by the internationalization of their economies, these countries are moving away from the dirigiste strategies of supply security that emerged in the wake of the oil shocks of the 1970s toward market mechanisms for allocating risk. Japan, for instance, is now considering phasing out the remainder of its oil market regulations by 2001. This marks a dramatic shift in thinking about energy security. In the words of Ryozo Hayashi, MITI's Director General for Petroleum, "Adjustment in supply and demand can be achieved much more efficiently through market mechanisms than through government intervention."¹⁰

¹⁰ See Ryozo Hayashi, *Future Challenges for Global Energy Security: An Asian View*, IEA Conference on Global Long-Term Energy Security, April 1997.

The domestic political fallout from the exposing of consumers and domestic energy companies to potential supply shock risks is perceived as less of a concern than the long-term economic distortions associated with state intervention in the energy sector. As competition for export markets heats up between the developing economies of Southeast Asia and China, planners are searching for non-labor related foundations for national competitiveness. Reducing energy and other utility input costs is one strategy for boosting national productivity growth.

Conclusion: "Energy Security" in Contemporary Asia.

Does the region find itself in the middle of a transition between rather traditional notions of resource diplomacy and associated tensions over sovereignty toward the type of diversified free-market reliance we have been sketching out above? The answer is a qualified 'yes.'

In discussing the prospects for natural gas development within the evolving Asian energy supply situation, we mentioned the very different infrastructure requirements of this fuel. Large finds; an increasingly persuasive case for gas as *the* electricity generating fuel; the large capital investments needed for non-portable, long-life infrastructure--all this leads to the imperative of cross-border cooperation on a scale that matches the tariff reduction program of the ASEAN Free Trade Area and the ambitious free trade goal of the APEC. Such cooperation has already begun in areas such as the Thai-Malay Joint Development Area, where natural gas resources are being developed jointly by both countries. That is to say that both development necessities *and* commercial realities will drive the process becoming, along the way, as strong an indicator of true regionalization in Asia, as any measure adopted under the more traditional reduction of government barriers which we have seen to date.

That is the first segment of what "energy security" means, or will come to mean, in contemporary Asia. A second element of this new definition rests on a growing mutual dependence between Middle East producers and Asian countries. The dependence cuts both ways: when thinking strategically, the Middle Eastern producers readily see a world in which some of their potential market may be assumed by companies and enterprises working in areas outside the Middle East. Still, Middle Eastern producers realize that a large part of their future market growth must come from Asia, which will mean an intensification of the type of collaborative moves witnessed in recent years between Asian governments (and NOCs) and Middle Eastern producers, investment companies, and governments.

That is *not* to say that aversion to dependence does not exert a hold on the thinking of Asian political elites. The tendency toward government control over resources, in general, remains strong in Asia. The grip of 'resource diplomacy', dating from the 1970s, has not lessened. The satisfactions that

come from reinforcing one's strategic position with tangible commercial advantages have not diminished for any of the major players in Asia.

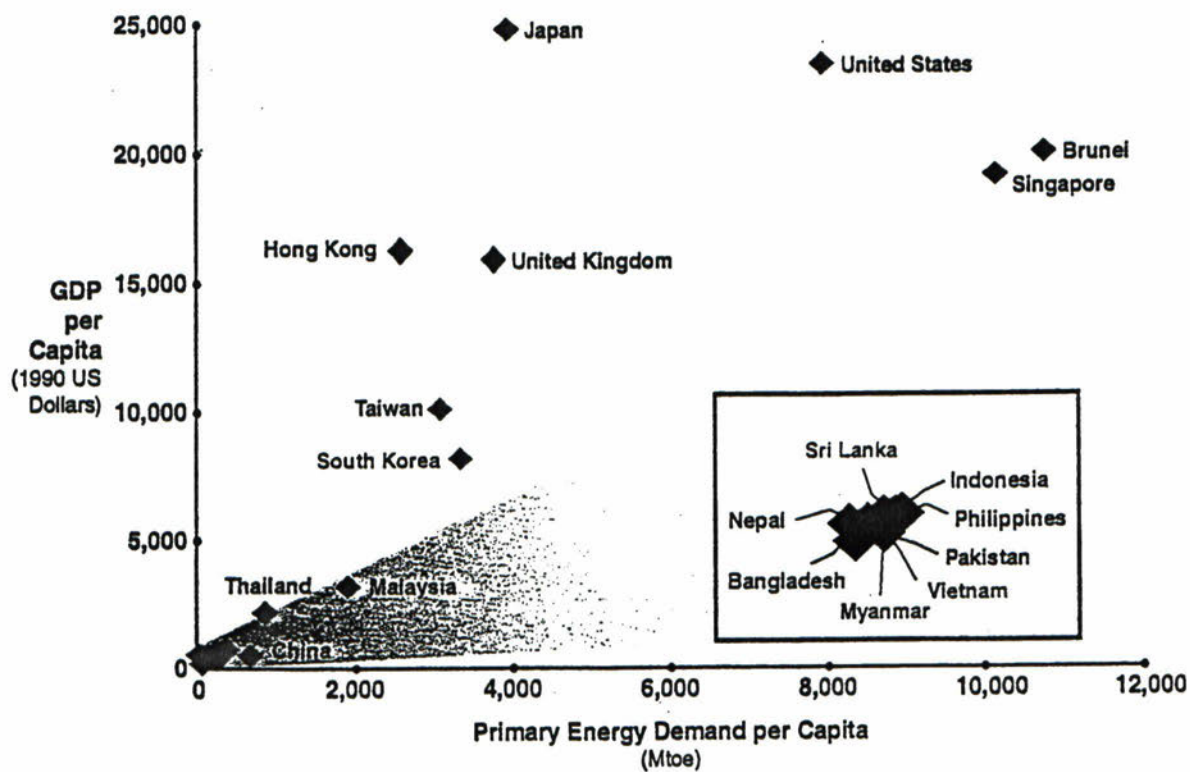
However, the dependence argument has dissipated over time, as the success of the resource poor countries in the region demonstrates. The steadiness of the market; its adaptability to meet new consumer and product demands; its growing size and transactional complexity—all these reinforce the argument that “security” now comes in the guise of diversified reliance on open markets. And Singapore's open market pricing mechanism has displayed one extra element of utility for a rapidly commercializing energy sector in Asia: the pricing indicators coming out of the Singapore market have enabled de-regulation to occur in a range of import markets, notably in the Philippines.

Many elements and *idees fixes* from the 1970s have changed, especially about “energy security.” One example is a lack of readiness to rely upon oil. But with oil, having the resources in the wrong place—if messy politics obtrudes—can have no lasting impact. It is otherwise with infrastructure for gas, inland coal, hydropower, or geothermal. These all require large fixed investments in infrastructure and depend on a range of political and economic concerns.

Some of these must necessarily, if the demand curve is to be met, depend in future on cross-border agreement. The evolving CERA study of Southeast Asian natural gas shows the logic behind the growing number of calls for various regional or even sub-regional grids. The future of the West Natuna field development, and of the associated benefits (perhaps) for Batam Island and for Singapore's electricity supply, provides just one example of this cross-border character of future solution.

At the very beginning of this paper, we observed Asia's second miracle -- high economic growth based upon very limited energy resources. That was because these countries oriented themselves to competing successfully in the international economy. They paid their own way. They made up for their lack of physical resources through their human resources, their capacity to innovate and to produce, and their capability to sell the fruits of their labors in the global marketplace. That gave them the wherewithal with which to pay for and finance their energy needs. The energy challenges facing Asia in the future are momentous, complex, and expensive. Yet that formula that served them surprisingly well in the past can well serve them in the future -- all the more so as countries place greater confidence in the markets and see less urgent reason to rely on traditional government ownership and control. Thus, perhaps the true solution to the energy security needs of Asia will be found in the issues that underlie, at least in significant part, the currency crisis of 1997 -- how well countries continue to adapt to the changing nature of the global marketplace and the rigors of international competition, and how successfully they maintain their astonishing record of earning their way in the world.

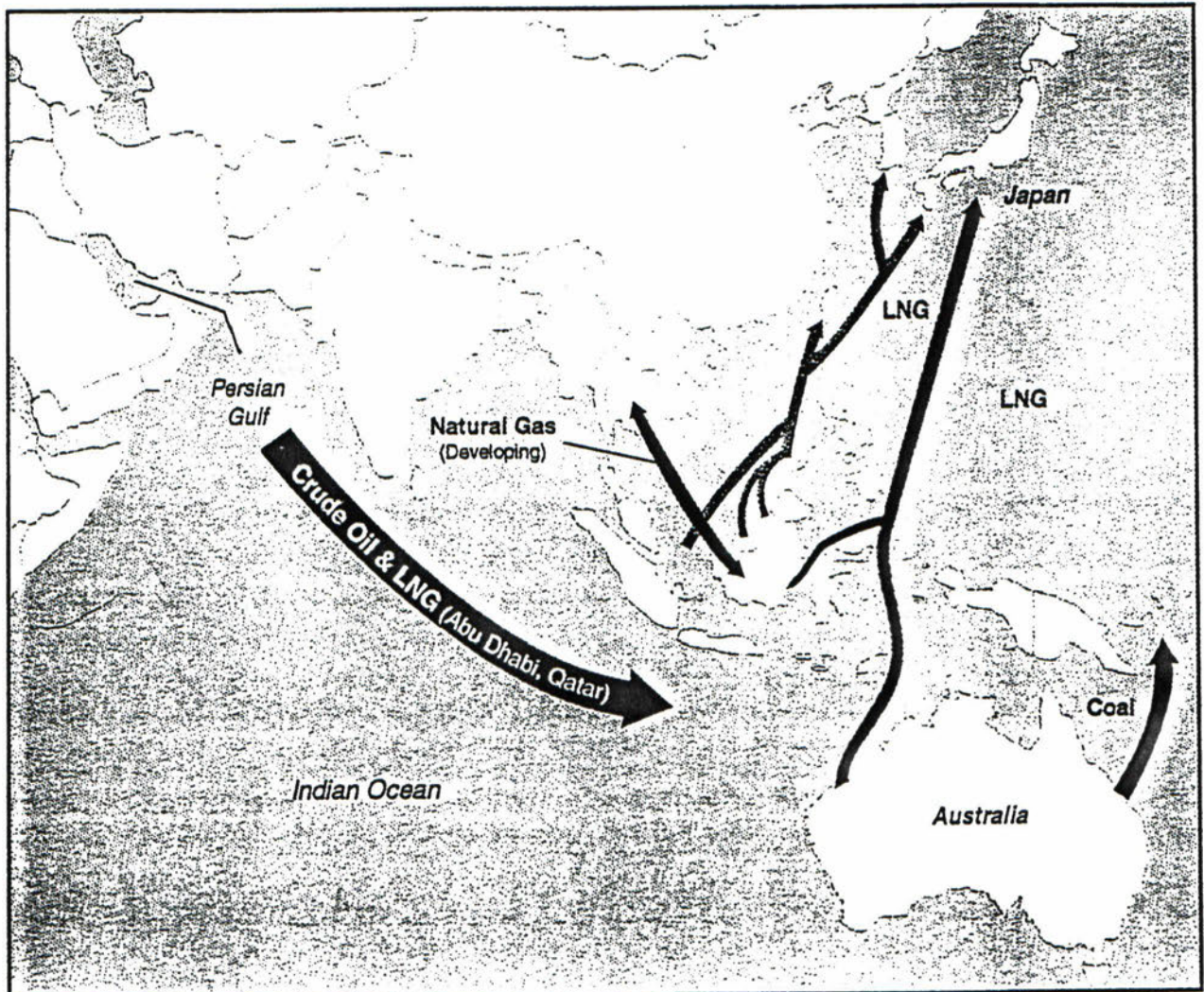
GDP per Capita versus Primary Energy Demand per Capita in Selected Asian Economies, 1995



Source: Cambridge Energy Research Associates.

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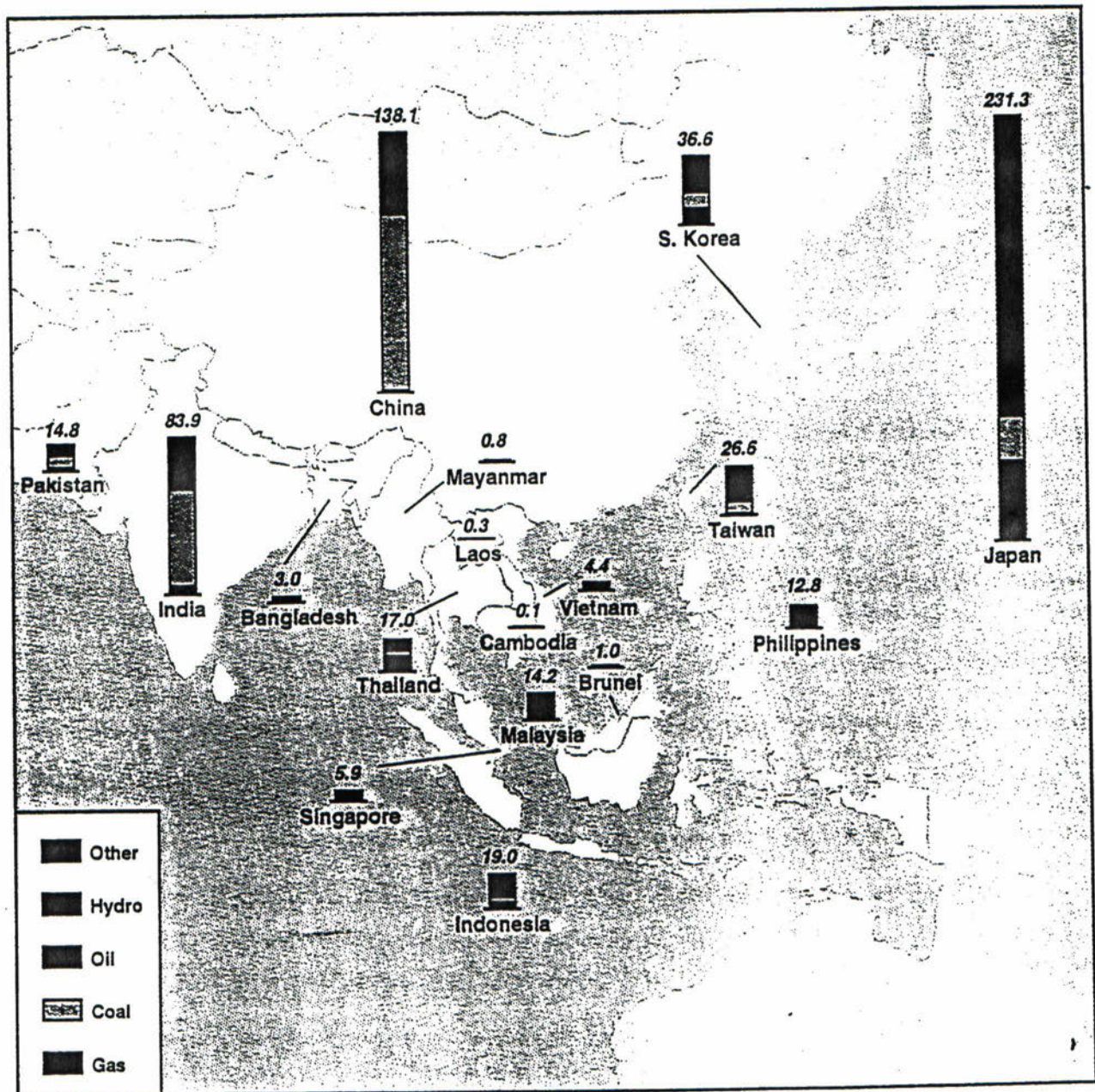
Energy Trade Flows in Asia



Source: Cambridge Energy Research Associates.

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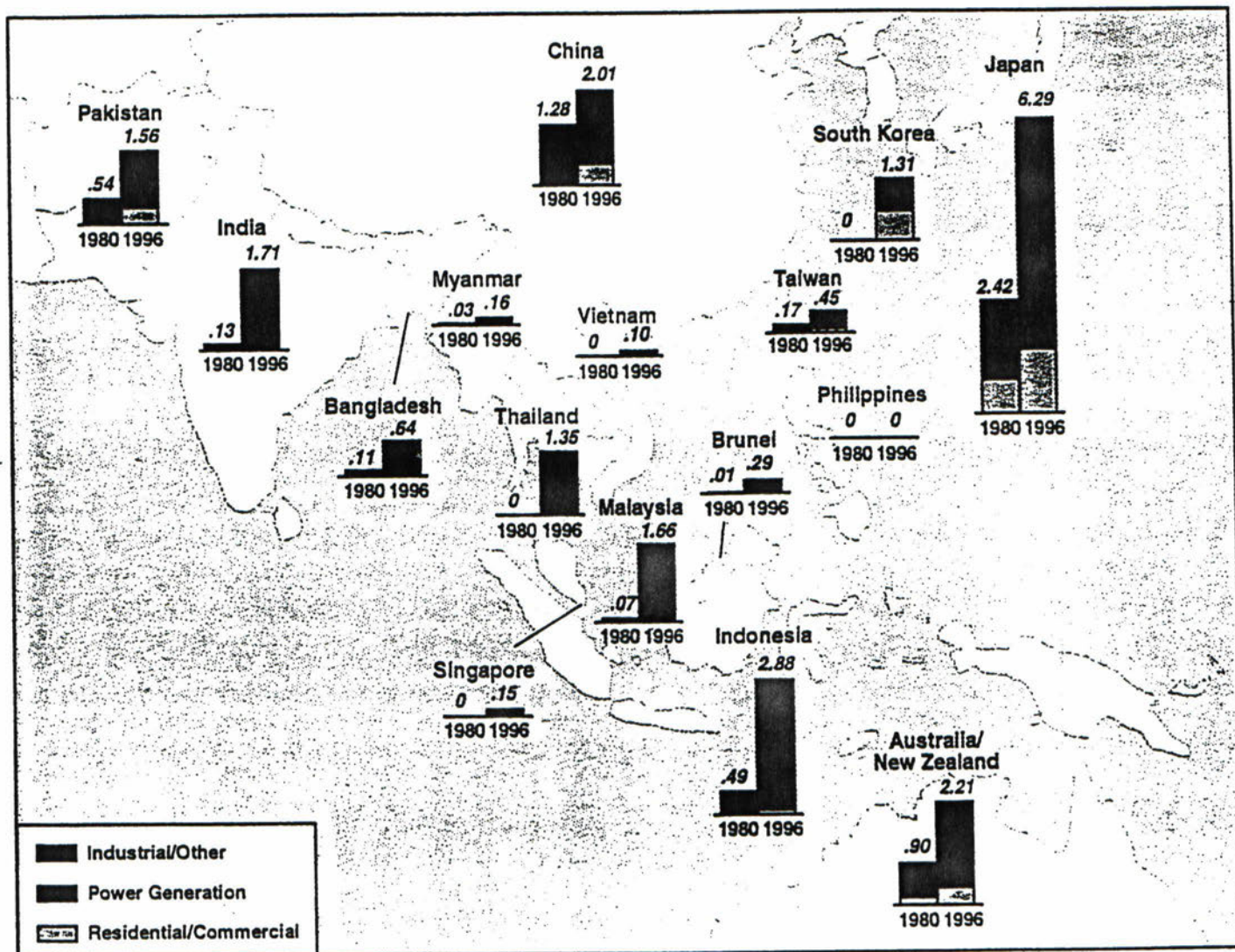
Asian Power Generation Capacity: 1997 (GW)



Source: Cambridge Energy Research Associates.

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Asian Natural Gas Consumption, 1980 and 1996 (Bcf per Day)

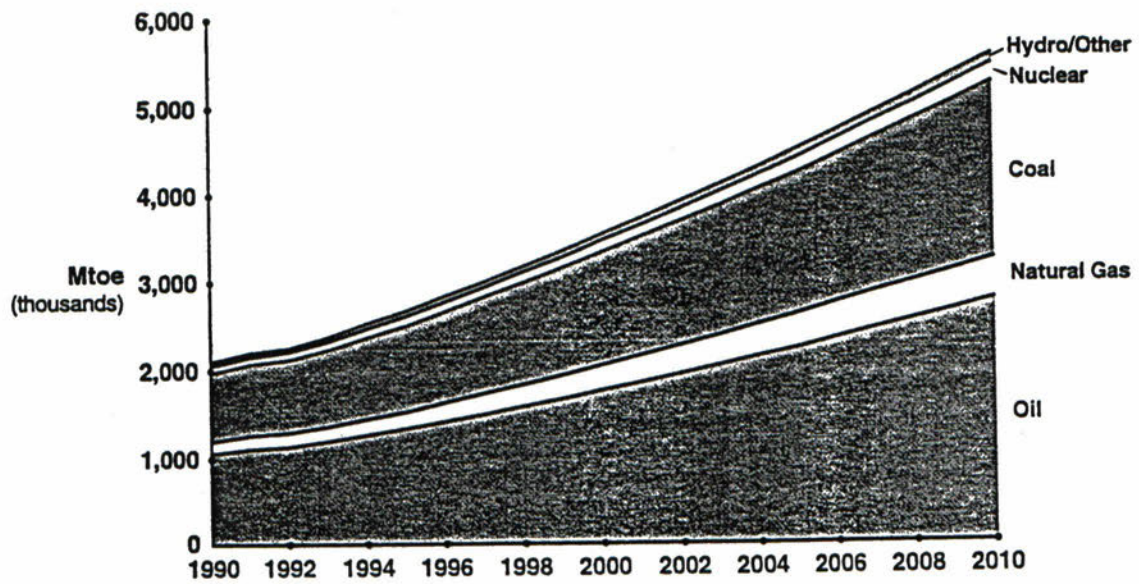


Source: Cambridge Energy Research Associates.

Note: 1996 numbers represent estimates

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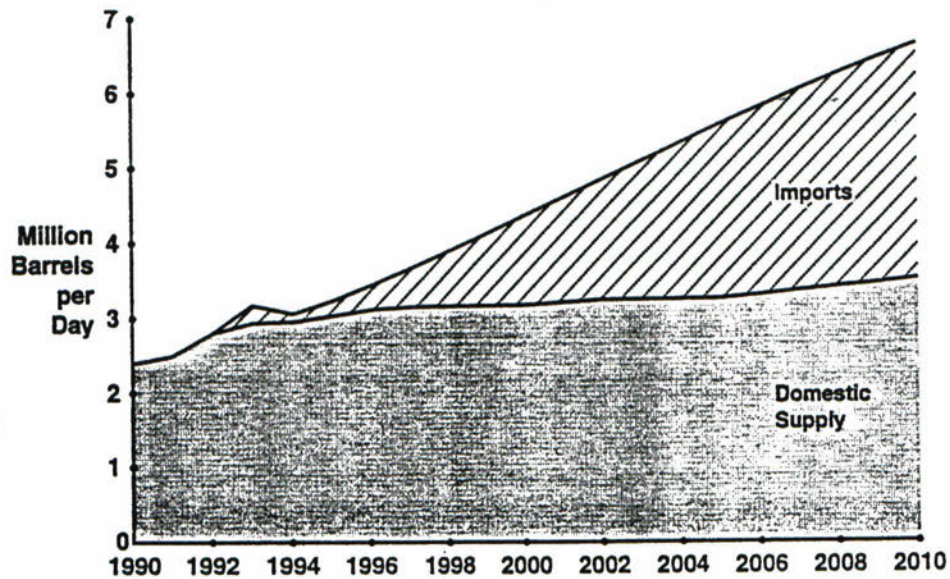
Primary Energy Demand: The Far East



Source: Cambridge Energy Research Associates.

70829-H1

Chinese Oil Demand: Growing Dependence Upon Imports



Source: Cambridge Energy Research Associates.
70823-H2

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HEADLINE: Sunnier outlook on planet Earth

BYLINE: Jo Kwong

BODY:

American attitudes toward the environment have matured. Gone are the days when industries felt free to treat rivers and streams as a common dumping ground. Gone are the days of pouring used motor oil on suburban lawns to kill unwanted weeds. Gone are the days when households discarded recyclables without a thought.

This heightened awareness has produced many benefits: The air, water and land are in noticeably better shape than they were 20 years ago. But perhaps the time has come to take environmental awareness to yet a new level and recognize that things have improved and our environmental outlook is really quite good.

That's the theme of "The True State of the Planet," a collection of essays edited by Ron Bailey. After two decades of hearing how we teeter on the brink of environmental disaster, the book's message may seem counterintuitive. Yet its common sense and wealth of scientific evidence make for a compelling argument.

Take global warming. We have all heard that global temperatures have been rising and will continue to rise another 2 to 8 degrees centigrade over the next 50 years. But what do climatologists and atmospheric scientists say? According to contributing author Robert Balling, director of the office of climatology at Arizona State University, the scientific evidence argues against the existence of a greenhouse crisis. Highly accurate satellite-based atmospheric temperature measurements reveal that the earth's atmosphere has actually cooled by 0.13 degrees centigrade since 1979.

Mr. Balling examines the climate models that have formed the basis for catastrophic predictions and refutes them on several counts. He notes, for example, their failure to accurately simulate observed climate changes during the past century and their failure to factor in the role of sea ice, snow caps, localized storms and clouds. His conclusion is that the models are simply not advanced enough to use as the basis for public policy. Ignoring arguments like Mr. Balling's can lead us down a path of reckless spending for very little benefit.

Here Mr. Balling touches upon one of several themes Mr. Bailey outlines in his prologue: the necessity of trade-offs in sound environmental policy. As he writes, "Modern smart environmentalism must avoid the 'crisis of the month' media mentality. ... It must focus on setting priorities and dealing with the biggest problems first. ... Trade-offs have to be made."

The essays in this collection argue that wealth, technology and the human being are not all bad for the environment. The idea that economic growth is a major contributor to environmental problems actually inhibits our ability to improve the environment and the human condition at the same time.

As societies become wealthier, spending increases for environmental improvement. Increasing wealth allows the luxury of caring about potential environmental threats. Poorer countries are too concerned with such pressing concerns as starvation and exposure to worry about mysterious and invisible threats like global warming or other environmental concerns. And often ignored is the fact that technological innovation and adaptation are precisely the vehicles that fuel much of the world's wealth gains.

In forging a "new, smarter environmentalism," "The True State of the Planet" offers several hundred pages of scientific findings, data and hard evidence.

Beyond global warming, the essays stand the culture of environmentalism on end. Nicholas Eberstadt describes how the world's population has tripled this century, yet the average person eats better and produces more. As for areas of the world where population pressures have led to environmental disasters and famine, Mr. Eberstadt shows how governmental policies, such as collectivization, are to blame for the century's great famines, rather than "overpopulation."

Other essays devoted to analyses of food, forest and ocean resources, biodiversity, pesticide use, air quality and environmental cancer all consider the trade-offs that sensible policy choices entail.

Beyond trade-offs, each contributor shows how innovation and technology have

helped alleviate pressure on resources. Wealth and technology, rather than being the culprit in environmental degradation, can help improve our physical world. The only thing that stands in our way are erroneous perceptions about finite resources and statist "solutions." "The True State of the Planet" is a great start for a smarter, more aware, environmental reasoning.

Jo Kwong is an environmental research associate with the Atlas Economic Research Foundation in Fairfax.

***** THE TRUE STATE OF THE PLANET

Edited by Ronald Bailey

Free Press, \$15 paper,

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HEADLINE: The True State of the Planet.book reviews

BYLINE: Athanasiou, Tom

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Edited by Ronald Bailey. Free Press. 4 72 pp. Paper \$ 15.

The green movement leads a double life. On the surface, romantic idylls and semi-scientific reductionism decorate a history that runs far back into the traditions of liberal optimism. Beneath there flows a second and more somber tradition in which radicalism, sought in appeals to biology and nature, too often substitutes for clear-eyed political explorations.

Greens know this well enough, though they generally take it as a family secret, one that is rarely discussed in public. Here, then, is a wake-up call in the guise of a literary trend. Attacks on environmental romanticism and on social-ecological pessimism in general have become weapons of anti-environmental backlash, as liberal and libertarian pundits--and some of the more aggressive corporate P.R. departments--attack environmentalism by pretending that in its most fundamentalist corners they have found its truest secrets.

The founder of this genre was, I think, Anna Bramwell, whose 1989 *Ecology in the Twentieth Century* is an irritating but not unhelpful dark-side history of green romanticism. More recently came Martin Lewis, with his 1992 *Green Delusions: An Environmentalist Critique of Radical Environmentalism*. Lewis made much of the rather wacko claim that radical green ideas have "devastating implications for the global ecosystem" because they lead to "self-defeating political strategies," thus "preventing society from making the reforms it so desperately needs." This was not the standard anti-green position, for it did not altogether deny ecological problems, but its main focus was on ridiculing the "radicals."

Today distinct brands of anti-environmentalism line the shelves, and the more insidious come costumed as attempts by reasonable men and women to reject the "extremes" and "pessimism" of the past and search for a new and "better" environmentalism. The answer, typically, is "science" and "realism." This is

particularly clear in economic debates, in which the "science" most loved by anti-greens is often not the same science most widely accepted by the scientific community. This raises no end of fine questions about method and meaning, but it does not disturb the believers. Money cannot, perhaps, buy love, but it certainly buys confidence.

Here, as Exhibit A, is *The True State of the Planet*, a compendium of anti-environmental antiscience just published by the Free Press in partnership with the Competitive Enterprise Institute, a right-libertarian think tank whose specialty is attacking greens. To that end, **editor Ron Bailey, former writer at Forbes, contributing editor of Reason and proud author of *Eco-Scam: The False Prophets of Ecological Apocalypse*, has collected the strongest anti-environmental narratives he could find.** Some, like Bruce Ames's argument that the vast bulk of all chemical carcinogens are either natural pesticides (like spices) or (like high-fat foods) taken electively, will be all too familiar to connoisseurs of greenwashing. Some, like Robert Balling's claims that global warming is only a doomster myth, are well known and dismissed as ideology by the majority of climatological scientists. Others, like Dennis Avery's "Saving the Planet with Pesticides," are 1990s rehashes of old technology-uber-alles fairy tales, in this case the tale of the Green Revolution's boundless capacity to increase grain supplies. Taken together, packaged with Cato Institute optimism and padded out with a bit of vague, seemingly liberal filler, they form a sort of attack syllabus for the long-suffering friends of "progress."

The True State opens with "Population, Food, and Income," by Nicholas Eberstadt. It's a strong lead, for it plays upon the oldest stupidity of green reductionism--the confusion of the biologic notion of "overpopulation" with the political problems of poverty and sustainable food production. If ever there was a measure of the green movement's confusion, it is that so many environmentalists honestly believe that by soberly intoning that there are just "too many people" they somehow cut across all the moral and political agonies of globalization, of rising human migrations, mass extinctions, atmospheric instability and all the rest of it. In fact, "overpopulation" explains none of these things, and as long as we cling to it we remain the confused citizens of an incomprehensible world. This is where Eberstadt comes in, for with rigorous disregard for the realities of global poverty, he sounds the collection's theme: Even for the world's poorest people life is rapidly improving, and if only markets are left alone to work their magic it will inevitably continue to do so. Such optimism is, of course, anything but new. The core of neoliberal dogma is that growth will bring prosperity to all; Julian Simon, an economist of limitless faith (see *The Ultimate Resource*), long ago found fame by wielding it against Paul Ehrlich.

Simon is the spiritual godfather of *The True State*, and his voice echoes in

its relentless technological confidence. The forests are in no real danger--in fact, ecosystems are incredibly resilient and even monocultural tree plantations, far from endangering biodiversity, actually protect wilderness by satisfying the demand for wood. High-tech, high-yield agriculture will feed us all, and produce enough meat to provide even the world's poor with the "better" protein they deserve, and at the same time it will actually reduce the amount of land that must be granted to agriculture. In fact, by a marvelous irony of the invisible hand, it is just now, with ecological pessimism high, that we are approaching the "age of abundance." There is no "population" crisis, and even the oceans, which really are in trouble, can be saved. We need only privatize them!

Lies are not always simple things. The True Staters insist that "overpopulation" is not an essential problem, and though the conclusions they then draw are unjustified, the claim itself is quite correct. Around the world, human fertility is dropping rapidly, and today's projections of the likely peak human population are far lower than those made even ten years ago. That's the good news. The bad is that the fertility decline in poor lands has been caused by what one team of demographers called "the sharp economic contraction of the late 1970s and early 1980s," and by the widespread realization by people throughout the Third World that with more children, "their standard of living fell." This is not how it was supposed to be. The most widely accepted theory of demographic transition had it that "development" would bring security and even affluence, and thus, painlessly, smaller families. Instead, insecurity, urbanization, birth control and the cosmopolitanism of a small world in which people have a clear sense of their bad prospects have stepped in to do the job.

Right-wing optimism about declining human fertility cannot last. Too bad, then, that greens, well-schooled in reducing explosive political issues to biological abstraction, only continue to mumble Malthusian pieties, and too bad that the right has become so adept in manipulating the resulting confusion and in constructing a strategic caricature that seeks to tar the environmental movement as a whole with its fundamentalist excesses. Too bad greens are so rarely able to refute the Big Lie that tells us that, given only time and free markets, the poor will follow the rich into the kingdom of development.

A Moment on the Earth weighs in at 745 pages and claims the last word on everything from global warming (no problem) to petrochemicals (no problem) to nuclear power (no problem) to deforestation (no problem) to biotechnology (no problem) to extinction (no problem) to God (see page 138).

Moment is the creation of Gregg Easterbrook, a clever journalist with an ax to grind and a finger to the winds. Easterbrook's approach is essentially the same as that of The True State--to paint environmentalism as a quasi-religious

movement full of "transrational" souls who cannot tolerate good news. But unlike Bailey and company, Easterbrook would be a liberal, an "ecorealist," an avatar of the "coming age of environmental optimism." He claims the center by blithely dismissing the Wise Use movement--that bastard child of right-wing populism and corporate public relations--as a "minor fad" (which it is not) and pointing out that the right has done more exaggerating--"communists running the State Department, fluoride in the water, nuclear weakness"--than the left. His strategy, in a nutshell, is to speak for "logic" and "rationalism," to demolish easy targets (he finds plenty and makes up more), to overlook the (copious and often excellent) objections to his arguments and, of course, to position himself against green romanticism as the voice of the "new" environmentalism. His very marketable conclusion is that heavy-metal development-as-usual, with some minor green model changes, is the true path of progress and justice.

Easterbrook has long patrolled the environmental perimeter for Newsweek and The Atlantic, but it is a piece that appeared in The New York Times Magazine on September 11 of last year that perhaps best illustrates his strategy. "Forget PCB's. Radon. Alar. The world's greatest environmental dangers are dung smoke and dirty water" could almost take the Oscar in green-tinted casuistry. The foreground here is the environmental problems that plague the world's poorest people, and thus we are primed--all we good people--for sympathy. But observe where Easterbrook steers us. First comes the introduction, and then the setup: A large faction within the environmental movement "focuses on the real but comparatively minor problems of developed nations in part to support a worldview that Western material production is the root of ecological malevolence." After that we are given a quote from water scientist Deborah Moore ("Issues like African sewage are not sexy, so they always fall to the bottom of the agenda") and a twisted retrospective on the 1992 Earth Summit--"the prospect of global warming . . . was put above the palpable, urgent loss of lives from Third World water and smoke pollution"--as if Rio's failure to address poverty could be chalked up to "Western guilt-tripping and America-bashing." From there, the knockout is easy: "What developing-world nations need to free their populations from extreme air pollution is . . . hydroelectric dams, modern petroleum refining, advanced high-efficiency power plants."

Deborah Moore, for one, was not convinced. An activist in the global campaign to redefine development and stop large dams, she told me that Easterbrook had deliberately "manipulated" concern for poverty and wretched Third World conditions into support for a development model that routinely devastates the lives of the poorest and most vulnerable people--just the opposite of what he claimed to be doing. Indeed, a few months later, Hydro Review, a trade journal that carries the burden of making big dams appear modern and humanistic (in fact they are as socially and ecologically destructive as nuclear power, and as uneconomic and corruption-friendly), ran a paean to

Easterbrook that commended his lucidity, eagerly quoted his attacks on solar power ("How come if small solar is too expensive for the Sierra Club set, it's a great idea for peasants in Malawi?") and recommended mass purchases of *Moment*, "not just to read, but for friends as well."

In his book, Easterbrook is more careful. Solar power would be welcome, if the price was right, and unlikely though it is, global warming could be a threat. It doesn't matter. Carbon emissions will be brought under control, since liberal ecorealists will find ways to transfer clean technologies to the Third World and, in fact, will soon be boasting of "having saved capitalism from itself by curbing environmentally destructive aspects of the market system and compelling corporations to become resource-efficient." If, in the meantime, utility industry front groups are running ads in magazines as liberal as *Harper's* (see the April issue) counseling us to oppose the "radical environmental agenda" and "Repeal Rio" (the greenhouse treaty), and if these ads make exactly the same argument as does *Moment*, what can this be but an odd coincidence?

Readers who slog through *The True State* and *Moment* should try to find time as well for the real thing--the 1995 edition of the Worldwatch Institute's *State of the World*. This is an annual that serious students of environmental politics not only buy but actually read. Worldwatch is one of the most cited research organizations in the world, and *State of the World*, its flagship publication, is each year translated into twenty-seven languages. The 1995 edition, as always, is a judicious mixture of the grim and the upbeat. This year, on the grim side, we have the crisis in world fisheries, pressures on mountain peoples and environments, human migration, rising ecological strains in China and that most vexed of subjects, "nature's limits." On the upbeat side, there are the ongoing revolutions in solar and wind technology that will, any year now, become impossible to ignore, the prospect for a "sustainable materials economy" and, on an overtly political line, "Budgeting for Disarmament" and "Forging a New Global Partnership."

State of the World is not Malthusian or Pollyanna-ish, but somehow, peculiarly, both and neither. When Lester Brown, Worldwatch's president, offers a dark analysis of trends in global rice production and consumption, he does not omit the new bioengineered varieties now being developed at the International Rice Research Institute in the Philippines. He just gives the numbers, which don't look particularly good, and reiterates the pressures--from aquifer depletion to the boom in Chinese demand for pork and beer--that make predictions of grain-market strain so plausible. A far cry from *The True State's* wild optimism about yield increases which altogether ignores the many and serious problems that come with new hybrids. These range from herbicide dependence and soil compaction to what UNICEF once called the "paradox of

plenty"--increases in food productivity, when won by methods of industrial agriculture that promote land monopoly (and they commonly do), often increase hunger as well.

As will be obvious to any fair reader, *State of the World: 1995* is a careful text, full of considered detail. Far from an organ of doomster culture, it is a model of discretion and scientific balance. *Worldwatch* has its pragmatists and its Big Thinkers, its hard-nosed researchers and its closet apocalyptics. Its politics do not altogether suit my temper, but I gladly admit that its culture allows a rigorous, descriptive pessimism to coexist with conventional technical and political optimism. Indeed, it seems that it is just this balance that most infuriates the right. If even mainstream outfits like *Worldwatch* are finding positions in which (1) scientific details are taken seriously and (2) there is nevertheless room to legitimately and publicly doubt if small changes will finally be sufficient, then the green movement may, after all, be incubating a new and radical form of realism. And without such a realism, clearly, there can be no hope of emancipation.

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HIGHLIGHT:

Foes of environmental rules are starting to fight back, and they're winning a few skirmishes.

BODY:

AFTER YEARS OF CAVING IN TO the seemingly irresistible power of the environmental movement, a growing number of U.S. firms, workers, local governments and ordinary citizens are starting to strike back. They're attacking rules they say cost far too much (the government admits \$ 130 billion a year in direct costs, and private estimates go 50% higher), infringe on their rights, are inequitable, often aren't even needed, and usually don't work.

Stung by this unexpected challenge, environmental activists are sounding the alarm. Greenpeace, the Washington, D.C.-based group best known for its highly publicized efforts to halt whaling and nuclear tests in the South Pacific, recently published *The Greenpeace Guide to Anti-Environmental Organizations*, a 110-page book warning that "anti-environmental groups have declared war on every issue environmentalists support." The book includes capsule descriptions of 54 groups that it considers "anti-environmentalist" -- from think tanks and public relations firms to what it labels "corporate-front groups." Declares author Carl Deal: "Most anti-environmentalists are heavily financed by industry."

Greenpeace may be protesting too much. Tim Brown, environmental policy analyst for the libertarian Cato Institute (which is on the list), surveyed the budgets of the organizations singled out and found that "in 1992, Greenpeace alone outspent all 54 groups listed in its guide combined, \$ 65 million to roughly \$ 62 million." The top 12 environmental organizations, he adds, spent more than \$ 636 million -- 10 times the amount available to their critics. So much for "heavy financing" from industry, he says.

While a handful of names on the Greenpeace enemies list are reasonably well

known (Cato, the Heritage Foundation, Accuracy in Media, Keep America Beautiful), the rest are much smaller, less well-known groups like the National Inholders Association, the Center for the Defense of Free Enterprise, the Global Climate Coalition and the Science and Environmental Policy Project.

The Greenpeace Guide, simply by putting all those names together in a list, gives a misleading impression that the backlash is a coordinated movement with universally shared goals. In fact, it consists of a variety of groups whose interests don't necessarily overlap.

The most vocal are defenders of property rights, including leases and permits to mine, cut timber or graze cattle on federal land. They constitute what most of them refer to as the "wise use [of land] movement" and are concentrated in Alaska and the western states. "Our concerns are not much related to those of business," says Myron Ebell, Washington, D.C., representative of the National Inholders Association (an inholder is an owner of property located inside or adjacent to a national park or other protected area, although such owners now constitute only 20% of the association's membership). "We're not involved with most of the issues that business is worried about -- toxic emissions, hazardous waste, water pollution and the like. What we're very much concerned with are things like wetlands, endangered species and grazing rights." On the other hand, observes David Howard, who founded the Alliance for America, "We do have one important thing in common with business: We're all being crushed by regulations that simply don't make sense."

Because their own direct personal interests are so clearly at stake, the individual participants in the "wise use" movement are passionately committed to their cause. "It's the Sagebrush Rebellion, round two," Ebell declares, "and it's going to make the original Sagebrush Rebellion look tame." Predicts Howard: "The hinterlands will rise up -- not in real violence but in a political revolt."

These groups and their allies can already take credit for the backlash forces' victory in two recent skirmishes. A Senate filibuster prevented passage of legislation to boost grazing fees on federal land controlled by the Interior Department. In the House, amendments to the National Biological Survey bill would require written permission from landowners before government officials can enter their property to count wildlife and would also forbid the use of volunteer enumerators, most of whom would come from environmental groups. Faced with the amendments, the Administration withdrew the bill.

Notwithstanding such gains, nobody in the backlash ranks is predicting a quick victory. Fred L. Smith Jr., president of the Competitive Enterprise Institute, a Washington, D.C., think tank that supports many of the backlash groups, says with a chuckle, "We're a bit like the French underground in 1941."

Our efforts are good, but the other side has the tanks." Not only the tanks, but the planes, ships and nuclear weapons. Robert Hahn, resident scholar at the American Enterprise Institute and a former official at the U.S. Environmental Protection Agency, says that environmental activists have captured the Clinton White House. "This Administration will be the greenest ever," he declares gloomily.

Vice President Al Gore, who has been a leading environmental activist for years, will spearhead efforts to break new ground in a number of regulatory areas. Other committed environmentalists have been appointed to jobs throughout the Administration. The most recent example: Jack Ward Thomas, the Oregon biologist who advised President Clinton to limit logging in the Northwest to protect the spotted owl, will be head of the Forest Service.

Adds Hahn: "The reason little has been done on the environment so far is that they've had so many other things to do. Clinton will take a tough line eventually on a whole series of laws coming up for renewal: clean water, endangered species, the Superfund, global warming. The outlook for this Administration and Congress seriously balancing the needs of the environment with the cost-effectiveness of regulations is bleak."

To others on the backlash side, however, that may mean opportunity. The environmental movement has enjoyed so many years of success, they contend, that it is often inclined to overreach itself. And each tightening of the regulatory screws that pinches another group generates new opposition. With Congress scheduled to deal with a long list of environmental issues in the coming year, some big fights are shaping up. Jonathan Adler, an environmental policy analyst at the Competitive Enterprise Institute, asserts that "the environmentalists are more threatened than they've ever been. They know that if they're not careful they could put themselves in a position to lose some of those battles."

People like Smith who espouse what they call "free market environmentalism," insist that the current system is doomed to fail. "Everyone had great dreams for the Environmental Protection Agency," he says, "but the environmental movement is based on the notion that markets are incapable of dealing with environmental concerns, so you have to have political oversight. And since every economic area has some environmental impact, you're left with the EPA trying to run the whole world. Ecologically, central planning is no more likely to work than it did in the socialist economies."

Environmentalists frequently cite polls showing that three out of four Americans consider the environment very important and say that they are willing to pay to protect it -- whether through taxes or higher prices for goods. But skeptics doubt the depth of that support. "They'd feel different if someone actually presented a bill," one remarks. Certainly there is almost no popular

support for the extreme views of environmental radicals who want to limit technology and deliberately lower material living standards for the sake of conserving natural resources.

Confident that many ordinary citizens are simply uninformed, backlash participants are fighting on three main fronts. First, they seek to demonstrate that some of the risks and perils that environmentalists claim we face are exaggerated or even nonexistent. Second, where real problems are acknowledged, backlashers demand that the cost of solving those problems be balanced against the benefits. Finally, many argue that whatever needs to be done, the government is not the only, or even the best, institution to deal with environmental threats.

To make their case, these critics are trying to use one of the environmental movement's own most successful tactics: using publicity to alter the climate of popular opinion. For example, several skeptical writers have begun casting doubt on much of the evidence that environmentalists cite to make the case for regulation. Such an approach is entirely appropriate, since it was Rachel Carson's *Silent Spring* that spawned the environmental movement three decades ago. Since then, a flood of similar volumes have been published (Vice President Gore's *Save the Earth* made the best-seller lists in 1992).

Until this year, almost nothing was published to challenge these predictions of impending disaster. **But recently, several authors have weighed in with such books as *Eco-Scam: The False Prophets of Ecological Apocalypse*, *Science Under Siege* and *Apocalypse Not: Science, Economics and Environmentalism*.** The writers examine, in exhaustive detail, claims that Americans were endangered by dioxin or other pesticides, by computer screen emissions, by acid rain, or ozone depletion, or global warming. In each case, they cite later findings by qualified scientists that the threats were unproven -- and that the public and politicians were panicked into taking unnecessary action. Another recent volume, *Environmental Politics: Public Costs, Private Rewards*, recounts the way in which farm organizations, waste treatment firms and other private interest groups teamed up with environmentalists to push through rules that earned big profits for a number of companies.

Books like these are not widely read, of course, but a few journalists have also begun to examine scary statistics more carefully and to seek the views of scientists rather than simply reporting the claims of activists. The New York Times, for example, recently ran a lengthy story by environmental reporter Keith Schneider that cast doubt on the dangers of contracting cancer from the chemical dioxin. It was dioxin that caused the panics at Love Canal in Niagara, N.Y., and Times Beach, Mo., and led to passage of the multi-billion-dollar Superfund program to clean up hazardous waste dumps across the country. And Boyce

Rensberger of the Washington Post has written skeptically about global warming and holes in the ozone layer. Not surprisingly, both men have been fiercely attacked by environmentalists as biased and inaccurate.

But what gives the backlash forces the most hope for the future is the way environmental regulations are starting to have a palpable impact on Americans' everyday lives. For example, over the next few years, employees of large companies in regions with heavy air pollution will come under severe pressure to give up driving their cars to work. In fact, employers will have to compel at least 20% of their workers to take public transportation or join car pools. In the Philadelphia area, 300,000 people will be affected, and local officials insist it's unnecessary. The air quality reading which put Philadelphia over the limit, they say, was a fluke. But the EPA ruled otherwise.

An even more striking example of regulatory overkill is the New York City school asbestos scandal. After an audit last summer showed that many inspections of asbestos in schools had been inaccurate, local officials launched a huge inspection and repair program to eliminate this supposed threat to the city's school children. Standards were so stringent that much of the repair work had to be redone.

By the time school was scheduled to start, it was 11 days before any classes were held, infuriating thousands of parents. The cost of the cleanup, originally estimated at \$ 34 million, is a staggering \$ 120 million and rising. That's a catastrophe in a system whose annual maintenance budget is \$ 70 million. As a result of the skyrocketing repair bill, New York City will have to forego a number of badly needed renovation and construction projects.

Worst of all, the evidence is overwhelming that such a crash program was an ill-advised, perhaps counterproductive overreaction. Two years ago, after an exhaustive review of existing research on asbestos hazards, an independent panel of 19 scientists concluded (with only two dissents) that undamaged asbestos in buildings poses no more health risk to occupants than if they were outdoors. A report by a panel of doctors convened by the American Medical Association came to similar conclusions. Even William Reilly, when he was administrator of the Environmental Protection Agency, said that removing asbestos from buildings can well be more dangerous than "managing it in place."

There is no question that some forms of asbestos are extremely dangerous carcinogens, and the tragic toll of illness and death among World War II shipyard workers is beyond dispute. But the form of asbestos fiber used in 95% of building construction materials (chrysotile) has not been linked conclusively to mesothelioma or lung cancer. Still, that fact has not prevented panics like the one over asbestos in the New York City school system -- and it

has not kept tens of thousands of plaintiffs from creating what one observer calls "the mother of all messes in our legal system."

Because of cases like these, says Hahn of the AEI, "people are now speaking out more strongly on the fact that we have passed the point of diminishing returns on regulations to improve air and water quality, protect species and clean up toxic waste sites -- all these rules that are crazy from the point of view of social costs and benefits." Adds the CEI's Smith: "The public is beginning to perceive connections. When homes burn down in California because their owners couldn't clear out the chaparral where the kangaroo rat lives, people see that's senseless. It's the kind of thing that's generating the backlash."

Clearly these people remain a minority, and most have not false optimism about how long it will take to make an impact on the public. Ron Bailey, author of Eco-Scam, observes, "The environmentalists have had more than 20 years to sell their views. And clearly some regulations have been useful, which adds to their credibility. It's going to take a while to counter them."

But the movement to do so has definitely gotten under way.

GRAPHIC: Photo 1, no caption, E. Schuh/Contrast/Gamma-Liaison; Photo 2, no caption, Michael Schumann/Saba; Photo 3, no caption, Eugene Richards/Magnum; Photo 4, no caption, Sygma

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Articles

M E M O R A N D U M

Re: Failure of "Ceiling Price" on Emissions Permits as a Climate Change Policy Tool

Introduction. In January, 1997, the U.S. government formally proposed that any international protocol to control the emissions of greenhouse gases (GHG) be structured in a way that imposed total GHG emissions "budgets", covering multi-year periods, on each participating nation. Nations could meet their budgets by trading surplus GHG emissions reductions with each other, and, presumably, permit their affected firms to do the same in private GHG emissions trading markets. There are a wide range of decisive environmental and economic advantages to this approach. Chief among these is that the global GHG emissions trading market that such a structure would unleash could be expected to do what markets do best: lower costs and spur (cost-saving) innovation. By defining nations' obligations as meeting actual budget limits for their total GHG emissions, the U.S. proposal is the single most effective way of ensuring the achievement of the "binding commitments" which many world leaders, including President Clinton, have pledged to make.

Unfortunately, despite the U.S. experience with its own market economy and with highly successful pollution markets, such as the sulfur dioxide emissions allowance trading system used to curb acid rain, some in the Clinton Administration have proposed the inclusion of a "ceiling price" in the U.S. proposal. Under this approach, the U.S. government would specify a cost-per-ton ceiling price for GHG emissions reductions. If the cost of making GHG reductions, or, presumably, the market price, rose above that level, then, the U.S. would be excused from making additional GHG emissions reductions even if that resulted in U.S. failure to meet the national GHG emissions budget. This approach would apply as well to individual firms, which would be required to pay the "ceiling price" for each ton of GHG emissions *in lieu* of making GHG emissions reductions.

The ostensible purpose of this proposal is to protect the U.S. economy from excessive costs in implementing its national GHG budget obligation. Ironically, the inclusion of a "ceiling price" in a GHG emissions trading program could have the perverse effect of impeding the capacity of an otherwise unfettered emissions trading market to maximize cost-savings. If that were the case, then the "ceiling price" proposal would actually make the cost to the U.S. economy of meeting its GHG emissions obligations more, rather than less, expensive.

Key to the success of an emissions trading market is the ability of competition to drive costs down. Two critical elements of competition are risk and reward. Firms take risks (e.g. developing new technologies, banking early reductions) because in their calculation they perceive the value of a specific business decision to be positive. Under the "ceiling-price" proposal both risks and rewards are capped at the level of the ceiling price. As a result there is only limited competition. Worse still, since the risk/reward calculation is based on estimating a variety of unknown variables, the presence of a known ceiling price will tend to encourage firms to estimate an even higher risk premium when evaluating new technologies with unknown costs or other near-term emissions reduction action with uncertain future returns. This distortion of the risk/reward

calculation is therefore likely to preclude much initial investment in the development of cost-saving reductions, even at the start of the program. At the same time, the costs added by this approach would not even enhance the environmental performance of the program. On the contrary, since the payment of the ceiling price would result in emissions increases, the proposal would all but ensure that the U.S. would not meet its GHG emissions budget.

1. The "Ceiling Price" Would Prevent the GHG Emissions Trading Market from Achieving the Full Measure of Potential Cost-Savings. The ability of firms to make and "bank" emissions reduction credits in the early years of a trading program for use in later years is almost universally regarded as critical to the success of trading programs (assuming that such treatment is compatible with environmental effects of the pollutant being managed). One of the reasons for this is that banking is instrumental to market formation – and to the process of achieving cost-reductions. If firms know that at least eventually there will be a market in which surplus reductions will be in demand, then they will be able to identify a financial incentive to find and make such reductions, even if the firms are "banking" surplus reductions simply for their own future use. The reductions they make, especially early on, tend to be relatively inexpensive; as a result, investment in such reductions begins the market dynamic of limiting the cost of compliance. Thanks to these near-term low-cost surplus reductions, the compliance program can "start off" with low-cost compliance options readily available. As the market becomes more active, firms find themselves subject to continuous signals favoring ongoing investment in cost-effective reductions, particularly reductions that can be achieved *below* whatever the market price is, or is anticipated to be.

Part of the confidence that banking instills in investors in surplus reductions comes from the knowledge that all affected sources have no compliance option other than to achieve emissions reductions themselves or to purchase surplus emission reductions from others who can make them at less expense. As a result, all expenditures made in connection with program compliance will either be made on the demand side to purchase reductions, or on a competitive supply side to achieve the most cost-effective reductions. The "ceiling price" approach undermines confidence in banking because it gives all affected sources an "out", and in so doing, unravels the dynamic of cost-reduction that a soundly designed emissions trading market can create.

Specifically, a "ceiling price", not connected in any way to the purchase of additional surplus reductions, is a vicious competitor to early reduction investment strategies. With a ceiling price present as an *alternative* to participation in an *emissions reduction* market, potential investors in early reductions, no matter how low cost, must alter their calculus radically. They cannot simply weigh, as they would in a sound emissions trading market, the cost of current investment in low-cost emissions reductions against the value (admittedly discounted) of a future return on that investment. Such return would take the form either of sales of their reductions or of the use of their reductions to avoid future higher compliance costs or of the overall flexibility for the firm's operations afforded by an available bank of surplus reductions – all outcomes whose current value is increased by a premium created by firms' uncertainties about future cost and changing economic conditions. Because these uncertainties are amply justified, the ability to pin down costs as well as increase

flexibility through the creation of a supply of low-cost reductions is especially valuable. In contrast, in the presence of a "ceiling price" escape path, firms contemplating near-term reduction options must compare the cost, including opportunity costs, of near-term investment in emissions reductions, against the discounted value of avoided future costs, but they must do so in a context where the "ceiling price" creates an artificial certainty as to future costs.

In theory, obviously, the ceiling price could be set high enough so as to preserve and ensure the value of the investment in early reductions. Unfortunately, the "ceiling price" proposal is, almost by definition, a political artifact, designed to ease the adverse pressure on decision-makers sensitive to claims that a GHG emissions budget would damage the U.S. economy. Consequently, as an administration of official has already acknowledged – unaware, apparently of the internal contradiction – proponents of the ceiling price approach anticipate that the price would be set at a relatively modest level, precisely for the purpose of creating the needed economic assurance and thus relieving the political pressures decision-makers are now facing.

At best, then, the introduction of a ceiling price "escape valve" complicates and creates grave uncertainties as to the outcome of firms' near-term reduction investment calculus. At the very least, it would contribute to a wait-and-see attitude that would divert some investment in low-cost early reductions that might otherwise be made. More troubling, if acknowledged political imperatives prevail, then the ceiling price will be set at a modest level; as a result, its discounted value will swamp the risk/reward calculations of many would-be investors in low-cost near-term reductions. Without this plentiful supply of low-cost reductions, the market will lose a significant portion of its power to contain and lower compliance costs by forcing compliance alternatives to compete with each other. As a result, actual compliance costs will rise to the level of the ceiling price and will do so much more quickly than otherwise – and, again, the costs will be that much higher than they would be were a greater amount of investment in near-term, bankable low-cost reductions made.

The presence of a ceiling price escape hatch defeats the cost-saving capacity of an emissions trading market at the higher end of the cost curve as well. As reduction costs rise, firms increasingly will find themselves simply paying the ceiling price and foregoing the achievement or purchase of additional reductions. As a result, the market will simply cease to generate incentives that would otherwise drive innovators and investors to find or use the means to bend high-end costs down. Many potential purchasers of the reductions generated by such innovations will simply pay the ceiling price and "escape" compliance. In their absence, the financial incentive that an emissions trading market would otherwise create to apply downward pressure over the entire cost curve will disappear.

For these reasons, the introduction of a ceiling price does not simply provide a beneficent outer bound on compliance costs. Rather, it fundamentally undermines the power of emissions trading markets to minimize compliance costs and generate cost-savings. The optimism that many have that an emissions trading market and the technologies, whose development and use such a market fosters, can keep costs "below the ceiling price" depends on the very cost-saving capacities that the ceiling price subverts. At the same time, the "ceiling price" proposal creates a perverse trade-off:

the economic certainties demanded by current decision-makers, and many traditional economists dependent on conventional analytic tools, are won at the price of the future economy's incurring real costs that could be avoided if the emissions trading market were permitted to work at its full capacity.

2. The Ceiling Price Transforms the Emissions Trading Program into a Tax Program, with the Attendant Economic Drag. With the cost-saving dynamics of the emission trading market seriously compromised by the ceiling price escape option, compliance costs over time would approximate the ceiling price level. Increasingly, firms would simply find themselves doing nothing but paying a GHG pollution tax in the form of the "ceiling price" payment to the government. This transfer would operate as a non-productive drag on economic performance *without* contributing to further reductions in the cost of compliance, or, for that matter, producing the economic and environmental benefits that emissions reductions would. The economic "drag" created by this tax becomes clear in contrast to the productive yield of an emissions trading market. In a trading market, companies that invest in surplus pollution reductions can earn credits that they can then sell in the trading market or bank for future use. Not only do these companies earn a return on their pollution reduction investment, but they provide the companies that buy their credits a lower cost compliance alternative. At the same time, this "cycling" of financial resources through buy-sell transactions contributes to the dissemination of lower cost compliance alternatives for the entire economy. Under the ceiling price proposal, however, companies with high compliance costs would not be contributing resources through the buy-sell cycle to support investment in low-cost compliance. Instead, they would simply be paying the government a fee for pollution, a payment that would come out of their bottom line, disconnected from any incentive to reduce GHG emissions, and would have the effect of deflating the value of investment in actual reductions.

3. The "Ceiling Price" Would Defeat an Early Reduction Program. On October 6, at the White House Conference on Climate Change, the Vice-President stressed his and the President's determination to establish a program, presumably relying on early reduction credits, to achieve GHG emissions reductions *prior* to the beginning of the first compliance period. The Vice-President's determination is well-founded. Achieving early GHG emissions reductions can provide critical environmental and economic benefits. Because GHG remain in the atmosphere for many decades and thus speed the warming process throughout their long lifetimes, slowing their build-up can be critical to restraining some of the adverse effects of rapid climate change. At the same time, slowing the build-up of GHG emissions during the period *prior* to the time that the U.S. had to comply with an international GHG emissions mandate will also soften any economic dislocations that might occur in connection with meeting that mandate.

Accordingly, a strategy that gives private firms a positive incentive for making early GHG reductions before mandatory compliance periods is critical. If successful, this strategy would not only provide the environmental and economic benefits associated with slowing GHG emissions build-up in the atmosphere and with lessening economic dislocation, but it could also spur and speed investment in the development and use of the kinds of innovative technologies that can reduce pollution while increasing economic performance, including by minimizing costs.

One way to create such incentives is by awarding to firms that achieve early, surplus reductions GHG emissions credits that they could bank and use against future compliance requirements. The results of the acid rain emissions trading program, under which utilities have achieved more than 30% more sulfur dioxide reductions than required – and thus created a substantial bank of surplus emissions reductions – provides strong evidence of how powerful an incentive device early reduction credits can be.

Unfortunately, the ceiling price escape option would fatally blunt that incentive. Again, this option would throw into serious question for many firms the financial wisdom of incurring present-dollar expenditures in the face of an alternative of spending future dollars to meet a fairly modest price to "buy out" of compliance. Because an strategy using early reduction credits is purely an incentive program, the administration simply cannot afford to muddy the incentive signal by forcing firms to contend with the ceiling price option.

At the same time, ironically, the success of such a program in inducing early reduction activity would provide precisely the kind of economic assurance that many are seeking through the "ceiling price" approach. A robust early reduction program not only would soften the increase in GHG emissions prior to the compliance period, thus smoothing economic dislocation and adjustment, but would furnish the economy with a reserve supply of low-cost reductions for meeting compliance.

4. The "Ceiling Price" Eschews a Key Design Lesson of the Acid Rain Program. Some have claimed that a similar "ceiling price" approach was included as part of the acid rain program. This is simply not true. Under the acid rain program, sources do have the option, after a perverse fashion, of paying the government instead of making the required reductions – but the price they must pay is set at penalty levels far higher than the cost of making reductions or purchasing reductions from other sources. More important, such sources would be paying the government not for the privilege of escaping, or being excused from, pollution control obligations. Under one provision, sources would be paying for additional emissions reductions needed to offset the sources' emissions increases, and they would be *purchasing* from the EPA surplus emissions allowances that had been set aside from the initial allocation by the EPA. Under another provision the sources themselves would be required to make the additional emissions reductions immediately after making the payment, since any excess emissions would be deducted immediately from their emissions allowance allocation. The high penalty encourages sources to find low-cost means of reducing emissions through the emissions trading market, indeed in its both of its first two years the acid rain program has experienced 100% compliance. The fact that they are paying for, or are required to achieve, additional reductions themselves, ensures that the environment remains whole – and that market itself and its cost-saving dynamics remain whole.

5. The "Ceiling Price" Approach Does Save Costs – But at the Expense of the Environment. To be sure, there is a manner of cost-savings created by the ceiling price escape hatch. Once costs reached a certain level, sources would never have to pay more than at that level. This price-ceiling would be sustained, however, at the direct

expense of the environment, since with every "ceiling price" payment GHG emissions would rise above the emissions budget level. Ultimately, then, costs would be saved by not requiring that the program perform to the full extent of the U.S. GHG emissions budget commitment. Again, this approach all but turns the emissions market on its head, since in emissions trading, cost savings are achieved only by actions that save costs while also achieving the required reductions. Perhaps even more obvious, however, is that the "ceiling price" approach turns the President's commitment to "binding" targets on its head. With the ceiling price escape option in place, the U.S. would defeat its own commitment to achieve a GHG emissions target.

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Pages: 7 (including cover sheet)

Message: **URGENT -- EXTREMELY TIME SENSITIVE**

**RE: FAILURE OF CEILING PRICE ON CO2 COSTS AS A CLIMATE
POLICY**

EDF paper

Argument 1: The ceiling price would prevent the GHG emissions trading market from achieving the full measure of potential cost-savings.

Response: This argument is valid only to the extent that firms expect a high permit price without the safety valve (i.e., they expect a price exceeding the ceiling). *In other words, it is internally inconsistent for the environmental groups to be arguing that 1990 by 2010 will be cheap -- and that the ceiling will cause a problem.* Their argument that firms will invest a lot thinking that the price would be high, and that investment would drive the price down, assumes that firms make systematic forecast errors -- that they invest thinking the price will be high, and then are surprised when the price is low.

Argument 2: The ceiling price transforms the emissions trading program into a tax.

Response: We don't expect that it will be necessary to trigger the safety valve. Even if we do, the emissions handled under the safety valve would be small and any funds raised could be used to cut other taxes. More importantly, there's no reason that the additional permits would necessarily have to be sold -- they could also be grandfathered to firms, perhaps based on some performance criteria.

Argument 3: The ceiling price would defeat an early action program

Response: The ceiling price would only reduce incentives for early action if prices were expected to be above the ceiling without the safety valve. So once again, there is tension between assuming that it would be easy to meet the target and assuming that a ceiling price would interfere with incentives.

Argument 4: The ceiling price does not follow the SO2 design

Response: A carbon trading program will be substantially larger than the SO2 program, and there will undoubtedly be many differences between the two programs.

Argument 5: Ceiling price may save costs, but only at the cost of the environment

Response: *This argument contradicts the earlier assertion that the ceiling price would raise the cost of the program.* Furthermore, we don't expect that the safety valve would be invoked -- so that we could achieve our environmental goal while protecting the economy against excessive costs.



Joe_Goffman @ edf.org
10/09/97 05:29:00 PM

202

Record Type: Record

To: William J. Antholis, Peter R. Orszag, Gene B. Sperling

cc:

Subject: Why the GHG "Ceiling Price" Will Increase Costs

MIME-Version: 1.0

Content-type: text/plain; charset=US-ASCII MEMORANDUM

Re: Failure of "Ceiling Price" on Emissions Permits as a Climate Change Policy Tool

Introduction. In January, 1997, the U.S. government formally proposed that any international protocol to control the emissions of greenhouse gases (GHG) be structured in a way that imposed total GHG emissions "budgets", covering multi-year periods, on each participating nation. Nations could meet their budgets by trading surplus GHG emissions reductions with each other, and, presumably, permit their affected firms to do the same in private GHG emissions trading markets. There are a wide range of decisive environmental and economic advantages to this approach. Chief among these is that the global GHG emissions trading market that such a structure would unleash could be expected to do what markets do best: lower costs and spur (cost-saving) innovation. By defining nations' obligations as meeting actual budget limits for their total GHG emissions, the U.S. proposal is the single most effective way of ensuring the achievement of the "binding commitments" which many world leaders, including President Clinton, have pledged to make.

Unfortunately, despite the U.S. experience with its own market economy and with highly successful pollution markets, such as the sulfur dioxide emissions allowance trading system used to curb acid rain, some in the Clinton Administration have proposed the inclusion of a "ceiling price" in the U.S. proposal. Under this approach, the U.S. government would specify a cost-per-ton ceiling price for GHG emissions reductions. If the cost of making GHG reductions, or, presumably, the market price, rose above that level, then, the U.S. would be excused from making additional GHG emissions reductions even if that resulted in U.S. failure to meet the national GHG emissions budget. This approach would apply as well to individual firms, which would be required to pay the "ceiling price" for each ton of GHG emissions in lieu of making GHG emissions reductions.

The ostensible purpose of this proposal is to protect the U.S. economy from excessive costs in implementing its national GHG budget obligation. Ironically, the inclusion of a "ceiling price" in a GHG emissions trading program could have the perverse effect of impeding the capacity of an otherwise unfettered emissions trading market to maximize cost-savings. If that were the case, then the "ceiling price" proposal would actually make the cost to the U.S. economy of meeting its GHG emissions obligations more,

1 2

rather than less, expensive. LX

Key to the success of an emissions trading market is the ability of competition to drive costs down. Two critical elements of competition are risk and reward. Firms take risks (e.g. developing new technologies, banking early reductions) because in their calculation they perceive the value of a specific business decision to be positive. Under the ?ceiling-price? proposal both risks and rewards are capped at the level of the ceiling price. As a result there is only limited competition. Worse still, since the risk/reward calculation is based on estimating a variety of unknown variables, the presence of a known ceiling price will tend to encourage firms to estimate an even higher risk premium when evaluating new technologies with unknown costs or other near-term emissions reduction action with uncertain future returns. This distortion of the risk/reward calculation is therefore likely to preclude much initial investment in the development of cost-saving reductions, even at the start of the program. At the same time, the costs added by this approach would not even enhance the environmental performance of the program. On the contrary, since the payment of the ceiling price would result in emissions increases, the proposal would all but ensure that the U.S. would not meet its GHG emissions budget.

1. The "Ceiling Price" Would Prevent the GHG Emissions Trading Market from Achieving the Full Measure of Potential Cost-Savings. The ability of firms to make and "bank" emissions reduction credits in the early years of a trading program for use in later years is almost universally regarded as critical to the success of trading programs (assuming that such treatment is compatible with environmental effects of the pollutant being managed). One of the reasons for this is that banking is instrumental to market formation ? and to the process of achieving cost-reductions. If firms know that at least eventually there will be a market in which surplus reductions will be in demand, then they will be able to identify a financial incentive to find and make such reductions, even if the firms are "banking" surplus reductions simply for their own future use. The reductions they make, especially early on, tend to be relatively inexpensive; as a result, investment in such reductions begins the market dynamic of limiting the cost of compliance. Thanks to these near-term low-cost surplus reductions, the compliance program can "start off" with low-cost compliance options readily available. As the market becomes more active, firms find themselves subject to continuous signals favoring ongoing investment in cost-effective reductions, particularly reductions that can be achieved below whatever the market price is, or is anticipated to be.

Part of the confidence that banking instills in investors in surplus reductions comes from the knowledge that all affected sources have no compliance option other than to achieve emissions reductions themselves or to purchase surplus emission reductions from others who can make them at less expense. As a result, all expenditures made in connection with program compliance will either be made on the demand side to purchase reductions, or on a competitive supply side to achieve the most cost-effective reductions. The "ceiling price" approach undermines confidence in banking because it gives all affected sources an ?out?, and in so doing, unravels the dynamic of cost-reduction that a soundly designed

emissions trading market can create.

Specifically, a "ceiling price", not connected in any way to the purchase of additional surplus reductions, is a vicious competitor to early reduction investment strategies. With a ceiling price present as an alternative to participation in an emissions reduction market, potential investors in early reductions, no matter how low cost, must alter their calculus radically. They cannot simply weigh, as they would in a sound emissions trading market, the cost of current investment in low-cost emissions reductions against the value (admittedly discounted) of a future return on that investment. Such return would take the form either of sales of their reductions or of the use of their reductions to avoid future higher compliance costs or of the overall flexibility for the firm's operations afforded by an available bank of surplus reductions ? all outcomes whose current value is increased by a premium created by firms' uncertainties about future cost and changing economic conditions. Because these uncertainties are amply justified, the ability to pin down costs as well as increase flexibility through the creation of a supply of low-cost reductions is especially valuable. In contrast, in the presence of a "ceiling price" escape path, firms contemplating near-term reduction options must compare the cost, including opportunity costs, of near-term investment in emissions reductions, against the discounted value of avoided future costs, but they must do so in a context where the "ceiling price" creates an artificial certainty as to future costs.

In theory, obviously, the ceiling price could be set high enough so as to preserve and ensure the value of the investment in early reductions. Unfortunately, the "ceiling price" proposal is, almost by definition, a political artifact, designed to ease the adverse pressure on decision-makers sensitive to claims that a GHG emissions budget would damage the U.S. economy. Consequently, as an administration of official has already acknowledged ? unaware, apparently of the internal contradiction ? proponents of the ceiling price approach anticipate that the price would be set at a relatively modest level, precisely for the purpose of creating the needed economic assurance and thus relieving the political pressures decision-makers are now facing.

At best, then, the introduction of a ceiling price "escape valve" complicates and creates grave uncertainties as to the outcome of firms' near-term reduction investment calculus. At the very least, it would contribute to a wait-and-see attitude that would divert some investment in low-cost early reductions that might otherwise be made. More troubling, if acknowledged political imperatives prevail, then the ceiling price will be set at a modest level; as a result, its discounted value will swamp the risk/reward calculations of many would-be investors in low-cost near-term reductions. Without this plentiful supply of low-cost reductions, the market will lose a significant portion of its power to contain and lower compliance costs by forcing compliance alternatives to compete with each other. As a result, actual compliance costs will rise to the level of the ceiling price and will do so much more quickly than otherwise? -- and, again, the costs will be that much higher than they would be were a greater amount of investment in near-term, bankable low-cost reductions made.

The presence of a ceiling price escape hatch defeats the cost-saving

capacity of an emissions trading market at the higher end of the cost curve as well. As reduction costs rise, firms increasingly will find themselves simply paying the ceiling price and foregoing the achievement or purchase of additional reductions. As a result, the market will simply cease to generate incentives that would otherwise drive innovators and investors to find or use the means to bend high-end costs down. Many potential purchasers of the reductions generated by such innovations will simply pay the ceiling price and "escape" compliance. In their absence, the financial incentive that an emissions trading market would otherwise create to apply downward pressure over the entire cost curve will disappear.

either forest
errors or
overinvesting

For these reasons, the introduction of a ceiling price does not simply provide a beneficent outer bound on compliance costs. Rather, it fundamentally undermines the power of emissions trading markets to minimize compliance costs and generate cost-savings. The optimism that many have that an emissions trading market and the technologies, whose development and use such a market fosters, can keep costs "below the ceiling price" depends on the very cost-saving capacities that the ceiling price subverts. At the same time, the "ceiling price" proposal creates a perverse trade-off: the economic certainties demanded by current decision-makers, and many traditional economists dependent on conventional analytic tools, are won at the price of the future economy's incurring real costs that could be avoided if the emissions trading market were permitted to work at its full capacity.

2. The Ceiling Price Transforms the Emissions Trading Program into a Tax Program, with the Attendant Economic Drag. With the cost-saving dynamics of the emission trading market seriously compromised by the ceiling price escape option, compliance costs over time would approximate the ceiling price level. Increasingly, firms would simply find themselves doing nothing but paying a GHG pollution tax in the form of the "ceiling price" payment to the government. This transfer would operate as a non-productive drag on economic performance without contributing to further reductions in the cost of compliance, or, for that matter, producing the economic and environmental benefits that emissions reductions would. The economic "drag" created by this tax becomes clear in contrast to the productive yield of an emissions trading market. In a trading market, companies that invest in surplus pollution reductions can earn credits that they can then sell in the trading market or bank for future use. Not only do these companies earn a return on their pollution reduction investment, but they provide the companies that buy their credits a lower cost compliance alternative. At the same time, this "cycling" of financial resources through buy-sell transactions contributes to the dissemination of lower cost compliance alternatives for the entire economy. Under the ceiling price proposal, however, companies with high compliance costs would not be contributing resources through the buy-sell cycle to support investment in low-cost compliance. Instead, they would simply be paying the government a fee for pollution, a payment that would come out of their bottom line, disconnected from any incentive to reduce GHG emissions, and would have the effect of deflating the value of investment in actual reductions.

① standard
US & UK
② it's small

3. The "Ceiling Price" Would Defeat an Early Reduction Program. On October 6, at the White House Conference on Climate Change, the

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Vice-President stressed his and the President's determination to establish a program, presumably relying on early reduction credits, to achieve GHG emissions reductions prior to the beginning of the first compliance period. The Vice-President's determination is well-founded. Achieving early GHG emissions reductions can provide critical environmental and economic benefits. Because GHG remain in the atmosphere for many decades and thus speed the warming process throughout their long lifetimes, slowing their build-up can be critical to restraining some of the adverse effects of rapid climate change. At the same time, slowing the build-up of GHG emissions during the period prior to the time that the U.S. had to comply with an international GHG emissions mandate will also soften any economic dislocations that might occur in connection with meeting that mandate.

Accordingly, a strategy that gives private firms a positive incentive for making early GHG reductions before mandatory compliance periods is critical. If successful, this strategy would not only provide the environmental and economic benefits associated with slowing GHG emissions build-up in the atmosphere and with lessening economic dislocation, but it could also spur and speed investment in the development and use of the kinds of innovative technologies that can reduce pollution while increasing economic performance, including by minimizing costs.

One way to create such incentives is by awarding to firms that achieve early, surplus reductions GHG emissions credits that they could bank and use against future compliance requirements. The results of the acid rain emissions trading program, under which utilities have achieved more than 30% more sulfur dioxide reductions than required ? and thus created a substantial bank of surplus emissions reductions ? provides strong evidence of how powerful an incentive device early reduction credits can be.

Unfortunately, the ceiling price escape option would fatally blunt that incentive. Again, this option would throw into serious question for many firms the financial wisdom of incurring present-dollar expenditures in the face of an alternative of spending future dollars to meet a fairly modest price to "buy out" of compliance. Because an strategy using early reduction credits is purely an incentive program, the administration simply cannot afford to muddy the incentive signal by forcing firms to contend with the ceiling price option.

At the same time, ironically, the success of such a program in inducing early reduction activity would provide precisely the kind of economic assurance that many are seeking through the "ceiling price" approach. A robust early reduction program not only would soften the increase in GHG emissions prior to the compliance period, thus smoothing economic dislocation and adjustment, but would furnish the economy with a reserve supply of low-cost reductions for meeting compliance.

4. The "Ceiling Price" Eschews a Key Design Lesson of the Acid Rain Program. Some have claimed that a similar "ceiling price" approach was included as part of the acid rain program. This is simply not true. Under the acid rain program, sources do have the option, after a perverse fashion, of paying the government instead of making the required reductions ? but the price they must pay is set at penalty levels far higher than the cost of making reductions or purchasing reductions from other sources.

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acid rain

More important, such sources would be paying the government not for the privilege of escaping, or being excused from, pollution control obligations. Under one provision, sources would be paying for additional emissions reductions needed to offset the sources' emissions increases, and they would be purchasing from the EPA surplus emissions allowances that had been set aside from the initial allocation by the EPA. Under another provision the sources themselves would be required to make the additional emissions reductions immediately after making the payment, since any excess emissions would be deducted immediately from their emissions allowance allocation. The high penalty encourages sources to find low-cost means of reducing emissions through the emissions trading market, indeed in its both of its first two years the acid rain program has experienced 100% compliance. The fact that they are paying for, or are required to achieve, additional reductions themselves, ensures that the environment remains whole ? and that market itself and its cost-saving dynamics remain whole.

*// 5. The "Ceiling Price" Approach Does Save Costs ? But at the Expense of the Environment. To be sure, there is a manner of cost-savings created by the ceiling price escape hatch. Once costs reached a certain level, sources would never have to pay more than at that level. This price-ceiling would be sustained, however, at the direct expense of the environment, since with every "ceiling price" payment GHG emissions would rise above the emissions budget level. Ultimately, then, costs would be saved by not requiring that the program perform to the full extent of the U.S. GHG emissions budget commitment. Again, this approach all but turns the emissions market on its head, since in emissions trading, cost-savings are achieved only by actions that save costs while also achieving the required reductions. Perhaps even more obvious, however, is that the "ceiling price" approach turns the President's commitment to "binding" targets on its head. With the ceiling price escape option in place, the U.S. would defeat its own commitment to achieve a GHG emissions target.

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of mine

(See attached file: co2 CEILING PRICE Sarah memo.doc)

Toll, Full Articles
Rosina

SUSTAINABLE ENERGY COALITION

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DOE LABS' CLIMATE CHANGE STUDY ON THE RIGHT TRACK BUT UNDERESTIMATES POTENTIAL TO REDUCE GREENHOUSE GAS EMISSIONS

**For Release: September 25, 1997
5:00 p.m. (EST)**

**Contact: Ken Bossong 301-270-2258
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Washington, DC -- A major study released today by five national U.S. Department of Energy (DOE) laboratories recognizes the prominent role to be played by renewable energy and energy efficient technologies in reducing greenhouse gas emissions. However, while acknowledging it to be the best federal government study yet released on the role these technologies could play in addressing climate change, the Sustainable Energy Coalition, a coalition of 40+ national business, environmental, consumer, and energy policy organizations, contends that its conclusions are still too conservative and underestimate the potential of renewables and energy efficiency.

The DOE study concludes that a "vigorous" national commitment to deploy cost-effective energy-efficient and low-carbon technologies, including renewable energy, could halt the growth in U.S. energy consumption and carbon emissions so that levels in 2010 are close to those in 1997 (for energy) and in 1990 (for carbon). It suggests that the near-term contribution of renewable energy technologies -- particularly biomass, hydropower, and wind -- would be at least modest although they, along with geothermal, and solar "could deliver significant quantities of electricity" by 2020. The DOE study finds that the reduction in energy use and carbon emissions can be realized without harming the U.S. economy; in fact, it might yield a net economic benefit -- an important conclusion consistent with the views of the Sustainable Energy Coalition.

However, noting that the United States accounts for only 4 percent of the world's population but is responsible for 22 percent of its greenhouse gas emissions, the Coalition believes the U.S. can -- and must -- move further and faster in deploying sustainable energy technologies than the DOE study envisions. In fact, the Coalition maintains that waiting until 2010 to stabilize greenhouse gas emissions at 1990 levels, a goal this country had earlier committed to reach by 2000, is both irresponsible and unnecessary. Instead, the

United States should assume a leadership role in negotiating an international agreement in Kyoto, Japan in December setting legally binding targets to achieve substantial reductions in the emissions of greenhouse gases from 1990 levels by 2010 at the latest as has been proposed by the European Union and other nations.

This goal can be achieved through policies that aggressively promote the expanded use of presently-available and cost-effective energy-efficient and renewable energy technologies. Widespread market penetration of energy-efficient technologies could insure that total energy consumption is no higher than today's levels by the year 2010 while, in combination with changes in the fuel mix, reducing greenhouse gas emissions by at least 10 percent below 1990 levels. Furthermore, by the year 2010, renewable energy could at least double its present contribution to meet 14 percent, or more, of the nation's energy consumption.

Achieving reductions beyond those in the new DOE study are possible through cuts in the growth in vehicle use, advanced building technologies, and expanded adoption of renewable energy sources -- measures that are excluded from, or only partially included, in the DOE report. Policies such as higher fuel efficiency standards for automobiles, appliances, motors, lighting, and buildings as well as requirements to include an increasing percentage of renewable energy in the electrical generation and transportation sectors are needed to remove the barriers inhibiting widespread adoption of these efficiency measures and renewable energy technologies.

Finally, the Sustainable Energy Coalition also questions DOE's suggestion that nuclear power plant life extension might play any role as a greenhouse gas control strategy. Although DOE sees nuclear power reducing greenhouse gas emissions by about only one-third of one percent, it is doubtful whether the nation's aging nuclear plants will survive in a deregulated utility market. In addition, safety and radioactive waste concerns coupled with the generation of carbon dioxide in the total nuclear fuel cycle make nuclear power a poor climate stabilization strategy.

A copy of the DOE study's 16-page "Analysis Results" is available upon request from the Sustainable Energy Coalition. A list of the participating organizations that comprise the Sustainable Energy Coalition is also available upon request.

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Articles

Sixth-draft full content (to be edited to various forms & lengths) for business audiences, 28 August 1997. Strictly confidential. For personal review only. Do not cite, copy, forward, or quote. Strictly embargoed until ultimate release at a date to be set.

Citations to come; kindly ignore square-bracketed placeholders for the full references.

Climate: Making Sense *and* Making Money

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On 19 May 1997, the chief executive of British Petroleum said: "[T]here is now an effective consensus among the world's leading scientists and serious and well informed people outside the scientific community that there is a discernible human influence on the climate, and a link between the concentration of carbon dioxide and the increase in temperature." He continued: "[W]e must now focus on what can and what should be done, not because we can be certain climate change is happening, but because the possibility can't be ignored."

The prospect of having to reduce carbon emissions has aroused dismay, foreboding, and resistance among many in the business community who fear it would hurt profits and growth. That is unfortunate, especially because their reaction stems from one unexamined assumption—which is incorrect.

Predictions of dire consequences from those on all sides—climate-protectors and cost-avoiders, interventionists and laissez-fairers, those concerned about their grandchildren and about their shareholders—freeze stakeholders into seemingly opposed positions. Their preoccupation with defending those positions masks vast opportunities for mutual gain. It might be more productive for all sides to acknowledge the hopes they share. All of us want to be safe, prudent, profitable, productive, and competitive. All want flexibility, entrepreneurship, and markets doing what they do best. All want the poor, at home and abroad, to have a fair chance to live better. And nearly all can get what they want, simultaneously and without compromise—a stable climate *and* a vibrant economy—if practical business experience is allowed to replace theoretical assumptions.

Robert J. Samuelson, in the 14 July 1997 *Newsweek*, concluded: "It would be political suicide to do anything serious about [climate]....So shrewd politicians are learning to dance around the dilemma." Climate policy is in this rut because such influential commentators *assume* that protecting the climate will be costly: in Samuelson's widely held view, saving a ton of carbon emissions would happen only under a roughly \$100 tax, a level he thinks might only cut 2010 emissions back to 1990 levels. Thus "Without a breakthrough in alternative energy—nuclear, solar, something—no one knows how to lower emissions adequately without crushing the world economy." Congress "won't impose pain on voters for no obvious gain to solve a hypothetical problem. And if the United States won't, neither will anyone else."

This articulate columnist holds that belief because it's the conclusion reached by many economic computer models. He may not realize, however, that the models find carbon abatement to be costly *because that's what they assume*. This assumption masquerading as a fact has been so widely repeated as the input and hence the output of supposedly authoritative models that it's often deemed infallible.

Yet an enormous body of overlooked empiricism, including government-sponsored studies [e.g., ICF 1990, NAS *Pol Implns of Grnhs Wrng*, D J Evans ed, 1992, & E S Rubin et al., "Realistic Mitigation Options for Global Warming," *Sci* 257:148ff, 10 July 1992; Okken et al. 1991, Krause, MDLevine&MABrown *Scenarios for U.S. Carbon Reduction* LBNL-40533 9/97] and worldwide business practice, shows that the breakthrough Samuelson seeks has already happened. Protecting the climate can be *not costly but profitable*—just as many industries are al-

ready turning the costs of environmental compliance into the profits from pollution prevention.¹ To prove that, this paper will:

- show how firms are starting to capture these profit opportunities, and can greatly broaden and intensify that success even on a national and global scale;
- examine how eight kinds of practical obstacles that have retarded implementation can be turned into lucrative business opportunities;
- explain how climate/economic models ignore those opportunities and wrongly assume that rapid adoption requires high energy prices;
- clarify how least-cost climate solutions can foster vibrant competitiveness and employment; and
- demonstrate that the climate issue represents a largely unexploited and underrecognized business bonanza.

Consider a few examples. Southwire, the top independent U.S. maker of rod, wire, and cable (a very energy-intensive business), cut its electricity use per pound of product by 40%, gas by 60%, during 1981–87—then kept on saving even more energy and money, still within two-year paybacks. The resulting savings created nearly all the company's profits in a tough period when competitors were going under. The two engineers who led the effort may have saved four thousand jobs at ten plants in six states. The lead engineer, Jim Clarkson, says the technologies are all simple and available; their effective use takes only "an act of management will and design mentality, consistently applied." Indeed, Southwire found that such dramatic energy savings both require and facilitate better management and production systems that are vital anyhow for competitiveness, so the energy savings—sufficient "to cut American industrial energy use in half," as Southwire did—tag along almost for free.

In 1981, Dow Chemical's 2,400-worker Louisiana division started prospecting for overlooked savings. Engineer Ken Nelson quietly set up a shop-floor-level contest for energy-saving ideas. Proposals had to offer at least 50% annual return on investment. The first year's 27 projects averaged 173% ROI. Startled at this unexpected bounty, though expecting it to peter out quickly, Nelson persevered. The next year, 32 projects averaged 340% ROI. Twelve years and almost 900 implemented projects later, the workers had averaged (in the 575 projects subjected to *ex post* audit) 202% predicted and 204% audited ROI. In the later years, the returns and the savings were both getting *bigger*, because the engineers were learning faster than they were exhausting the "negawatt" resource. In only one year did returns dip into double digits (97% annual ROI). The whole suite of projects paid Dow's shareholders \$110 million every year.

DuPont expects to save the equivalent of 18 million tons of CO₂ by 2000 through simple measures that will also save \$31 million each year. Roche Vitamins (Belvedere, NJ) has profitably cut its steam use per unit of production by more than half in five years. A new chiller and related improvements at a Kraft ice-cream plant saved 33% of its electricity and 2,500 tons of CO₂ a year; productivity rose 10% and the plant turned from a money-loser into one of the most competitive. A process innovation at Blandin Paper Company (Grand Rapids, MN) saved each year 37,000 tons of CO₂ and more than \$1.8 million.² The first two years of billion-dollar carpetmaker Interface Corporation's efficiency efforts, *The Wall Street Journal* reports [11 July 1997 p B1], have saved "a stunning \$25 million..., with another \$50 million expected the next two years." Greenville Tube Corporation's demonstration of new drivesystems under DOE's Motor Challenge program boosted productivity 15% and energy efficiency 30%, reduced scrap 15%, and saved \$77,000 a year with a five-month payback [Romm present'n]. And Southern Company's 1984–94 improvements in the thermal efficiency of its fossil-fueled power plants saved 400,000 tons of SO₂, 35 million tons of CO₂, and an annual \$108 million.

Because such examples are the exception, not yet the rule, America is confronted, as Pogo said, by insurmountable opportunities. Those opportunities can create enough practical ways to mitigate climatic concerns *and* save more money than they cost, without ascribing any value to the abatement itself, to turn climate change into an unnecessary artifact of the uneconomically wasteful use of resources. Specifically³:

- Over half⁴ of the threat to climate disappears if energy is used in a way that saves money. In general, *it's far cheaper to save fuel than to burn it*.
- Another one-fourth or so of the threat can be abated by farming and forestry practices that take carbon out of the air and put it back in the soil and plants where it belongs, in the rich tilth and diverse biota that create lasting value. Soil-conserving and -building practices are generally at least as profitable as soil-mining, chemical-dependent methods [NRC 1989, AREE], so let's call them at least a breakeven.

- The rest of the threat vanishes when we replace CFCs with the new substitutes which, thanks to industrial innovation, work the same or better and typically cost about the same or less. (They're also required by global treaty to protect the stratospheric ozone layer.)

So if the "cost" of protecting the climate ranges from strongly negative to roughly zero or irrelevant, what are we waiting for?

Assuming the conclusion

Climate policy has been held hostage to a tacit presumption that if saving a lot more energy were possible at an affordable price, it would already have been implemented. That's like not picking up a \$100 bill from the sidewalk because if it were real, someone would previously have picked it up; or like an entrepreneur who abandons a good business idea because if it were sound, it would have been done earlier.

All economists know that real markets are far from theoretical perfection. But most climate/economy models assume that almost all profitable energy savings must already have been bought—as if in a perfect market. On this basis, the modelers suppose, buying significantly bigger savings will be worthwhile only at higher energy prices. They then use big computer models to calculate how big an energy tax is needed (based on historic elasticities), how much that will depress the economy, and hence what the "cost" of protecting the climate must be.

Those models have driven policy for the past two decades. They may get the amount of money about right—but flowing in the wrong direction. A model popular in the Reagan-Bush years trumpeted the notion that meeting the Toronto carbon-reduction goals would *cost* the U.S. about \$200 billion a year; but the empirical evidence of what energy savings actually cost showed that saving that much fossil fuel would *save* the U.S. about \$200 billion a year compared with buying and burning that fuel. Ever more elaborate models, discussed further below, continue to be built on the same fundamental assumption—that saving energy isn't profitable at present prices and hence will require higher prices that will burden firms and the national economy.

Had those theorists ever run an energy-saving business, they'd know better. GE Chairman Jack Welch said of American industry [*Fortune* Cover Conversation, 11Dec95], "Our productivity is at the beginning stages. There's so much waste. There's so much more to get, it's unbelievable. And somehow or other people think all these things are finite." Practitioners often find that the more the waste that pervades industry is corrected, the more new opportunities emerge to save even *more* resources, even faster and cheaper—especially electricity, which is the costliest and most climate-affecting form of energy.⁵

Big, cheap energy savings

Consider a simple example about pumping—the biggest use of electric motors. Leading American carpet-maker Interface was recently building a factory in Shanghai. One of its processes required 14 pumps. The top Western specialist firm sized them to total 95 horsepower. But a fresh look by Interface/Holland's engineer Jan Schilham, applying methods learned from Singapore expert Eng Lock Lee, cut the design's pumping power to only 7 hp—a 92% or 12-fold energy saving. It also *reduced* the system's capital cost, and made it easier to build and maintain and more reliable and controllable.

These astonishing results required two changes in design. First, Schilham chose big pipes and small pumps instead of small pipes and big pumps: friction falls as nearly the fifth power of pipe diameter. Second, he laid out the pipes first, then installed the equipment, not the reverse: the pipes are therefore short and straight, with far less friction, requiring still smaller and cheaper pumps, motors, inverters, and electricals. The straighter pipes also allowed him to add more insulation, saving 70 kilowatts of heat loss with a two-month payback.

Schilham marveled at how he and his colleagues could have overlooked such simple opportunities for decades. His redesign required, as inventor Edwin Land used to say, not so much having a new idea as stopping having an old idea; not rocket science but rather correcting a common error in engineering economics. The original specification used a rule-of-thumb that balanced the extra capital cost of fatter pipe only against the saved *operating* cost of reduced pumping energy. The new design instead optimized for lifecycle savings in pumping energy *plus* capital cost—not just of the pipes but the *whole system*. The extra cost of the slightly bigger pipes was far smaller than the cost reduction for the dramatically smaller pumps and drivesystems. Such whole-system lifecycle costing is widely

used in principle but rarely in practice. Optimizing energy-using components in isolation tends to pessimize the whole system and hence the bottom line.

Such opportunities exist in more than just pumping. Major energy savings are available in valves, ducts, dampers, fans, motors, wires, heat exchangers, insulation, and most other technical design elements, in most technical systems that use energy, in most applications, in all sectors. Virtually all energy uses are designed using rules-of-thumb that are wrong by about three- to tenfold. Substituting economically rational design would therefore save much of the energy used by industry, while *reducing* capital costs. Many of those savings can also be profitably retrofitted into existing plants, either immediately or as part of routine renovations and expansions.

Similar rethinking of building design has lately yielded, among hundreds of examples,

- houses that are comfortable with no heating or cooling equipment in climates ranging from -47°F in the Colorado Rockies [H1] to $+115^{\circ}\text{F}$ in central California [ACT² refs, TM-93-5], yet cost less to build;
- air-conditioning savings ranging from 90% in a new Bangkok house, at no extra cost [Suntoorn], to 97% in a cost-effective California office retrofit design [F4];
- total energy savings from over 50% to nearly 90% in cost-effective U.S. house and small-office retrofits [F4, ACT² Sunset/ENSAR]; and
- a retrofit design to save 75% of the energy in a typical 20-year-old Chicago curtainwall office tower [ASHRAE J], providing far greater comfort and a simple payback of -5 to $+9$ months.⁶

A particularly effective retrofit strategy, illustrated by the last example, is to coordinate energy efficiency with renovations needed anyhow, such as replacing aging glazings and mechanical systems. New superwindows can insulate fourfold better and let in six times as much daylight but a tenth less unwanted heat. That can trigger further savings, notably in lighting, that can cut air-conditioning needs fourfold. Then the mechanical system can be replaced with a redesigned version four times smaller, four times as efficient, and cheaper than renovating the old one. That saves about enough money to pay for the extra costs of the superwindows and other improvements. Every city in America has such buildings ripe for similar treatment—100,000 of them nationwide.

Careful scrutiny of actual market prices for equipment (“In God we trust; all others bring data”) reveals that even at the single-component level, many technical devices—motors, valves, pumps, rooftop chillers, etc.—show no correlation whatever between efficiency and price. A 100-hp American motor, for example, can be cheaper at 95.8% efficiency than an otherwise identical 91.7%-efficient model. But if you don’t know that—if you assume, as economic theory predicts, that more efficient models always cost more—then you probably won’t shop for it. And that can be costly. If the motor runs continuously, then each one-percentage-point gain adds about \$50 per horsepower to the bottom line, so not choosing the most efficient 100-hp motor can slash present-valued profits by \$20,000.

Again, the key is not so much adopting new technologies, though they’re important, as using proper recipes for combining the best available technologies in the optimal manner, sequence, and proportions. Some of the recipes are embarrassingly obvious. In hot cities, heat-reflecting roofs can save nearly 70% of cooling energy. Up to 40%—90% for houses—can be saved by combining light-colored paints and pavement with revegetation to help bounce solar heat away. An urban tree keeps about 10–14 times as much carbon out of the air as the same tree planted in a forest where it can’t also save air-conditioning energy by keeping people and buildings cooled and shaded. Such effects multiply: traditional passive cooling methods formerly provided summer comfort even in steamy Bangkok, and can do so again if superefficient cars and buildings are gradually introduced so the waste heat from cars’ engines and air conditioners stops making the city too hot.⁷

Proven examples abound in every kind of business:

- Properly choosing office equipment and commercial and household appliances has saved over two-thirds of their energy use with the same or better service and comparable or lower cost [Shepard et al. 1990]. (Such choices cut our household electric bill to \$5 a month with a 10-month payback using 1983 technology.)
- Skilled retrofits have saved 70–90% of office and retail lighting energy, yet the light quality is more attractive and the occupants can see better. In many cases, the better lighting equipment more than pays for itself by costing less to maintain [Lovins & Sardinsky 1988, Piette et al. 1989].
- Motors use three-fourths of industrial electricity, three-fifths of all electricity, and more primary energy than highway vehicles. This use is highly concentrated: about half of all motor electricity is used in the million larg-

est motors, three-fourths in the three million largest. Since big motors use their own capital cost's worth of electricity every few *weeks*, switching to more efficient motors can pay back quickly. This plus retrofitting the rest of the motor system saves about half its energy and pays back in around 16 months [Lovins et al. 1989, Fickett et al. 1990]. Doing this right requires integrating up to 35 kinds of improvements to the motors, controls, electrical supply, and drivetrains, but the resulting saving is twice as big, yet one-fifth as costly, as conventional retrofits that use only two kinds of improvements.

- The chemical industry saved half its energy per unit of product during 1973–90 by plugging steam leaks, installing insulation, and recovering lost heat. Now it's discovered that better catalysts and matching heat to the required temperature can often save 70% or so of what's left, yet pay back within two years.⁸ Next-generation industrial plant design, now moving from the chemical industry into semiconductors, is uncovering 50–75% savings with lower capital cost, faster construction, and better performance. Early adopters will prosper.

Many of these examples illustrate a new design concept: that whole-system engineering can often make it cheaper to save a large than a small fraction of energy use. This "tunneling through the cost barrier" typically comes from integrating the design of an entire package of measures so they do multiple duty (such as saving on both energy and equipment costs), or piggyback on renovations being done anyway for other reasons, or both. Good engineers think this is fun. Most economic theorists assume it's impossible.

Moreover, the cornucopia of efficiency opportunities keeps expanding far into the future:

- Just selling "waste" heat to other users could cost-effectively save up to about 30% of U.S. and 45% of Japanese industrial energy. (America's power stations waste more heat than Japan's total energy use.)
- Still largely unexploited are new kinds of heat exchangers and motors, membrane separators and smart materials, sensors and controls, rapid prototyping and ultraprecision fabrication, and radically more frugal processes using enzymes, bacteria, and biological design principles.
- Saving materials also saves the energy needed to produce, process, transport, and dispose of them. Product longevity, minimum-materials design and manufacturing, recovery of any scrap not designed out, repair, reuse, remanufacturing, and recycling together present a formidable menu of business opportunities that also save energy, pollution, mining, and landfilling. Japan cut its materials intensity by 40% just during 1973–84; but far more is yet to come. Americans throw away enough aluminum to rebuild the country's commercial aircraft fleet every three months, even though recycling aluminum takes 95% less energy than making it from scratch. Smart manufacturers now take their products back for profitable remanufacturing, as IBM just did with computers in Japan and Xerox does with photocopiers worldwide. Interface, the world's top carpet-tile maker, reckons to cut its materials flow by about tenfold, ultimately by a hundredfold, by leasing floor-covering services instead of selling carpet, remanufacturing old carpet, and ultimately mining nylon from landfilled carpet.
- Innovative new approaches also seem about to solve the most intractable part of the climate problem—road vehicles.⁹ Ultralight, ultralow-drag, hybrid-electric "hypercars" [refs] with 70–90% fuel savings, better performance in all respects¹⁰, and competitive costs have attracted about \$2.5 billion of private investment by 25-plus firms worldwide, half of them new market entrants. GM has announced it's developing cars with half the weight, half the drag, and hybrid drive (hypercars in all but name). In autumn 1997, Ford will test a dozen 40%-lighter 6-passenger cars (including two kinds with hybrid drive), meeting essentially the goals of the government's tripled-efficiency car program but 3–6 years early, while Toyota will mass-market in Japan a hybrid Corolla-class car with doubled efficiency, tenfold lower emissions, and only \$4,000 higher initial price. Daimler-Benz has pledged to be making 100,000 fuel-cell cars a year by 2005. With such progress being *announced*, imagine what's going on behind closed doors. Ultimately hypercars will save, probably at a handsome profit, as much oil worldwide as OPEC now sells.
- Many energy savings reduce climatic threats from more gases than just CO₂. Advanced refrigerators, using vacuum insulation and helium-engine coolers, can save over 90% of standard refrigerators' energy, thus avoid burning enough coal to fill the refrigerator every year. This also eliminates climate- and ozone-disrupting CFCs from insulation and refrigerant. Landfill and coal-mine gas recovery turns heat-trapping and hazardous methane emissions into a valuable fuel while making electricity that displaces coal-burning. Recycling paper (the average person in a rich country uses as much wood for paper, mostly wasted, as the average person in a poor country uses for fuel) saves it from turning cellulose's carbon into landfill methane, and also saves fossil-fueled manufacturing and transportation. Superefficient cars simultaneously reduce at least eight classes of heat-trapping gases. These and scores more examples represent business opportunities with multiple profit streams.

Providing the energy that a severalfold larger global population, many of them desperately poor, will need for a decent life mainly requires much more efficient use. This offers about threefold greater relative scope, and meets an even more urgent developmental need, in the South than in the North. But it will also require energy production. Where will that energy come from if not fossil fuels?

Such firms as British Petroleum and Enron are investing heavily in renewables—for good reason [Romm & Curtis Atl 4/96 “Mideast Oil Forever?”]. London’s Delphi Group advised its institutional investors in 1995 that alternative energy industries not only help “offset the risks of climate change,” but also offer “greater growth prospects than the carbon fuel industry” [Mansley rpt on Gelbspan 87]. In 1990, five U.S. National Laboratories reported that either fair competition plus restored research priority¹¹, or proper counting of environmental benefits, could cost-effectively expand renewables to a level equivalent to three-fifths as much energy as the United States uses today; renewable electricity supply could be one-fifth *more* than present usage [SERI 1990]. In 1997, a new five-Labs study [Levine & Brown 97] found that efficiency, renewables, and other low-carbon options could profitably or very cheaply hold 2010 U.S. carbon emissions at about the 1990 level—reducing the carbon intensity of the economy at a 1997–2010 average rate of 2.3–2.5% per year.¹² Just in the buildings sector, reducing the 1990–2010 carbon increase from 26% to 4% would save about \$22 billion a year more (1995 \$ in 2010) than it would cost [*id.* 3.6].

Best of all, sunlight is most abundant where most of the world’s poorest people live. In every part of the world between the polar circles, freely distributed and efficiently used renewable energy is adequate to support a good life continuously, indefinitely, and economically using present technologies [Sørensen 1979, Reddy & Goldemberg 1988, Lovins et al. 1981, Johansson et al. 1989, 1992]. And this potential, once considered visionary, is starting to be validated in the marketplace. The world’s fastest-growing energy source, outpacing even energy savings, is now...windpower, up 26% during 1995–1996, and led by Germany (which just overtook American installed capacity), India, Denmark, and Spain. Double-digit annual growth in solar cell shipments is bringing costs steadily down, and counting some of the dozens of kinds of “distributed benefits” can make those cells cost-effective right now in many uses [Lovins & Lehmann 1997]. (The Sacramento utility even found it’s cheaper to hook alley lights to solar cells than to the existing wires.) Adding other advanced renewables can cut utilities’ carbon emissions by as much as 97% with unchanged reliability and essentially the same cost [Johansson et al. *rens. bk.* 1992 pp 23ff].

Meanwhile, doubled-efficiency combined-cycle gas turbines, with only one-fourth the carbon-intensity of coal-fired power plants, have quietly grabbed more than half the market. The new dark horse is low-temperature polymer fuel cells: equally efficient but silent, clean, reliable, scaleable from large to computer-battery-sized, and likely to transform global power markets. Indeed, converting wellhead natural gas to hydrogen for fuel cells could offer a new option. That separation is already cost-justified by the fuel cell’s high efficiency, so its free byproduct—CO₂—can be reinjected into a depleted gasfield. This cheaply sequesters all the carbon—up to about twice as much as the field’s natural gas originally contained—and is nearly paid for by the extra gas recovered by repressurizing the field [Williams 1996].

In contrast, the products of socialized costs and central planning have not fared well. The world’s slowest-growing energy source is nuclear power—under 1% in 1996, with no prospect of improvement. Despite strenuous effort, its global capacity in 2000 will be a tenth, and its ordering rate is now only a hundredth, of the lowest official forecasts made a quarter-century ago. In America, civilian nuclear technology ate \$1 trillion, yet delivers less energy than wood. It died of an incurable attack of market forces. The only question is whether, as many analysts believe, a third or more of U.S. nuclear plants will retire early because their operating and repair bills are unaffordable. The writing is on the wall: worldwide, around 90 nuclear plants have already retired after serving fewer than 17 years. Even in France, nuclear expansion was far outpaced by its poor cousin—unheralded, unnoticed, unsupported, but more cost-effective energy efficiency.

The collapse of nuclear power—once the great hope for displacing coal-burning—might at first appear to be bad for climate. But since nuclear power is the costliest way to displace fossil fuels, every dollar spent on it displaces less climatic risk than would have been avoided by spending that same dollar on the best buys first. This opportunity cost is why nuclear power actually makes climatic threats worse rather than better.

Whole countries, especially heavily industrialized ones, can achieve big energy savings, and alternative supplies, just by adding up individual ones. During 1979–86, in the wake of second oil shock, America got nearly five times as much new energy from savings as from all net expansions of supply, and 14% more energy from sun, wind, water, and wood but 10% less from oil, gas, coal, and uranium. By 1986, CO₂ emissions were one-third lower than they would have been at 1973 efficiency levels. The average new car burned half the fuel (4% of that gain came from making cars smaller, 96% from making them smarter) and emitted almost a ton less carbon per year. Annual energy bills fell by ~\$150 billion. Annual oil-and-gas savings grew to become three-fifths as large as OPEC's capacity [Rosenfeld et al. 1990a in AREE]. In those seven years, GDP rose 19% but energy use shrank 6%. No problem.

All that effort in the '80s only scratched the surface. In 1989, the Swedish State Power Board (Vattenfall) published—without, by order of its CEO, the usual disclaimer saying it didn't represent official policy—a thorough and conservative technical study of Sweden's further potential to save electricity and heat (which are often made jointly, or "cogenerated") [ref]. The team found that fully using mid-1980s technologies could save half of Sweden's electricity, 78% more cheaply than making more. That plus switching to less carbon-intensive fuels and relying most on the least carbon-intensive power stations could enable Sweden simultaneously to

- achieve the forecast 54% GDP growth during 1987–2010,
- complete the voter-mandated phaseout of the nuclear half of the nation's power supply,
- reduce the utilities' carbon releases by one-third, and
- reduce the private internal cost of electrical services by nearly \$1 billion per year.

If this is possible in a country that's full of energy-intensive heavy industry, cold, cloudy, very far north, and among the most energy-efficient in the world to start with, then countries not so handicapped must have important opportunities too. A year later, a study for the Indian state of Karnataka found that even a limited menu—several simple efficiency improvements, small hydro, cogeneration from sugarcane waste, biogas, a small amount of natural gas, and solar water heaters—would achieve far greater and earlier development progress than the fossil-fueled plan of the state utility, with two-fifths less electricity, two-thirds lower cost, and 95% less fossil-fuel CO₂ (Reddy & Goldemberg 1990).¹³ These two analyses spanned essentially the full global range of energy intensity and efficiency, technology, climate, wealth, income distribution disparities, and social conditions. Yet they both found that efficiency plus renewables yielded a highly profitable carbon-reducing investment package.

That Karnataka study exposes the twin canards that climate is the North's problem and that reducing the South's carbon emissions would inequitably cripple development. Precisely because energy waste hobbles economic progress, some governments in the South and East have lately been quietly cutting subsidies to energy-intensive industries and even to fossil fuels themselves—the latter more than twice as fast in the South as in the North. Reformers are also opening up the energy sector to greater competition, innovation, and efficiency. Such policies have achieved better overall economic efficiency *and*, as a free byproduct, much lower carbon emissions. Such countries are saving carbon about twice as fast as OECD countries have committed to do, and they're probably saving more carbon in absolute terms than OECD countries actually will do, while boosting their own economic growth. In short, they're saving energy for *economic* reasons and reaping the incidental environmental benefits. Among the strongest economic advantages is that building superwindow and efficient-lamp factories instead of power stations and transmission lines can use a thousandfold less capital [Gadgil] and recover it ten times as fast for reinvestment—thus liberating for other development needs the one-fourth of global development capital now consumed by the power sector [Asian paper].

China has three times the energy intensity of Japan (which itself has surprisingly big efficiency opportunities still untapped). But China is improving rapidly. Spurred by energy shortages that idle an estimated 25–30% of its manufacturing capacity, China now gets a quarter of its total primary energy from renewables and over an eighth of its electricity from cogeneration. It's converting all large industrial boilers to cogeneration. It's cut its coal subsidies from 37% to 29% (1984–95) and its oil subsidies from 55% to 2% (1990–95). These and other policy initiatives reduced the 1980–90 growth in China's carbon emissions by 40%. Now, encouraged by internal rates of return on recent manufacturing energy efficiency projects all exceeding 12% and usually exceeding 20%, China is tackling a further savings potential which the World Bank last year estimated would reach in 2020 a level greater than China's entire 1990 energy consumption [Reid & Goldemberg 1997]: in steelmaking alone, best practice could reduce the typical 1990 energy per ton by 64% promptly and 82% ultimately [UNDP 1997 p 72].

Similar conclusions have been found at scales ranging from New England (Krause et al. 1991a) and California (Calwell et al. 1990) to the five largest western European economies (Krause et al. 1991) to the world (LCE, Goldemberg et al. 1988). Studies for the governments of Canada (DPA Group 1989) and Australia (Greene 1990) confirmed that ~20% CO₂ cuts would be highly profitable. In Australia, for example, a 36% energy and 19% CO₂ reduction from projected 2005 levels would save \$6.5 billion (Australian) of private costs per year by 2005, because each \$5 invested in efficiency would save \$15 worth of fuel purchases and 1 ton of CO₂. A new U.S. study [E Innovns 6/97] similarly found that saving 26% of carbon emissions and 15% of primary energy by 2010 would also save 13% of national energy costs—\$85 billion a year, or \$205 per ton of avoided carbon emissions, or \$530 per household per year—and create nearly 800,000 net jobs. Investments in more efficient energy-using devices to 2010 would average \$29 billion a year, but direct monetary savings would average \$48 billion a year, excluding any value of stabler climate and cleaner air.

Such profitably efficient energy futures are simply a logical extension of past achievements. Energy savings since 1973 have cut this country's energy bill by \$150–200 billion a year¹⁴ and carbon emissions by one-fourth. We did all that quietly, easily, and profitably—but now we know how to do far better: America, and the world, have barely begun to capture the energy efficiency that's available and worth buying. Modern cars, after a century of devoted engineering refinement, use only 1% of their fuel energy to move the driver. An ordinary light-bulb converts only 3% of the power-plant fuel into light. The entire U.S. economy is only about 2% energy-efficient compared with what the laws of physics permit. National materials efficiency is even worse: only about 1% of all mobilized materials are actually put into and remain in the average product six weeks after its sale. Thus despite impressive achievements so far, America still wastes upwards of \$300 billion a year worth of energy: more than the entire military budget, far more than the federal budget deficit, and enough to increase personal wealth by more than \$1,000 per American per year. That waste begs to be turned into profits.

Marketplace energy savings: turning obstacles into opportunities

So if such big savings are both feasible and profitable, why haven't they all been done? Because the free market, effective though it is, is burdened by subtle imperfections that inhibit the efficient allocation and use of resources. It is necessary at the outset, writes Professor Stephen DeCanio, Senior Staff Economist for President Reagan's Council of Economic Advisers [sp sic][cite JGM],

...to discard the baggage carried by most economists (the author confesses membership of that much-maligned group) that immersion in a market environment guarantees efficient behavior by the market participants. Much of modern economic theory practically *defines* efficiency as the outcome of competitive market exchanges. But the bloodless "competition" of mathematical general equilibrium models bears only a partial relationship to the actual experience of real firms.

This is tacitly conceded whenever market economists, as a senior government official recently wrote, "are unpersuaded that just because an act seems to make good economic sense it will happen." That is true—precisely because of real-world obstacles and complexities that aren't reflected in the perfect-market economic models relied upon for the conventional conclusion that saving much energy will require much higher energy prices. In fact, those barriers block economically optimal investment in efficient use of energy in at least eight main ways. The good news is that *each of these obstacles represents a business opportunity* [F4Pt2]. Some examples of how they match up:

Obstacles

Capital misallocation

Energy is only 1–2% of most industries' costs, and most managers pay little attention to seemingly small line-items, even though small savings can look big on the bottom line. Surprisingly many executives focus on the top line and forget where saved overheads go; and without their attention, nothing happens. In addition, manufacturing firms tend to be biased toward investments that increase output or market share and away from those that cut operating costs [Levine & Brown 1997 p. 2.2].

Opportunities

A few years ago, one of us was able to tell the CEO of a Fortune 100 company that one of his sites had an outstanding energy manager who was saving \$3.50 per square foot-year. The CEO said, "That's nice—it's a million-square-foot facility, isn't it? So that guy must be adding \$3.5 million a year to our bottom line." He got that right—until he added in his next breath, "I can't really get excited about energy, though—it's only a few percent of my cost of doing business." He had to be

shown the arithmetic to realize that similar results, if hypothetically achieved in his 90-odd million square feet of facilities worldwide, would boost his corporation's net earnings that year by 56%. The energy manager was quickly promoted so he could spread his practices across the company.

About four-fifths of firms don't assess potential energy savings using discounted-cashflow criteria, as sound business practice requires; instead, they require a simple payback whose median is 1.9 years [DeCanio JGM]. At (say) a 36% total marginal tax rate, a 1.9-year payback means a 71% real aftertax rate of return, or around six times the marginal cost of capital. (For example, before state and then federal standards required them, high-efficiency magnetic ballasts, with a 60% real internal rate of return, won only a 9% market share [Levine et al AREE '95]. Many capital-constrained industries use even more absurd hurdle rates: in some, the energy managers can't buy anything beyond a six-month payback.

Many supposedly sophisticated firms count lifecycle cost only for big items and make routine "small" purchases based on first cost alone. Thus 90% of the 1.5 million electric distribution transformers bought every year, including the ones on utility poles, are bought for low first cost—passing up an aftertax ROI of at least 14% a year and many operational advantages, and misallocating \$1 billion a year.¹⁵

If you invest to save energy in your business or home, you probably want your money back within a couple of years, whereas utilities are content to recover their power-plant investments in 20–30 years—about ten times as long. Thus both managers and householders typically require about tenfold higher returns for saving energy than for producing it.¹⁶ This is equivalent to a tenfold price distortion. It makes us buy far too much energy and too little efficiency. Not fairly comparing ways to save with ways to supply energy means not choosing the best buys first, hence grossly misallocating capital—lots of capital. Until the late '80s, the U.S. wasted on uneconomic power plants and their subsidies (each roughly \$30 billion a year) about as much as it invested in all durable-goods manufacturing industries. This misallocation badly crimped the nation's competitiveness.

High consumer discount rates are especially tough: folks used to paying fifty cents for an incandescent light-bulb are often unwilling or unable to pay \$15–20 for a compact fluorescent lamp which, over its life (about 13 times that of the incandescent lamp), keeps nearly a ton of CO₂ out of the air and saves tens of dollars more in power-plant fuel, replacement lamps, and installation labor than it costs. It's a good deal, but sounds like too much

Top finance firms have joined the U.S. Department of Energy in an International Performance Measurement and Verification Protocol [IPMVP, DOE/EE-0081(97), 9/97, www.ipmvp.org]. This industry-consensus approach, like FHA mortgage rules, standardizes streams of energy-cost savings so they can be aggregated and securitized. That's creating a booming market in which loans to finance energy and water savings can be originated as fast as they can be sold into the new secondary market. Achieving the savings therefore no longer requires one's own capital, can be affordably financed, and needn't compete with other internal investment needs.

A new generation of building is overcoming the psychological barrier of supposedly higher capital cost. A hundred case-studies [GDS bk] demonstrate that energy savings of 75% or more can come with superior comfort, amenity, and real-estate market and financial performance—yet *identical or lower* capital cost, because integrated design creates synergies that drastically cut equipment and infrastructure costs. Major developers are starting to move such buildings into mainstream practice.

Arbitrageurs make fortunes from spreads of a tenth of a percentage point. The spread between the discount rates used in buying energy savings and supply are often hundreds of times bigger than that—surely big enough to overcome the transaction costs of marketing and delivering lots of small savings.¹⁷ (Scores of utilities proved this in well-designed '80s and early '90s programs that delivered efficiency improvements at total costs far cheaper than just *operating* existing thermal power stations [Nadel, ABL/Joskow].) This is the basis of the Energy Service Company concept, where entrepreneurs offer to help cut your energy bills for nothing up front—just a share of the savings. Skilled firms of this type are flourishing worldwide, although the domestic ESCO industry is still in its shakeout phase.

Southern California Edison Company gave away more than a million compact fluorescent lamps because that cost less than running power stations. SCE then cut the lamps' retail price by about 70% via a temporary subsidy paid not to buyers but to lamp manufacturers, thus leveraging all the markups. Some other utilities *lease* the lamps for, say, \$0.20 per lamp per month, with free replacements; customers can thus pay over time, just as

money.

Most international vehicles for investing in national or utility-level electric power systems consider only supply-side, not demand-side, options and have no way to compare them. The resulting misallocation is like the recipe for Elephant and Rabbit Stew—one elephant, one rabbit—and it's the wrong way around.¹⁸

Organizational failures

Old habits die hard. A famous company that hasn't needed steam for years still runs a big boiler plant, with round-the-clock licensed operators, simply to heat distribution pipes (many uninsulated and leaking) lest they fail from thermal cycling; nobody has gotten around to shutting the system down. Why rock the boat to make someone else look good? Why stick your neck out when the status quo seems to work and nobody's squawking?

Schedules conquer sensible design. One of us once called the chief engineer of a huge firm to introduce opportunities like a cleanroom that uses a small fraction of the energy he was used to, performs better, costs less, and builds faster. His reply: "Sounds great, but I pay a \$100,000-an-hour penalty if I don't have the drawings for our next plant done by Wednesday noon, so I can't talk to you. Sorry. Bye." The result is "infectious repetitis"—like the semiconductor plant where a pipe took an inexplicable jog in mid-air as if it were going around some invisible obstacle. The piping design had been copied from another plant that did have a structural pillar in that location. In short, intense schedule pressures combine with design professionals' poor compensation and prestige, overspecialized training, and utterly disintegrated processes to yield commoditized and pervasively poor technical design.

Few firms carefully measure how their buildings and processes actually work. Their design assumptions are therefore untested and often incorrect. Their design process is linear—require, design, build, repeat—rather than cyclic—require, design, build, measure, analyze, improve, repeat. No measurement, no improvement. And no discoveries—like the plant that for decades had been unwittingly running a 40-kilowatt electric heater year-round under its parking lot to melt snow. Nobody remembered or noticed until measurement found the books didn't balance, and the wiring was traced to track down the discrepancy.

Departments often don't or can't cooperate. A noted firm calculated that its proposed new office building should get all-new, superefficient office equipment, because the

they now pay for power stations, but the lamps are cheaper.

Rapidly growing new investment funds, partly funded by the climate-risk-averse insurance industry, are bypassing utilities altogether and investing directly in developing-countries' house-level "leapfrog" efficiency-plus-solar power systems. Those often cost less than villagers typically pay now for lighting kerosene and radio batteries, and represent a new market of two billion people.

Columbia University had entrenched practices too. When a tough new energy manager, Lindsay Audin, was told to cut 10% off its \$10-million-a-year energy bill, with uncompromised service and no upfront capital, authorizations were painfully slow—until he showed they were costing \$3,000 a day in lost savings, more than the delayers' monthly paychecks. Five years later he was saving \$2.8 million a year, 60% of it just in lighting; had won 9 awards and \$3 million in grants and rebates; and had brought 16 new efficiency products to market [CS-94-1].

Both such designers and their clients can get away with this, and probably won't notice it, so long as their competitors use the same methods, consultants, and vendors. But once such striking improvements are introduced to a given market segment, the laggards must adopt them or lose market share. Thus competitive forces can do automatically much of the marketing and outreach normally required. Rocky Mountain Institute, having successfully promoted superefficient buildings and cars by this method, is now helping with a new initiative to overhaul the semiconductor industry, which has \$100 billion worth of fabrication plants on the drawing boards worldwide, all inefficient. The opportunity for clean-sheet redesign is intriguing industry leaders who now understand that they cannot compete without leapfrogging over old methods.

The late economist Kenneth Boulding said hierarchies are "an ordered arrangement of wastebaskets, designed to prevent information from reaching the executive." But letting viscous information flow freely to those who need it stimulates intelligence, curiosity, and profits. At a large hard-disk factory, the cleanroom operator started saving lots of money once the gauge that showed when to change dirty filters was marked not just in green and red zones but in "cents per drive" and "thousand dollars' profit per year." In another plant, just labeling the light-switches, so everyone could see which switches controlled which lights, saved \$30,000 in the first year.

Electric utilities traditionally dis-integrate their operations too. But Canada's giant Ontario Hydro inverted its culture to make end-use efficiency and distribution plan-

extra cost of buying it early (rather than waiting for normal turnover) would be less than the up-front savings from smaller cooling equipment. No deal: the chiller was in one budget, office equipment in another. Similarly, Federal buildings are bought from one budget, then operated by a different organization from another; in some cases, they're prohibited from sharing investments so as to reduce taxpayers' total costs.

If you save, the beancounters simply cut your budget some more. Institutional or personal rewards for cutting energy costs are rare, even in the private sector.

Corporate turmoil spoils continuity. Many firms, assuming they'd already done all the worthwhile energy savings, downsized their energy managers right out of a job, stuffed the task onto other overloaded agendas, and watched it slip to an invisible priority. How many economists does it take to screw in a compact fluorescent lamp? None, goes the joke—the free market will do it. But we all know that somebody actually has to get the lamp from shelf to socket; otherwise the wealth isn't created. In many firms, that somebody doesn't exist.

Companies full of smart, competent, rational, and profit-oriented people often fail to optimize because of even deeper kinds of inherent organizational failures well described in the economic literature.¹⁹

Regulatory failures

All but a handful of states and nations reward regulated utilities for selling more energy²⁰ and penalize them for cutting your bill, so shareholders and customers have opposite goals—with predictable results. Many proposed restructuring efforts would enshrine the same perverse incentive in new commodity-based market rules—rewarding the sale of as many kilowatt-hours as possible at the lowest possible price, rather than rewarding better service at lower cost [Negawatts: 12 Transitions].

In some (though increasingly rare) cases, obsolete codes, standards (as for cement composition [Levine & Brown 97 4.41]), specifications (including those for corporate and military procurement), and laws actually prohibit sound and efficient practices. Far more often, standards meant to set a floor—like “meets code” (euphemism for “the worst building you can put up without being put in jail”), or the British expression “CATNAP” (Cheapest Available Technology Narrowly Avoiding Prosecution)—are misinterpreted as a ceiling or as an economic optimum.

ning its primary focus and generation an afterthought. Its first three experiments in meeting customers' needs by the cheapest means—typically demand-side investments plus better wires management—rather than reflexively building transmission and generating capacity cut its investment needs by up to 90%, saving US\$600 million. Such achievements can motivate deep structural and cultural reforms.

Washington State routinely shares the savings between their achievers, the General Fund, and an account reserved for reinvestment in more savings.

After Ken Nelson, the sparkplug of the remarkable Dow/Louisiana savings, retired in 1993, a reorganization disbanded his organizing committee, tracking ceased, and it became impossible to evaluate how much progress, if any, continued without him. (Lacking a champion, the neighboring Texas division reportedly never undertook a comparable effort in the first place.) But now Mr. Nelson, like Southwire's Mr. Clarkson, is an independent consultant, sharing his skills with more firms.

Proper measurement and incentives help: a utility that started paying its efficiency marketing staff a dollar for every measured kilowatt they saved quickly found that verified savings got bigger and cheaper—both by an order of magnitude.

Simple accounting innovations in a few states decouple utilities' profits from their sales volumes, and let utilities keep as extra profit part of whatever they save off their customers' bills. The nation's largest investor-owned utility, PG&E, thus added over \$40 million of riskless return to its 1992 bottom line while saving customers nine times that much. In California alone, Governor Wilson's PUC found that efficiency investments rewarded and motivated by this incentive system's emulation of efficient market outcomes, just during 1990–93, had saved customers a net present value of nearly \$2 billion. Thoughtful utility restructuring can do the same.

To encourage developers to exceed the minimal energy-saving requirements of building codes, Santa Barbara County entitled overcompliers (by 15–45+%) to jump the queue for approvals—a valuable reward at no cost. Elsewhere, some builders of superinsulated homes that leapfrogged far beyond code requirements have won credibility, and dominant market share, by offering to pay any heating bills over, say, \$100 a year, or all utility bills for the first five years' ownership.

The transportation sector is the fastest-growing and seemingly most intractable source of carbon emissions precisely because it is the most socialized, subsidized²¹, and centrally planned sector of the U.S. economy—at least for favored modes like road transport and aviation. It has the least true competition among modes, and the most untruthful prices, with hidden costs of hundreds of billions of dollars per year per year for U.S. road vehicles alone [refs]. These distortions leverage more billions into otherwise uneconomic infrastructure and locational decisions.

The dispersion of uses that causes so much excessive driving is mandated by obsolete single-use zoning rules meant to segregate noxious industries that scarcely exist today. Congestion is specifically caused by non-pricing or underpricing of the road resource: most roads are supported by taxes, not users, so they look free to drivers who behave much as Soviet customers did in demanding a great deal of energy when it looked free. Congestion is further exacerbated by building more subsidized roads that elicit even more traffic, and by requiring developers to provide as much parking as people use when they pay nothing for it. Future generations will marvel that the incredible social costs of these policies—costs deeply intertwined with many inner-city ills—went so long unremarked and uncorrected.

Thailand loses a sixth of its GDP to Bangkok traffic jams, so it's building Los Angeles-style freeways that will create more traffic.

Informational failures

The extremely high returns implicitly required for buying efficiency often reflect a paucity of accurate and up-to-date information. Do you know where to get everything you would need to optimize your own energy use, how to shop for it, how to get it properly installed, who would stand behind it? If any of the preceding examples of big, cheap savings surprised you, you've just observed a market barrier: if you didn't know something is possible, you can't choose to do it.

Strong evidence is emerging that co-locating where people live, play, shop, and work creates such desirable, friendly, low-crime, walking-and-biking-dominated neighborhoods that they yield exceptional market performance. Such co-location, and land-use policies that integrate housing and jobs with transit, can be further encouraged by "locationally efficient mortgages"—the subject of a \$1-billion Fannie Mae experiment—that effectively let homebuyers capitalize the avoided costs of a car they no longer need in order to get to work.

Employers can profit from "cashing out" employee parking spaces—charging fair market value for each space, and paying each employee a "commuting allowance" of equal aftertax value. By monetizing competition between all means of getting to work (or, through telecommuting, of not needing to), this will typically reduce demand for parking spaces, which often cost \$10–30,000 apiece, by more than it enriches the Treasury through the newly taxable perk.

Real-estate developers can profit from annuitizing perpetual transit passes rather than providing a \$25,000 parking place with each housing unit (which yields less but costlier housing). Allowing residents to rent out their daytime parking spaces can pay their home property tax [Shoup 1997].

Singapore is almost congestion-free because it charges drivers their true social cost and invests the proceeds in effective public transit and coordinated land-use.

Labeling tells buyers how competing models compare. Some voluntary labeling systems (as of a quarter-million San Francisco houses in 1978–80) have swept the market because buyers quickly became suspicious of any house that *wasn't* labeled. EPA's voluntary Energy Star standard for office equipment did the same, now embracing over 2,000 products by more than 400 manufacturers, because the efficient machines worked better, cost the same or less, and were therefore mandated for federal purchasing. They're saving a half-billion dollars a year, and promise a profitable ten-million-ton-a-year carbon saving by 2005. Other voluntary programs that provide informational, technical, and trade-ally support, like EPA's Green Lights [www.epa.gov/appdstar/green/glb-home.html], are succeeding because they create competitive advantage. Involving more than 2,300 organizations, Green Lights' retrofits save over half the lighting energy with 30% ROI and unchanged or improved lighting quality. The national potential for this effort alone is a \$16-billion annual saving, plus a 12% reduction in utilities' carbon and other emissions.

"Hassle factor" and transaction costs prevent efficient microdecisions in day-to-day life. For example, how much do you pay at home for a kilowatt-hour of electricity, and how many kilowatt-hours does your refrigerator—typically the biggest single user in the household unless you have electric space or water heating—use each year? If you don't know, because you're too busy living to delve into such minutiae, then you're part of another market barrier. And if you do know, then there's probably another barrier, because for the same price, you could have bought a seemingly identical refrigerator 2–3-fold more efficient, or nearer 20-fold with advanced techniques not yet brought to the mass market.

Risks to manufacturers and distributors

Industry lacks information too—about what customers really want and whether they'll put their money where their mouths are. Manufacturers often hesitate to take the risk of developing and making new energy-saving products, because of limited confidence that they'll sell in the face of all the obstacles listed here.

Efficient equipment often isn't available when and where it's needed—as anyone knows who's tried to replace a burned-out water-heater, furnace, refrigerator, etc. on short notice. Yet distributors, aware of the slow uptake of efficient devices, don't want to take the risk of carrying inventory that may sell slowly or not at all. Thus British Columbia Hydro found that the huge motors in that Province's mining and pulp-and-paper mills were virtually all inefficient, simply because that's what local vendors customarily stocked; anything else took too long to order, and the mills couldn't afford to wait.

Perverse incentives

Compensation to architects and engineers worldwide is based directly or indirectly on a percentage of the *cost* of the building or equipment specified. Designers who work harder to eliminate costly equipment therefore end up with lower fees, or at best with the same fees for more work. Such backwards incentives have led the U.S. to misallocate about \$1 trillion to air-conditioning equipment (and utility systems to power them) that wouldn't have been bought if the same buildings had been optimally designed to produce the same or better comfort at least cost [SOA:SC or ?SCTA or SIP2].

The real-estate value chain is full of incentives so perverse that each of the 25 or so parties in a typical large

It's precisely to make such decisions hassle-free—and because most appliances are bought not by billpayers but by landlords, homebuilders, and public housing authorities—that Congress almost unanimously approved mandatory efficiency standards for household appliances. They merit further extension to commercial and industrial devices. Such standards knock the worst equipment off the market and reward manufacturers for continuous improvement. That's largely why careless shopping for a same-priced refrigerator can sacrifice only 2–3-fold efficiency gains in America, vs. 6-fold in Europe. Smart utilities also reinforce standards by rewarding customers for beating them.

Swedish official Hans Nilsson pioneered contests for bringing efficient devices into the mass market. A major public-sector purchasing office issues a Request for Proposal guaranteeing to buy a large number of devices, bid from certain prices, if they meet certain technical specifications, including energy savings highly cost-effective to the user. This explicit expression of market demand has already elicited many important innovations giving a strong advantage to Swedish industry in both home and export markets. A "golden carrot" devised by Dr. David Goldstein of the Natural Resources Defense Council followed suit with improved U.S. refrigerators.

BC Hydro paid a small, temporary subsidy to stock only efficient models, so vendors' extra carrying cost was covered. In three years, premium-efficiency motors' market share soared from 3% to 60%. The subsidy was then phased out, supported by a modest backup standard. Similarly, PG&E found in the '80s that rather than paying customers a rebate for buying efficient refrigerators, it could improve refrigerator efficiencies faster, at less than a third the cost, by paying retailers a small bonus for each efficient model stocked, but nothing for stocking inefficient ones. The inefficient models quickly vanished from the shops, so when you wanted the next unit the dealer could put on the truck, it'd be efficient, because that's all they'd have.

Pilot projects launched by RMI are now testing how much more efficient buildings become if their designers are rewarded for what they save, not what they spend, by letting them keep several years' measured energy savings as extra profit. Early results are highly encouraging. The German and Swiss architectural associations are pursuing similar reforms.

Careful case-studies are revealing that in well-designed, highly efficient buildings, the better visual, acoustic, and

deal is systematically rewarded for inefficiency and penalized for efficiency [SIP2]. The 75% energy saving designed for the Chicago office tower mentioned earlier, with instant payback, wasn't bought: the property was controlled by a local leasing office, incentivized on dealflow, that didn't want to delay its commissions a few months by retrofitting before leasing up the building. The building then proved unmarketably costly and disagreeable, so it had to be sold off to a bottom-feeder. Yet the owner wasn't unsophisticated—it was one of the world's largest fiduciaries.

Split incentives—one party selecting the technology, another paying its energy costs—limit ultimate consumers' choices by substituting intermediaries who don't bear the cost of their poor decisions [DOE '96 @ 5L 2.2]. This issue is ubiquitous. Why should you fix up your rented premises if you don't own them? Why should the landlord do it if you pay the energy bills? Alternatively, if you *don't* pay the bills, why use energy thoughtfully (for example, why maintain or efficiently drive a company car whose costs are paid for you)? In the Shanghai pumping example above, the pipefitters don't mind putting in lots of extra bends, because they're paid by the hour and they won't pay the equipment or electricity bills.

Similar split incentives apply to the makers and users of all kinds of equipment used in buildings and factories. Such equipment is almost always inefficient, optimized on first cost alone, since those who sell it won't pay the operating costs and most buyers won't shop carefully. (Indeed, for most kinds of equipment, efficient equipment simply isn't available—until a big customer demands better, as Wal-Mart successfully did for day-lighting and air-conditioning equipment.)

In one respect the market works all too well: wasteful old equipment often gets salvaged for resale in the secondary market—mainly to poor people who can least afford the high running costs that motivated the scrappage in the first place. Such “negative technology transfer” can cripple development efforts [Asian paper].

False or absent price signals

Energy prices are often badly distorted by subsidies and by uncounted external (larcenous) costs not internalized by the Clean Air Act's laudable trading system. The U.S. still subsidizes energy supply by about \$21–36 billion per year [Koplow ASE93 for '89; EIA92 omits many terms], mostly for the least competitive options and essentially all for supply—implying significant costless reductions in carbon emissions just by removing subsidies [Shelby et al. 1995]. And that doesn't count an even

thermal comfort enables people to do about 6–16% more and better work. In a typical office, where people cost 100 times as much as energy, that boost in labor productivity is about 6–16 times as valuable to the bottom line as eliminating the entire energy bill! Analogous benefits, big enough to create decisive competitive advantage, are also being found in retail sales and manufacturing. These results may help to explain why firms participating in EPA's voluntary Green Lights lighting-efficiency programs showed stronger earnings growth than nonparticipants [cite DeCanio in Feldman bk]. Increasingly educated tenants will not long tolerate buildings that don't contribute to their success.

Lease riders can fairly share savings between landlords and tenants so both have an incentive to achieve them. Energy utilities could also (as some water/wastewater utilities already do) apply “feebates” to new building hookups: you pay a fee or get a rebate to connect to the system, but which and how big depends on how efficient you are, and each year the fees pay for the rebates. Unlike building codes and appliance standards—which are better than nothing, but become instantly obsolete and offer no incentive to do better—such a revenue-neutral economic instrument drives continuous improvement. It also signals lifecycle costs up front when long-lived investments are being made.

The world's largest maker of air conditioners, Carrier Corporation, is leasing comfort services—much as elevator-maker Schindler leases vertical transportation services and Dow leases solvent services. This improves not only resource efficiency but also incentives: the *more* efficient, durable, and flexible Carrier's air-conditioning systems become, the *greater* its profits, and the better the service it provides at lower cost to more customers. Service leasing aligns the providers' incentive with its customers' objective.

Some big California utilities buy up inefficient old motors, refrigerators, and other devices in order to scrap them before they enter the second-hand market: they're worth far more dead than alive. Unocal even bought and scrapped polluting old cars in order to gain pollution credits for its refinery near Los Angeles.

Subsidies are under increasing pressure by a more skeptical Congress and a better-informed public. Utility regulators in about 30 of the United States also take account of some externalities in considering utilities' proposed resource acquisition decisions. Some proposals for industry restructuring would worsen but others would help to correct these longstanding distortions.

bigger item: subsidies to security of supply that make the true cost over \$100 per barrel²² for Persian Gulf oil, all of it unnecessary.²³ (Yes, more was at stake in the Gulf War than just oil, but we'd hardly have sent a half-million troops there if Kuwait just grew broccoli.)

Energy price signals are diluted by other costs. For example, U.S. gasoline, cheaper than bottled water, is only an eighth of the total cost of driving, even though the car is cheaper per pound than a Big Mac. Why buy a 50- instead of a 20-mpg car when both cost about the same per mile to own and run?

Few firms track energy costs as a line-item for which profit centers are accountable. Firms in rented space may have energy bills prorated rather than submetered. Most billing systems give no end-use information that lets customers link costs to specific devices. Many firms, especially chains and franchises, never even see their energy bills, which are sent directly to a remote accounting department for payment. Some large firms still assume that utility bills are a fixed cost not worth examining.

Appraisers rarely credit efficient buildings for their actual energy savings, so efficiency's value isn't capitalized. Most leasing brokers base pro forma financials on average assumed operating costs, not actual ones. Few buildings have efficiency labels. Few renters have access to past energy bills.

Tax asymmetries further distort energy choices. For example, energy purchases are deductible business expenses, but investments to save energy get capitalized.

Market prices don't include many environmental costs and risks: the Clean Air Act, for example, creates a cap-and-trade regime for sulfur but not for carbon emissions.

Incomplete markets and property rights

There is no market in saved energy: "negawatts" aren't yet a fungible commodity subject to competitive bidding, arbitrage, secondary markets, derivatives, and all the other mechanisms that make real markets in copper, wheat, and sowbellies. You can't yet go bounty-hunting for wasted energy, trade negawatt futures and options (or bid them in a spot market against megawatts), or even, in general, bid them fairly against expansions of energy supply. You can seldom sell reduced demand or reduced uncertainty of demand; yet both are valuable resources that deserve markets. Property rights in most forms of depletion and pollution are incomplete or absent and hence cannot be traded.

Feebates (above) can reward turning over big capital stocks like car fleets more quickly, so we get the worst ones off the road soonest. This offers a huge new market opportunity—especially if the rebate for your efficient new car depends on the *difference* in efficiency between the new one you buy and the old one you scrap.

New bill-paying and -minimizing service companies are springing up to meet exactly this need. Many provide submetering and two-way communications to pinpoint opportunities for improvement. Such simple efforts as ensuring that each meter generating a bill is actually on the customer's premises often generate big savings.

Some jurisdictions have right-to-know laws; others get similar results by training renters and buyers to be assertively inquisitive. Smart leasing brokers are distinguishing their services by offering valuable advice on minimizing occupancy costs. Home and commercial-building energy rating systems are rapidly emerging.

Some countries do better. When the Japanese government wanted to clean up sulfur emissions from power plants, it allowed them to be expensed the same year.

Natural Resources Defense Council published an index of relative exposure to carbon-tax risks for all U.S. utilities and let capital markets adjust ratings accordingly.

When Morro Bay, California, ran short of water, it simply required any developer wanting a building permit to save, somewhere else in town, twice as much water as the new building would use. Many creative transactions occurred as developers discovered what saved water is worth. Two-fifths of the houses were retrofitted with efficient fixtures in the first four years. A more comprehensive market transformation effort enabled Goleta, California, to cut per-capital residential water use by over 50%, and total water use by over 30%, in one year and with no loss of service quality—thereby deferring indefinitely a multi-million-dollar wastewater-treatment-plant expansion.

So which models are unreliable?

Critics of climate protection often cast doubt on the elaborate computer models that simulate the physical processes of the earth's climate. But those models, which now closely fit the climate data, are far more detailed and realistic than the climate-economics models used to claim that climate protection is too costly. The pervasive barriers to buying energy efficiency make the economic models' perfect-market assumption as otherworldly as if the physical climate models omitted atmosphere, clouds, and oceans, and relied instead on a theoretical assumption based on a simple historical regression linking CO₂ levels to global average temperatures.

Compare the "actually existing market" in the left column above with the requirements of a *theoretical* free market: perfect information about the future, perfectly accurate and complete price signals, perfect competition, no monopoly or monopsony (sole buyer), no unemployment or underemployment of any resource, no transaction cost, no subsidy, and so forth. It's a different universe. Ignoring those real-world distinctions leaves most of the climate-economics models riddled with flaws: for example,

- The economic models all forget that renewable sources get cheaper as you produce them in higher volumes, as they've done for decades—leading Royal Dutch/Shell Group Planning to consider it plausible that over the next half-century, renewables could grow to supply more than half the world's energy [Sustained Growth scenario, Kassler 1994, from UNDP 1997 p 110].
- The economic models also don't let technologies improve as price incentives increase, even though rising prices are well known to spur innovation [Newell et al 1996, Grubb et al 1995, Goulder & Schneider 1996].
- Most models quietly assume that carbon-tax or -permit-auction revenues are simply rebated (which lowers GDP) instead of being used to displace the distorting taxes that discourage savings, work, or investment (which would raise GDP) [WRI pp 23-26].
- The relatively few models that allow international trading of emissions and reductions assume that all countries have essentially perfect market economies—even those, like the former USSR and China, that don't have economies at all, but only giant machines for eating resources (and hence the biggest opportunities for improvement).
- Most economic models are very sensitive to how fast, if at all, energy efficiency is assumed to improve by itself at present prices: one model, for instance, found that as this rate was increased from 0.5 to 1.5% per year (it actually averaged 1.54% per year during 1973–95²⁴), the calculated cost of cutting carbon emissions to 20% below 1990 levels fell from \$1 trillion nearly to zero [Manne & Richels 1990s; see WRI p 19].
- Very few of the models take any explicit account of efficiency technologies, and those that do (like the government studies that show ways to save 20–25% of the carbon at negative cost, with much further potential at low cost [IPCC 1996b, NAS 1991, OTA 1991, Levine & Brown 1997,...]) are ultraconservative: they use outmoded, costly, incremental, component-based technologies rather than reflecting the modern whole-system approach.

A lucid guide to 162 predictions by the 16 top climate/economy models [WRI] found that seven underlying assumptions explained 80% of the differences in their results. Does a model assume there's any "backstop" energy source, such as renewables or nuclear, that can be widely adopted if fossil-fuel prices get high enough? Does it assume the economy responds efficiently to price signals and can make significant substitutions between fuels and between products? Can different countries trade their savings opportunities? Are revenues recycled efficiently? Does the model count the value of avoiding climate change (perhaps a relatively minor term, but enough, with efficient revenue recycling, to improve economic welfare [Nordhaus & Young 1996, Jorgensen et al 1995, Nordhaus 1994, 1993])? Does it count the benefit of abating associated forms of conventional air pollution as a free byproduct of burning less fossil fuel—benefits large enough to offset 30–100% [IPPC 1996b] or more [Ekins 1995, Jorgenson et al 1995, Boyd Krutilla & Viscusi 1995] of the assumed cost of carbon abatement?²⁵ For (say) a 60% carbon reduction in 2020, *these seven assumptions can predetermine whether the model shows by then a 7% reduction or a 5% increase in GDP* [WRI 1997].²⁶ That noted economists should find such wildly divergent results underscores not only their lack of unanimity on whether climate protection is disastrous or beneficial for the economy, but also that the difference arises from divergent model structures and assumptions.

In sum, most economic models—especially the extreme ones publicized by fossil-fuel companies' \$30-million ad campaign—calculate large costs because they assume rigid, constrained, and unintelligent responses to economic signals. The few models that show economic *benefit* from protecting climate, even if they assume outmoded energy-

efficiency techniques and impute no value to reducing carbon or other pollution, merely assume that people and firms behave with the ordinary sagacity and flexibility that market mechanisms offer.

Even cheap energy can be saved quickly

Energy efficiency can be implemented very rapidly, by either or both of two quite different methods. One method, demonstrated in the 1970s and '80s, is to have high or rising energy prices and a sense of urgency:

- During roughly 1975–85, most new U.S. energy-using devices—cars, buildings, refrigerators, lighting systems, etc.—*doubled* their efficiency, improving at an annual rate averaging around 7%.
- If all Americans saved electricity as quickly and cheaply as ten million people served by Southern California Edison Company did during 1983–85, then each year they'd decrease the forecast need for power supplies a decade hence by about 7%, at a cost to the utility around one-tenth that of today's cheapest new power stations [Lovins 1985 pp 180–83, Fickett et al. 1990].
- In the 1980s, skillful utilities captured ~70–90+% of particular efficiency micromarkets, mainly difficult ones like retrofitting house shells, in just one or two years.
- Speed can extend to renewables as well as efficiency. Maine used auctions and other competitive processes to raise its private share of power generation from 2% in 1984 to 20% in 1989 to 36% in 1995—and more than two-thirds of that new production was renewable.

Of course, a lot has changed since the '80s. At first, U.S. primary energy consumption “froze at about 74 quads” (quadrillion BTU per year) during 1973–86 “while the GNP grew by 35%” [Levine & Brown 1997 p x]. Those huge energy savings largely caused the mid-1980s crash in energy prices. This in turn retarded further savings: “Starting in 1986, [real] energy prices began their descent...that has continued to the present. As a result, energy demand grew from 74 quads in 1986 to 91 quads in 1995”—a 22% increase, while GDP grew 23%. With more fuel being burned, “carbon emissions have been increasing at a similar pace” [Levine & Brown 1997 p x].

This history makes it natural for economists to suppose that resuming rapid energy savings will require a return to the costlier energy that propelled rapid savings before. But lower and still-declining fuel prices don't bar us from regaining that decade-old momentum. Today's better technologies and smarter delivery methods can far outweigh the lower energy prices and the used-up initial opportunities, achieving quick savings even *without* the spur of high prices:

- During 1990–96, utility facilitation enabled electric customers in Seattle—with the cheapest electricity of any major U.S. city—to save electric load nearly 12 times as fast as those in Chicago, and electric energy more than 3,600 times as fast, even though Seattle electricity prices are about half of Chicago's.²⁷ This conclusively shows that making an informed, effective, and efficient market in energy-saving devices and practices—as Seattle City Light's efforts helped to do—can fully substitute for a bare price signal, and indeed can influence energy-saving choices even more than can price alone. That is, *people can save energy faster if they have extensive ability to respond to a weak price signal than if they have little ability to respond to a strong one.*²⁸
- Investor-owned utilities, when rewarded for cutting bills, sold efficiency ever faster and more skillfully despite falling electricity prices. In 1990, New England Electric System captured 90% of a small-commercial pilot retrofit market in two months. Pacific Gas and Electric Company captured 25% of its entire new-commercial-construction market—150% of the year's target—in three months, so it raised its 1991 target...and captured all of it in the first nine days of January.

Higher energy prices do not automatically yield substantial energy savings, as can be seen simply by comparing the virtually identical electricity-using devices found in U.S. cities that pay severalfold different electric rates. Nor, as the Seattle/Chicago comparison shows, do low energy prices preclude rapid energy savings where policy encourages and support them. Thus higher energy prices do help spur savings and reflect true social costs. But high energy prices are neither a necessary nor a sufficient condition for economically and technically efficient use of energy: not necessary because vast savings are already worthwhile at present prices but blocked by the barriers described earlier, and not sufficient because the same obstacles, if not deliberately removed, would persist even at higher prices.

Honest energy prices do increase economic efficiency: if we don't know what energy really costs, we won't know how much is enough. Combining desubsidized and internalized energy prices with policy “trimtabs” that reduce the barriers would yield the fastest possible savings. The most balanced approach to price, however, is not to focus spe-

cifically on *energy* prices, but to shift taxation from jobs and income to *all* forms of resource depletion and pollution—just as the British, Danes, Dutch, Finns, and Swedes are starting to use revenues from environmental taxes to cut taxes on labor. Today's outmoded U.S. tax system penalizes work and employment while often subsidizing depletion and pollution. The present system rewards, and therefore gets, just the opposite of what we want. In a 21st-century world of more abundant people and scarcer natural capital, it makes good theoretical and practical business sense to rebalance factor inputs by correctly signaling their relative scarcities.²⁹

Energy prices and national competitiveness

If for whatever reason the price of emitting CO₂ into the atmosphere were raised above its current value of zero, Americans need not fear damage to national competitiveness. After all, the nations that have traditionally been the toughest competitors, like Japan and Germany, have long had energy prices two to three times those of the U.S. This simply made them use the energy about twice as efficiently. Learning how to do this drove their industrial innovation on a broad front, further widening the competitive gap against a cheap-fuel America. Similar flexibility, and more, exists in our own economy—as Americans have already proved by invisibly cutting the nation's annual energy bill by some \$150–200 billion compared with 1973 levels of inefficiency. And there's a hidden bonus: just as energy efficiency created the conditions that crashed world oil prices in 1986 and have made them decline ever since, triggering a durable boom [Schwartz 1997], so repeating and accelerating that success can continue to suppress OPEC's cartel power and dampen oil prices. This would cut America's oil trade deficit (\$61 billion in 1996 alone) while not causing material adverse trade shifts of other kinds [WRI p 9].

Nor need we fear that costlier energy in industrial countries would make American jobs (and carbon emissions) flee to an untaxed South—akin to the “pollution haven” notion which analysts have searched for in the data but not yet found [DeCanio new MS cite]. Electricity prices would be the most sensitive to any carbon tax or emissions trading; yet 1994 electricity bills averaged only 1.3% of the value shipped by average U.S. manufacturing firms, 3.4% for the most electricity-intensive sector (pulp and paper) [EEI Stat Yrbk 1995, p. 82].³⁰ If electricity is too small a factor cost to worry about saving, it's hardly big enough to justify moving one's factory overseas. Conversely, if its price rises enough to motivate moving abroad, it's certainly a strong enough reason to save most of that electricity, at a profit, and stay at home.

After all, a small saving in such a tiny factor cost is far less important to industrial competitiveness than the manyfold saving that's *already* available in the biggest factor cost—labor. Yet most American jobs have remained here: firms that haven't already exported jobs in search of cheap labor have generally concluded that other countries don't have the infrastructure, skills, local markets, laws, tax rules, or other conditions they need. Differences in energy price would be a much weaker incentive to migrate—as we can infer from American firms' failure to move to the few countries, like Venezuela and Saudi Arabia, that have long had even cheaper energy than we do. Another thought-experiment reveals the absurdity of this notion that energy prices are the sole or main determinant of industrial location. If this were true, then Japan and Europe would long ago have transplanted all their factories to America to take advantage of our severalfold lower energy prices. They didn't.

Those who prefer pricing to obstacle-busting policy instruments for climatic protection contemplate price increases far smaller than the differences that already exist: for example, a 1–2¢/kWh rise in electricity price—less than the differences that already exist between different parts of the United States, or even between some adjacent utilities, without triggering industrial mass migrations. Japanese industry pays about 10¢/kWh more than its American counterparts, but as Japan long ago discovered, even such a threefold difference in energy price can be offset by more productive energy use. That's the durable source of competitive advantage; and it's far easier to sustain amidst the rich infrastructure and skill base of the North than of the South, so migrating Southwards would generally lose advantage, not gain it.

Almost everyone wins

Using energy far more efficiently does mean that less fossil fuel would be sold than if we continued to waste it so profligately. Lower physical volumes may not mean lower profits, but vendors fear that they would make less profit than expected if demand grew more slowly, or stabilized, or even declined—as it would have done eventually from depletion. (For example, a standard model of stabilizing emissions at 1990 levels through a carbon tax [Jorgenson et al. 1992] shows U.S. coal output 25% below the rapid growth in its baseline projection—but output would still grow.) Where is it written, however, that coal companies or OPEC countries have an inalienable right to sell ever

more of their product—or, as their mouthpieces³¹ now urge, to be compensated for lost profits if their hoped-for demand growth slackens or reverses?

This nation has never been good at helping workers or industries in transition, and now would be a good time to get better at it. Much of the Rust Belt is now recovering, but little thanks to outside help. In today's climate-induced shifts, a similar failure to help coal miners, depressed communities, and even disappointed shareholders will encourage them to oppose measures that benefit society. But those measures are also profitable enough that society can afford to ease their difficulties. The total payroll of all U.S. coal-miners is about \$5 billion, or 1% of the nation's energy bills—less than spontaneous gains in energy efficiency save in any typical year. Climate policies threaten miners' jobs much less than do the coal companies, which since 1980 have eliminated more than half of the miners' jobs for which they profess such concern.

As for the shareholders, hard-nosed free-marketeers might say they should have foreseen that climate would become an issue, so they should have invested in natural gas, efficiency, or renewables instead of coal, or in gas pipelines instead of coal-hauling railways. If efficient energy use costs less than coal, then coal will lose in fair competition, and no friend of a thriving economy should wish otherwise. But the best outcome, especially for the workers, would be to structure the incentives so that the companies at risk in the transition will start selling a more profitable mixture of less fuel *and* more efficiency in using it—as a few oil companies and hundreds of electric and gas utilities are already successfully doing to improve both customer service and their own profits. That's the same logic that has already led the likes of BP, DuPont, Ford, Tokyo Electric, Norsk Hydro, and ABB to fund both internal and consortium research to protect the climate while advancing their own business interests [ChrSciMon editorial "21st Century Weather," 6Aug97p20].

Time to dump the myths

With this understanding of how modern technologies and creatively used markets can profitably protect the climate *and* the economy, we can see the aridity and irrelevance of the myths underlying the conventional climate debate:

- *It's about climate science.* No; it doesn't matter what the climate science says, or even whether it's right, because we ought to be purchasing energy efficiency anyway just to save money.
- *It's about decision-making under uncertainty.* The uncertainty doesn't matter, because the robust economic benefits depend only on private internal costs and benefits, not on any imputed environmental values or risks.
- *It's about carbon taxes.* No; they may be helpful and appropriate, especially as part of a general tax shift from people to resource depletion and from production to consumption, but present prices are ample to elicit all the energy savings we need—if we just get serious about vaulting the barriers that inhibit people from buying energy efficiency.
- *It's about command-and-control.* Wrong; it's about helping markets to work properly—and then letting them do their job.
- *It's about who should bear the costs.* What costs? The interesting question is who should get the *profits*. That's a good thing to compete about in the marketplace, but it shouldn't require difficult negotiations.³² The "polluter pays principle"—OECD doctrine since 1974—remains valid, but this time the polluter can profit.
- *It's about sharing sacrifices for the common good.* On the contrary, it's about helping individuals, firms, and nations behave in their economic self-interest.
- *It's about changing to a lifestyle of privation and discomfort*—as the Chairman of Chrysler Corporation recently put it, "dimming the lights, turning off the air conditioning, sacrificing some of our industrial competitiveness and curtailing economic growth" [WPost 7/17/97 p A19]. No; it's about living even better with less, by using smarter technologies that yield the same or better service. The showers will be as hot and tingly as now, the beer as cold, the rooms as well-lit, the homes as cozy in winter and as cool in summer, the cars as peppy, safe, and comfortable; but we'll have substituted brains for therms and design for dollars.
- *It's about keeping the poor down.* Quite the opposite; if equitably provided as the cornerstone of the development process [Asian paper], energy efficiency could be a boost for those most burdened with the least efficient buildings and equipment, and least able to afford such waste. Even if the price of fossil fuels did rise, that's not very regressive, because poor people spend more of their income directly on energy but less indirectly (embodied in goods and services). Any disproportionate harm to the poor could be corrected by straightforward adjustments elsewhere in the tax or welfare systems [WRI, p 8, pp 32–33]. Equity issues merit careful attention, but are no reason to keep on subsidizing energy for the rich.

- *It's about consuming too much in the North and not enough in the South.* That's a real issue, and we in the North have to start thinking hard about what we want, how much is enough, how to meet nonmaterial needs by nonmaterial means, what will make us better human beings, and the difference between a good life and what scripture calls "vanity." But the resource-efficiency revolution described in two new books³³ can buy much time by simultaneously sustaining or enhancing Northern *and* greatly improving Southern living standards while dramatically reducing the use of energy and materials.

Protecting the climate for fun and profit

A proper grasp of the practical engineering economics of energy efficiency (and of other climate-stabilizing opportunities) can thus give nearly all the parties to the climate debate what they want. Those who worry about climate can see it stabilized. Those who don't will still make more money. Those who worry about costs and burdens will see them replaced by profits. Those who want improved jobs, productivity, competitiveness, quality of life, public and environmental health, and individual choice and liberty will get those things too. Two emphases—energy efficiency, and climate-protecting farming and forestry practices that treat nature as model and mentor—can deal profitably not only with climate but with about 90% of EPA's pollution concerns. These actions are therefore not inimical but vital to a vigorous economy, a healthful environment, sustainable development, social justice, and a livable world. As an eminent group of economists supported by more than 2,000 of their colleagues recently concluded, in short, "policy options exist that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run" [Arrow et al. 1997].

The true pragmatists in this debate are those who suggest that we have at hand—and should elevate to the central role in climate policy—the tools we need to turn climate into a business opportunity, at home and worldwide. This can, but need not, involve changing energy prices. Innovative, market-oriented public policies, especially at a state and local level, can focus chiefly on barrier-busting to help markets work properly and reward the economically efficient use of fuel and money. This requires much *less* intervention in the market than we now have with regulatory rules and standards: it properly assumes that the role of government is to steer, not row, and that market actors guided by clear and simple rules can best figure out what will make sense and make money. But we need to steer in the right direction—the line of least resistance and least cost—guided by a detailed and exact understanding of the barriers that now block energy efficiency, and thereby damage global development and national security [Nitze W Post A22 2 July 1997].

A bizarre irony lurks beneath the climate debate. Why do the same people who favor competitive markets in other contexts seem to have the least faith in their efficacy for saving fossil fuels? Let's recall what happened the last time this gloom-and-doom attitude overcame these people's better instincts. Just before Congress approved in 1990 the cap-and-trade system for reducing sulfur dioxide emissions, environmentalists predicted that reductions would cost about \$350 a ton, or ultimately (said the optimists) perhaps \$250. Government economic models predicted \$500–750; the higher figure was the most widely cited. Industry models upped the ante to about \$1,000–1,500. In fact, the sulfur-allowance market opened in 1992 at about \$250 a ton; in 1995, it cleared at \$130 a ton; in 1996, at \$66.³⁴ Moreover, national sulfur emissions have fallen 37% in just the past decade—and 38% faster than the Clean Air Act envisaged, because of simple incentives to reward early achievers. Much the same thing is happening with CFCs.

The genius of private enterprise and advanced technologies found a way billions of dollars cheaper than command-and-control regulation. It would do so again if we competed to save the most carbon in the cheapest ways. In fact, a double bonus would emerge: we'd automatically and profitably meet most of the stringent new ozone and fine-particle standards too, via the same reduced combustion that helps the climate and cuts our energy bills; and we could easily use similar incentives for doing so early.

In the past half-century, global carbon emissions have quadrupled. But in the next half-century, the climate problem could become as faded a memory as the energy crises of the '70s are now³⁵—because it's not an inevitable result of normal economic activity, but an artifact of energizing that activity in extraordinarily inefficient ways.

Let's vault the barriers, use energy in a way that saves money, and put enterprise where it belongs: in the vanguard of sound solutions. Climatic change is a problem we can't afford, don't need—and can avoid at a resounding profit.

* * *

About the authors: Amory Lovins has worked on climate and energy issues for the past three decades, chiefly in the private sector. A consultant physicist educated at Harvard and Oxford, he received an Oxford MA (by virtue of being a don), six honorary doctorates, a MacArthur Fellowship, and the Onassis Prize, and has briefed nine heads of state. *The Wall Street Journal's* Centennial Issue named him among 28 people in the world most likely to change the course of business in the 1990s. His wife and colleague L. Hunter Lovins (BA, BA, JD, LHD *h.c.*) is a sociologist, political scientist, forester, and member of the California Bar. In 1982, the Lovinses cofounded Rocky Mountain Institute—a 45-person, independent, nonprofit, market-oriented resource policy center (www.rmi.org). They have shared the Nissan and Mitchell Prizes, the Right Livelihood Award (usually called in Europe the “alternative Nobel Prize”), and visiting academic chairs. Singly or jointly, the Lovinses have published 25 books, including *Least-Cost Energy: Solving the CO₂ Problem* (1981), and several hundred papers, and have consulted for scores of industries and governments worldwide on the interlinked issues of energy, resources, environment, development, and security.

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Notes [references to be added]

¹ That switch saves \$8 billion in the pulp and paper industry alone [*Agenda 2020*, Am. Forest & Paper Assn., 11/94, ref'd by Romm present'n]; similar findings of a DOE/industry process include 20% energy savings in glass, 50% in aluminum, and 15% in chemicals.

² These case-studies are from the USDOE ClimateWise Case Study Compendium, Report 1, DOE/GO-10096-217.

³ For detailed documentation on each of these matters, omitting only the newest developments such as hypercars, please see our survey paper “Least-Cost Climatic Stabilization,” *Ann. Rev. En. Envt.* 16:433–531 (1991).

⁴ The exact percentages don't matter because such big and profitable savings are available in each gas, source, and sector [*id.*].

⁵ Average U.S. industrial electricity in 1996 cost the heat-equivalent of oil at about \$79 per barrel, over three times the world crude-oil price. Commercial and residential electricity prices averaged respectively 75% and 83% higher yet. Electricity is therefore the most lucrative form of energy to save. It is also the form whose savings yield the greatest climatic leverage: each unit saved saves 3–4 units—in developing and socialist economies, more like 5–6 units—of power-plant fuel, and that fuel is mainly the most carbon-intensive kind—coal. (U.S. electricity is 52% coal-fired, and 88% of U.S. coal makes electricity.) For these reasons, our case-studies focus on new ways to save electricity, although similarly large savings are profitable for most directly used fuels too [AREE].

⁶ The negative figure means the building would have saved a capital investment equivalent to five months' worth of operating cost before you even turn it on.

⁷ The engines are especially inefficient when running air conditioners in cars stuck in traffic (*i.e.*, most cars most of the time), and all of the 5–6 GW of electricity brought into the city ends up as heat. Dr. Suntoorn [ref] notes that together, these heat sources add nearly as much artificial heat per square meter as is delivered by all the sunlight striking the city. In the nearby countryside, ingenious ventilative and radiative passive designs still work fine.

⁸ Just the temperature optimization typically saves 50% in new plants, and pays back in six months in retrofits [Levine & Brown 97 4.20].

⁹ Hypercar-like heavy road vehicles look attractive too, and new uses of information technology to smooth or displace the flow of goods can make much freight traffic unnecessary. Major savings are also available in other transport modes. Ships and passenger aircraft doubled their efficiency in the 1970s and '80s and can do it again: the National Research Council has called for 40% less fuel per seat by 2010–15 [Levine & Brown 97 5.31]. As one hint of what's possible, a 1996 Lockheed-Martin Skunkworks fighter-plane design, made of 95% carbon-fiber and the like, cut weight 35% and cost 65%. Other new vehicles are starting to enter the market, from tenfold lighter and cheaper trains to convertible road-rail vehicles (like GM's Roadrailer) and Lufthansa's freight dirigible to hybrid-electric bikes.

¹⁰ A sophisticated model perhaps a decade or two from now could combine Lexus comfort and refinement, Mercedes solidity and stiffness, Volvo safety, Porsche acceleration, roughly Taurus price, 100–200 miles per gallon-equivalent (the upper range using hydrogen fuel cells), and zero or equivalent-zero emissions. All the technologies needed to do this exist today.

¹¹ Costing only one reactor's worth (\$3 billion) spread over 20 years. Federal renewable-energy R&D was slashed 89% in real terms during 1979–89, and remains under continual attack. In consequence, American industry must already import many renewable energy technologies that were invented here, then left to wither on the vine. Effi-

ciency R&D has a similar history, with drastic cuts, slow rebuilding interrupted by continual sniping, and little attention to the \$28 billion energy saving achieved through 1996 from just five of the numerous technologies developed or demonstrated with DOE's \$28-billion efficiency RD&D budget during 1975–95 [Levine & Brown 97 p 2.5].

¹² This potential is economically consistent with the National Academy of Sciences' 1992 findings (*Policy Implications of Greenhouse Warming*) but about one-fourth to one-third as large, because the Academy examined long-term potential without regard to timing, while the five-Labs study explicitly counted retrofit and replacement dynamics.

¹³ This is possible because efficiency is abysmal to start with—so low that when an Indian village switched from kerosene to fluorescent lamps, illumination rose 19-fold, energy input decreased ninefold, and household lighting expenditure fell by half [Reddy 1994 cited at UNDP 1997 p 70].

¹⁴ This range [Levine & Brown 1997, p x] depends on what fraction of the 1973–96 reduction in primary-energy/GDP ratio is due to improved technical efficiency; with most authorities, we estimate upwards of two-thirds, the DOE estimate for 1973–86 [*id.*, p. 2.1]. The rest is due to shifts in composition of economic output and to minor behavioral changes.

¹⁵ Bill Howe, "Distribution Transformers: A Growing Energy Savings Opportunity," E SOURCE TU-93-10, 12/93; dominant models are ~96–98.5% efficient, the best amorphous-iron model 99.33%, but it costs \$680 instead of \$320, so its market share is only 10%. Compared with the best standard model, it yields a 14%/y aftertax ROI, a 20-year saving more than twice its marginal cost, a longer life, and far greater service flexibility. This analysis assumes 25-kVA oil-filled units, 0.50 load factor, 0.95 power factor, 6¢/kWh, 5%/y real discount rate, 36% marginal tax rate. The misallocation is assessed as the present value, over a 20-y minimum life, of avoided generation at 2¢/kWh and generation-plus-transmission at \$700/kW (busbar) with 3% transmission loss; each 10,000 transformers sold at 98.44% instead of 99.33% waste 2.5 peak MW and ~22 GWh/y (*id.*). One-third are bought by nonutilities; 35 million units are U.S. service; and virtually all electricity flows through similar transformers.

¹⁶ Implicit real discount rates for buying efficiency typically range upwards from 60% a year [refs], while big energy supply firms have traditionally been content with 5–6%.

¹⁷ Some theorists argue that "transaction costs"—the supposedly prohibitive cost and hassle of searching out every little source of energy inefficiency and negotiating with its owner to correct it—will eat up any profits and make further energy savings impractical. Nonsense. Transaction costs in some poorly designed early utility programs were up to tens of percent of total costs—which were still severalfold smaller than the savings they achieved. But more mature programs cut those transaction costs by tenfold, to just a few percent overhead, making the net profits even juicier [AREE p 3n/SCE pri ref].

¹⁸ Most of the misallocation is driven also by the enormous personal profits for dealmakers. Those transactional rewards drive many investments with unsound fundamentals (like most recent Asian project-financed power plants), just as they propelled the '80s real-estate bubble and S&L fiasco. Those tens of billions of dollars per year get tied up for a decade or more and can't be invested instead in cheaper efficiency. But efficiency doesn't offer fat commissions.

¹⁹ Firms are not individuals and are not of a single mind—hence often experience [DeCanio Epol p 907...] the "divergence between goals and actions" familiar in all bureaucracies. Indeed, economic theory correctly states that in general, "rational, self-interested individuals will not act to achieve their common or group interests." Corporate inefficiency may be invisible if profits are positive and competitors use similarly inefficient practices. As Nobel economist Herbert Simon convincingly describes, firms do not in fact fully maximize profits but rather resort to "satisficing" because of the inherent complexities of their environment and the limits of their processes for making and executing decisions. Shareholders hold diversified asset portfolios, but managers whose careers ride on the success of specific projects are far more risk-averse, so they go only for extremely high-return investments—and so on down the hierarchical chain of control, where subordinates bear the personal risks of failure while superiors see the results and know which projects were chosen but not why. This leads to systematic suboptimization—to second-best solutions perceived as less risky individually, but less profitable overall than they should be. In summary, the reasons for corporate (or for that matter government) underinvestment in energy efficiency are described by economists as bounded rationality, principal-agent problems, and "moral hazard" (an old insurance term for situations where behavior can take advantage of and thereby change actuarial odds or prices, as where people are more likely to abuse a rental car than one they own, forcing the rental firm to raise its price). Overlaid on these is widespread myopia—hurdle rates for capital budgeting generally (not just to save energy) well above investors' required returns. The complex reasons for this relate mainly to takeover and investment-analyst pressures.

²⁰ When regulators convert revenue requirements for a fair return on and of capital into a schedule of tariffs (cents charged per kWh used by various customers), they must assume how much energy will be sold. If the utility then sells more energy than assumed, its profits go up; if less, its profits go down. The solution is to decouple profits

from sales volumes via a simple balancing account, so the utility is no longer rewarded for selling more energy nor penalized for selling less. This also eliminates the incentive to game the forecast (lowball forecast sells so you can sell more), and does not make utilities' profits depend on things they cannot control such as weather [EPol].

²¹ Developing countries subsidize their energy by an estimated \$111 billion per year, but America subsidizes just its car drivers by more than that (the gap between their public direct costs and their fee and tax payments) [Worldwatch ref: Vital Signs '97?]. We pay to create the problem and we pay to deal with it. It would be cheaper and smarter to pay no subsidy and thus avoid the problem.

²² The military costs of forces whose primary mission is intervention in the Persian Gulf totaled at least \$73 billion in 1994—plausibly 3+ times that [Cavallo 1996]. Allocating that cost generously to all, not just Gulf, oil use is equivalent to a hidden shift of about \$2–7 per million BTU, or \$13–37 per barrel, from energy bills to tax bills.

²³ The U.S. wouldn't have needed a drop of oil from the Gulf if it had kept on saving oil as fast after 1986 as it did for the previous nine years. During 1975–87, the U.S. had boosted its oil productivity four-fifths faster than it had to in order to match both economic growth and declining domestic oil output. By 1986, the annual energy savings, chiefly in oil and gas, were providing two-fifths more energy than the entire domestic oil industry, which had taken a century to build; by 1995 the savings had surpassed *all* oil use. But after doubling, new-car efficiency stagnated for a decade and is now declining again under the weight of inefficient light trucks, vans, and sport-utilities.

²⁴ But with localized spurts, like New England's 6%/y gains during 1978–80 (the period of the second oil shock). To be sure, national improvements were much faster before the 1986 price crash than since, but if a lower-than-historic rate is to be assumed because greater energy efficiency will continue to lower energy prices, then the stimulative effect of that cheaper energy must also be considered.

²⁵ EPA's 1994 *Emission Trends Report* states that conventional energy use causes 95% of U.S. CO₂ and NO_x emissions, 73% of volatile organic compounds, and 70% of CO, so as *The Economist* remarked in June 1990, "Using energy in today's ways leads to more environmental damage than any other peaceful human activity."

²⁶ Such a long-term change is quite small in annual terms: a review of nearly 100 modeling studies showed that holding long-term CO₂ emissions at about current levels (much more stringent than current proposals for stabilizing emissions) "may if carried out in an efficient manner be expected to reduce...average GNP growth rates over the period [to the mid-21st century] by less than 0.02–0.03% per year" [M. Grubb *et al.*, "The Costs of Limiting Fossil Fuel CO₂ Emissions: A Survey and Analysis," *Ann. Rev. En. Env't.* 18:397–478 (1993) at 472].

²⁷ Seattle City Light's measured savings achieved through 1990–96 investments in demand-side management, emphasizing energy rather than peak-load savings, were 313 GWh/y or 38 average MW—3.2% of 1996 energy sales and average load (J. Todd, personal communication, 7 August 1997, documented in annual *EMSD Accomplishment Reports*). By 1996, but nearly all during 1995–96, the nearly tenfold larger Chicago utility Commonwealth Edison saved 51 peak MW (0.27% of its 19-GW peak load), or an 11.8-fold smaller fraction of load. ComEd made essentially no effort to save electrical energy, yielding savings of only 800 MWh/y, or 0.00088% of its sales [M. Brandt, personal communications, 13 and 21 August 1997]—a 3,640-fold smaller fraction than in Seattle. The ComEd figures are not corrected for any offsetting sales increases resulting from promotional tariffs and practices. Big customers in Seattle in 1996 paid 1.9 times less and small customers paid 2.3–2.4 times less per kilowatt-hour than in Chicago.

²⁸ This is not surprising, since "nonprice measures have an important role in improving economic efficiency....All markets in open societies and in all sectors of economic activity...function within a framework of laws,...standards and public and private information services designed to improve the clarity and integrity of economic transactions and in so doing improve economic efficiency....[P]ure market transactions, in which prices, along with other economic variables such as income and wealth are the sole variables, are rare" [D. Anderson, World Bank, AREE '95, pp 563–4].

²⁹ Environmental taxes certainly work: as *The Economist* [28 June 1997] summarizes, "the OECD says that in Sweden, where dirtier automotive diesel has been taxed relatively heavily since 1991, almost all diesel is now of the cleanest type and sulfur emissions from diesel vehicles have fallen by 75%. In Norway, the carbon-dioxide tax has prompted a switch away from fossil fuels, cutting emissions from power stations and factories by one-fifth since 1991." Making "labor taxes less damaging...is worthwhile anyway." Tax-shifting simply combines both benefits. Phased-in, revenue-neutral tax shifts [Jeff Hammond, Peggy Duxbury, Alan Sanstad, & Stephen DeCanio, *Tax Waste, Not Work*, Redefining Progress, SFO, 1997] offer rich potential for strengthening the public and private economy and for avoiding many social costs whose remediation now increases the total burden of taxation. Tax-shifting would signal managers to fire the unproductive tons, gallons, and kilowatt-hours, and thereby help them to keep the people, who'd then have more and better work to do. There is an intimate link between the waste of people, resources, and money—and the solutions to all three problems are also intertwined [NatCap/MJ].

³⁰ Moreover, less than half the price of electricity is fuel, and under a mere \$20–40/ton carbon tax, coal-fired electricity would be quickly displaced by modern gas-fired plants that emit only one-fourth as much CO₂ per kWh and are hence only one-fourth as sensitive to the tax—or even by competitive renewable sources.

³¹ Including some leading non-oil-exporting Southern diplomats whom OPEC has coöpted for this purpose.

³² As chief U.S. negotiator Tim Wirth put it [Intl Env'tl Reporter 2 Oct 1996], “probably the most complicated scientific, environmental, economic and political challenge in history.”

³³ *Factor Four: Doubling Wealth, Halving Resource Use* [cite] and the forthcoming book *Natural Capitalism: The Worthy Employment of People and Resources* [cite]. The European Union, German, and Dutch Environment Ministers have endorsed the Factor Four approach as a new basis for sustainable development—the only dissent coming from Sweden which, farsighted as ever, prefers a Factor Ten goal, as do the OECD Environment Ministers. Fair enough: the latest technical findings described in *Natural Capitalism* do make that a realistic goal. But four is on the way to ten and is much better than zero.

³⁴ See Bohi & Burtraw, *EJ* Aug/Sept 97 pp 67–75. The price subsequently spiked up to \$115 in spring 1997 as Enron and other traders bought the cheap allowances. By mid-1997 it had fallen back to \$90. One could well conclude [Ackerman & Moomaw, *EJ* Aug/Sept 97 pp 61–66] that “If pollution reduction is so cheap, perhaps society should buy more of it.”

³⁵ In the 1970s, experts were nearly unanimous that energy use and GDP must forever march in lockstep. The Chairman of Chrysler Corporation still holds this view and more: although his 17 July 1997 *Washington Post* op-ed “Global Warming: Industry’s Reponse” [p A19] acknowledges that “new technology will allow us to continue to grow our economy while managing the level of CO₂ output,” he also states that curtailing fossil-fuel use “in the next dozen years by more than 20 percent” by obliging ourselves to “heavily tax or somehow rigidly ration our own energy use” would have the “certain consequence” of “a decline in the country’s economic growth by a similar amount,” so without sustaining historically high levels of energy use, the U.S. is “not likely to remain” a developed country. Of course, GDP and energy have long since parted ways—we now produce 44% more GDP per unit of energy than we did in 1970—and that’s only the beginning. Even those who wonder how much further such progress can persist should be happy to try the experiment; both economically and politically, they have nothing to lose but their waste.

Something for Everyone: A Climate Policy That Both Environmentalists and Industry Can Live With

By Raymond Kopp, Richard Morgenstern
and William Pizer

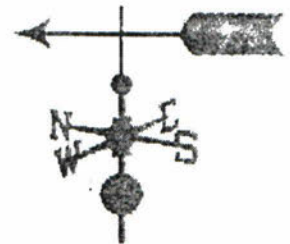
SUMMARY: Researchers at Resources for the Future propose an alternate climate policy that has the potential to make both environmentalists and industry happy -- it establishes binding emissions targets as long as costs remain reasonable and allows the target to rise somewhat if costs are unexpectedly high.

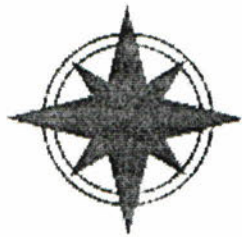
SEPTEMBER 29, 1997 -- Over the next few months big business and environmental advocates will bombard the American public with high dollar, slick advertisements reflecting the deep disagreement that exists within the U.S. and across the world regarding global warming and what actions, if any, need to be taken.

The motivator for this media blitz is the upcoming December meeting of the United Nation's Conference of the Parties in Kyoto, Japan to consider climate change policy options. Environmental advocates hope the U.S. will agree to binding targets and timetables for reductions in the emissions of greenhouse gases (GHG) which may be linked to disastrous changes in the world's climate. Many in the business community would like nothing better than to see no agreement at all. We propose a policy approach that can make everyone at least somewhat satisfied.

About the only thing the protagonists in this debate can agree upon is that there exists great uncertainty about the two pieces of information that are crucial to the development of a reasonable climate policy: the gains from reducing GHG emissions and the costs of attaining those reductions. While acknowledging our lack of precise information, environmental advocates believe the risks to our planet posed by climate change are so great that aggressive action must be taken now. By the same token they see the cost of that action as relatively low. In contrast, many in the business community see the climate risks as too uncertain and the costs too high to warrant drastic action. They would prefer a wait-and-see policy or, at most, a limited expenditure on GHG emission reductions.

As a compromise, we propose an alternate policy. Recent research* using a climate policy model developed at Resources for the Future by Pizer suggests that a hybrid system coupling an emissions target with a relief mechanism for unexpectedly high costs goes a long way towards addressing each groups' concerns. In particular, the policy (1) fixes emissions targets that are binding as long as costs remain reasonable and (2) allows the target to rise somewhat if costs are unexpectedly high.





Consider the position of those concerned about the environment. Their policy of choice is a tradable permit system where each permit gives the holder the right to emit a specified amount of GHG into the atmosphere. By limiting the number of permits, one can precisely control GHG emissions and guarantee they remain below the threshold for disastrous climate change. In contrast, while GHG emissions can be set with certainty using a permit system -- and by implication the benefits of GHG control obtained with certainty-- the cost of control is highly uncertain. That is, the cost to society, in terms of higher prices for fuel and reduced productivity, varies greatly under a permit system.

Within the business community, as well as among consumers in general, the ideal climate policy is one that sets an upper limit on climate related expenditures. Businesses are interested in maintaining a stable environment for planning and investment. The risk of unexpectedly high compliance costs under a strict permit system thwarts that stability. For that reason, most businesses would prefer some sort of contingent policy that would keep costs low and predictable.

The hybrid system we propose would establish a fixed number of tradable permits based on an emission target. It would then provide additional permits at a pre-specified trigger price. As long as the cost of controlling a ton of GHG emissions remains below the trigger level, the emission target would be attained.

For environmental advocates, the hybrid approach guarantees that emissions will not exceed the tradable permit limit as long as the price of the tradable permits (i.e., the marginal cost of GHG control) does not rise above the trigger price. Based on their belief that the cost of reducing GHG emissions is low -- and assuming these beliefs turn out to be correct -- the permit price will never reach the trigger level and emissions will remain capped.

The current choice of policies facing both environmental advocates and the business community are too tightly drawn. What we propose is a more flexible policy with the potential to address the substantive concerns of both groups, i.e., uncertainties about both benefits and costs. The hybrid policy does just that. By implementing a tradable permit system where the pool of available permits remains fixed as long as the price remains below a reasonable threshold, the risk of catastrophic climate damages is greatly diminished. By capping the potential expenditure on GHG abatement and allowing additional permits to be purchased if costs turn out to be particularly high, the policy protects against runaway costs for business and consumers, enabling sound business planning.

This may not be fully satisfactory from the perspective of an environmental advocate, but if the cost of GHG control is as low as suggested by both the environmental community and our experience with the sulfur trading program, these concerns are unwarranted. Similarly, the business community may be unhappy with the level of required expenditures -- but at least those expenditures remain capped. While a hybrid policy does not address all the thorny issues of GHG control, we believe it provides a valuable degree of freedom to bring the sides together and it may, indeed, be a valuable approach for the Clinton Administration in Kyoto.



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** The recent research by William Pizer mentioned in this article is detailed in the RFF discussion paper, Prices vs. Quantities Revisited: The Case of Climate Change. It is the second of two papers by Pizer that deals with uncertainty in climate policy. Click [here](#) to download this paper in PDF format (which can be read with Adobe Acrobat Reader; if your computer is not equipped with Acrobat Reader, click [here](#) to download the software FREE). Click [here](#) for a summary of Pizer's first paper, Optimal Choice of Policy Instrument and Stringency Under Uncertainty: The Case of Climate Change.*

Click [here](#) to read the New York Times article by Peter Passell that mentions this Weathervane article and discusses related policy options for combatting climate change.

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For businesses, the policy guarantees that the cost of control per unit of GHG emitted can never exceed the specified trigger price that would be charged for additional permits (and could always be less). Thus, while business leaders may still feel the benefits of GHG control are not commensurate with costs, they can at least make business plans based on the knowledge of a well-specified cost structure.

The hybrid approach proposed here is not entirely new. Aficionados of U.S. air pollution policy will remember that the 1990 Amendments to the Clean Air Act, which established the sulfur permit trading system, also had a provision that enabled industry to buy additional permits at a pre-specified fee. This option was never exercised because the price of the permits (the cost of sulfur control) began low and has fallen over time. Similar mechanisms have been employed to regulate imports and domestic agricultural production. More recently, economists McKibbin and Wilcoxon went on record as favoring a hybrid policy for GHG controls based on their concern about enforcement, monitoring and international trade – important issues, but distinct from our focus on benefit and cost uncertainties.

A final advantage of the hybrid policy is its enhanced credibility relative to a straight permit alternative. The idea that binding targets and timetables will remain inflexible in the face of unexpectedly high costs is unrealistic. By providing an automatic mechanism to relieve cost pressure, the hybrid policy stands a much greater chance of remaining in force and consequently convincing businesses to take action immediately (instead of waiting to see if the policy is eventually abandoned).

