"Electricity Solutions for California," presented to the Commonwealth Club of San Francisco on 11 July 2001. Lightly edited and corrected by the speaker: Amory Lovins, CEO (Research), Rocky Mountain Institute, Snowmass, Colorado (www.rmi.org).

To understand what's been happening with California electricity and its relevance to the rest of the nation, it's important to start with some facts—just the facts, ma'am. As we say at Rocky Mountain Institute, "In God we trust; all others bring data."

I'd like to make some statements that, in view of the press coverage of this issue, may seem a little startling:

- California's electricity consumption did not soar, in Silicon Valley or anywhere else, due to the Internet or anything else. It simply didn't happen.
- California did not stop building power plants in the 1990s. Reserves did tighten, but stayed adequate.
- Probably California has not even been short of generating capacity during any of its power emergencies.
- The supply expansions now under way may well already be in overshoot (building more than is needed) even before the savings also underway have really ripened.

Let me say why I think those things are true.

The electricity mess in California, of which I've been a student for some time, started around 1994 when people with strong ideological views decided to fix a system that wasn't broken and that they didn't understand. At that time, the West Coast had vibrant wholesale electric markets; in fact, it had had them since 1980 or so. California had ample supplies of electricity at modestly higher-than-average rates that were stable or declining. Nonetheless, the governor at the time thought it would be a good idea to refinance the nuclear debt with cheaper public debt in order to reduce rates still further, particularly to industrial customers. A political deal was therefore formulated and was then sweetened with enough consumer and environmental goodies to get the deal through the Legislature. The sales pitch had to do with customer choice and competition, but both were soon sacrificed—an early casualty of the negotiations.

Contradictory promises were overlooked. Some of my colleagues and I pointed out, starting in 1994, that it was inconsistent to say on the one hand that prices will definitely go down, and on the other hand that there's no need to worry about nobody's looking after the portfolio function (making sure there's enough supply) because if there's a shortage, prices will go up so that people will know to use less or build more.

As restructuring unfolded, the utilities behaved in a less intelligent way than the traders—very smart MBAs and PhDs. The causes and solutions of the resulting mess have been appallingly misreported, more than for any other energy story I can remember, thus reinforcing dumb agendas at both ends of the country. However, the actual causes of what happened are quite complex and interactive. To follow the tale, I'm going to quote a few numbers in "gigawatts" (GW)—a billion watts or a million kilowatts or a thousand megawatts. It's a lot of power—about

enough to run the City of San Francisco. The statewide maximum or "peak" demand for electricity in recent years has been running just over 50 GW.

Let me ask a simple question that hasn't seemed to have occurred to everybody yet. The California electricity system cheerfully met a 53-GW peak load in the summer of 1999. It then crashed at a 29-GW peak load in January 2001. How on earth could that happen? Did half the power plants that had met the load two summers earlier just disappear somehow? Well, no, they were still there.

To be sure, a hydro drought in the Northwest reduced supply by up to 4–5 GW. Some plants were offline for maintenance, but nowhere near enough to account for a 20-GW difference—or nearly half the system is suddenly disappearing. Well, it didn't disappear. There was enough *capacity*, but for some reason not enough *electricity*. So what happened?

Let's start with what *didn't* happen.

We are told that the cause of a supposed shortage of supply was soaring electricity demand. Looking at the published data, one can't find any such thing, because it didn't happen. From 1990 through 1999, the average growth of electricity use in California was 1.15% a year, only half as fast as the State's economy grew. In fact, the only thing you might consider a little odd was in the year 2000, when the usage went up about 4 1/2%, although the peak load went down 4 1/2%. But really, nothing very unusual was happening in 2000 either. It was a hot year. It was also a leap year, with an extra day's worth of consumption. Most importantly, the State's economy grew almost 9%. So demand didn't really soar, and through the 1990s, it grew only half a percent more in Silicon Valley than it did in the rest of the State. So what's going on here?

We're told the culprit is really huge electricity demand growth from the Internet. This is a fiction created by the coal lobby to try to convince us that a prosperous digital economy requires the burning of more coal. They disseminated the deliberate lie that the Internet uses 8–13%, and will soon use 50%, of U.S. electricity. This lie has been so widely repeated that many people believe it. Actually, all the digital equipment—computers, routers, servers, etc.—plus all telephone switchgear, plus all the other office equipment that has nothing to do with the Internet, like photocopiers, plus all the energy to make all that stuff, totals only 3% of electricity use in the U.S. Server farms—the data centers we've heard so much about—use no more than 1.6% of Bay Area and 0.12% of U.S. electricity. There is no evidence that electricity demand is going up because of the Internet. In fact, there is some evidence it may be going *down* because of the Internet, due to the structural changes that the Internet brings in the economy. The myth of important Internet-driven growth in electricity demand has been decisively rebutted by Lawrence Berkeley National Laboratory (http://enduse.lbl.gov/Projects/Infotech.html) and by others.

There is also the myth that California built no power plants in the 1990s. Actually, in the 1990s California added power plants that generated at least 4 1/2 GW—a little more than the State's nuclear capacity. But essentially all of that new capacity was non-utility and decentralized units, typically tens of megawatts each, so to many it was invisible.

The new version of this myth is that California built no *major* power plants in the 1990s. If "major" means many, many hundreds of megawatts, that's true. The reason nobody built them is that they made no economic sense. However, a megawatt is a megawatt, whether it's made at a big plant or a small plant. Small plants were built instead because they were cheaper, faster, more reliable, and less risky.

There weren't any environmental or siting constraints that prevented people from building power plants of any size in California in the 1990s, but nobody wanted to build big plants. For about four years, nobody applied to build any big plants. After that, smaller proposals were submitted and duly approved. I'm not saying it's easy to site power plants—or anything else—in California, but it can be done, and companies did it and got their applications approved.

There's a further myth of a "desperate fuel shortage," exacerbated by White House statements that "We're running out of energy," in an effort to conflate California electricity with supposed national oil shortages. Well, that doesn't hold up. Less than one percent of California's electricity is made from oil. Nationally, it is two or three percent. There is essentially no connection between electricity and oil.

In fact, neither California nor the nation is even short of generating capacity. But in California, we had something unique: a singularly botched restructuring in which there was competition to generate, albeit very bad competition; no price signal to users (except San Diego businesses); and no bid competition by efficiency. You could compete on supplying—on making—electricity, but not on saving it.

Moreover, after careful study, ten eminent economists recently found that there was excessively concentrated market power. Half of what was supposed to be the competitive bidding space was actually pre-filled by plants that had to run or power that had to be taken. Of the remaining space that truly was open to competition, just seven companies controlled two-thirds of it, so each of them *by itself* could move the market. It didn't take them long to figure that out.

Under the nutty bidding system that had been set up, they found that through strategic bidding, they would actually make a lot more profit (which is the business they're in) by selling *less* electricity at a *higher* price, rather than more electricity at a lower price as had been promised. So for about a year starting in late summer 2000, 10–15 GW of generating capacity was calling in sick. It's rather like when an employee calls in sick—you can't tell for sure if they really are sick. Anybody who runs a power plant and wants not to operate it on a given day can easily find twenty good reasons not to run it. Willful withholding of supply is therefore hard to prove. Nor am I suggesting that any collusion occurred between these or other companies. Probably none occurred. None was necessary. In fact, so many bidding data got published that the suppliers could do what might be called "virtual collusion": they had all the information they needed to act *as if* they were colluding. And even without the data, just by their own behavior, they could each move the market all by themselves.

When these power plants started calling in sick, it became obvious that something odd was going on. The so-called "forced outage rate"—how much of the time the plant is unexpectedly not

operating due to maintenance or other reasons—went up by at least two- or threefold, and in some cases much more, compared to when the utilities had owned the same plants. Granted, many of these were old plants being run hard, possibly contributing to more frequent breakdowns. However, it really does look like rational profit maximization.

It appears that both statewide and in the Western regional power pool level, there's been adequate capacity at historic forced outage rates throughout all of California's power emergencies. But much of it was systematically offline because the bidding system and market structure rewarded gaming the market. It was a ticket-scalper's paradise, and we built it ourselves.

As a measure of how wrong things went, from December 1999 (when we had normal prices) to December 2000, the Independent System Operator (ISO) reported that load increased by 0.7%, hardly at all. Monthly peak load decreased 1.9%—also not much. So there was not much change. Yet the wholesale price of electricity went up *thirteen-fold*, and the price of what's called "spinning reserve"—power instantly available to back up anything that fails—went up *120-fold*.

A clue may help us understand what happened: little or none of this price volatility existed for most of 2000 in sixteen other states and provinces—nor in the California municipal utilities, like Los Angeles and Sacramento—that did not do this sort of restructuring. Yet they shared all the same power plants in the same regional power pool. Doesn't that tell us something?

There were lots of other things going wrong as well. Governor Wilson's PUC thought it would be a good idea to make the utilities buy almost all of their power on the spot market. They were severely restricted in long-term contracts, which had always been their mainstay. Indeed, utilities didn't take advantage of the few opportunities they *were* offered to buy anything long-term. Because their retail rates were frozen—and still are despite surcharges— they got squeezed when wholesale rates went through the roof. They had hoped rates would go down, so they could benefit by pocketing some of the difference due to regulatory lag. But instead, they got squeezed the other way, so they became insolvent. The bad credit of the two biggest utilities, Pacific Gas and Electric Company and Southern California Edison Company, then restricted their supply even more. They started getting charged risk premia, and they stopped paying their suppliers, including the independent generators. Consequently, about a tenth of the supply in the State got lost because the nonutility generators weren't being paid, so they couldn't buy gas or pay their employees and lenders. Some anti-competitive practices also took a bite out of supplies.

Another part of the mess was what you might call public policy malpractice. The previous Public Utility Commissioners had delegated the portfolio management function from utilities to customers. (Portfolio managers' responsibility is to buy enough supply to ensure that the lights stay on and there's a prudently diverse mix of sources.) Customers were deemed free to buy whatever financial hedges they wished in order to protect themselves from price volatility. The genius of the marketplace would reveal all. It sure did.

An ISO was put in charge of all of these arrangements, and although it tried valiantly, I think it is fair to say that it wasn't equal to the task. It didn't have control over dispatching some of the

independent generators and other resources crucial to the system. It appears not to have been fully dispatching all the resources available. It has been charged with creating scarcity in the midst of abundance. One analyst believes that if the California power plants were notionally transported across the Oregon border, their output would increase 30–50 % because they would be run in a more effective way. The Independent System Operator isn't really "independent" as its name implies. Many of the generating companies actually sit on its board. There's not much transparency either. Many data are kept secret, hampering analyses vital for detecting and diagnosing any market failures, yet the ISO publishes data that should be kept secret to ensure real competition. These arrangements are rather odd.

By now, the ISO and Southern California Edison are insolvent; PG&E and the Power Exchange are bankrupt. The financial future of the State is clouded. This was all a disaster designed by a committee.

To make matters far worse, the Federal Energy Regulatory Commission (FERC) has had the duty, since at least 1935, of ensuring that wholesale electric prices nationwide are "just and reasonable" but in the midst of this crisis, FERC radically abdicated that responsibility, and decided that whatever the market will bear—or very close to it—is just and reasonable by definition. I don't think it occurred to any of the architects of this system that ignoring a clear legal duty with sixty years of precedent behind it would ever occur. It's now starting to be fixed somewhat, but with very limited scope and retroactivity. There's a long way to go to return to what Congress undoubtedly had in mind when drafting the Federal Power Act**.**

Other, deeper causes lie behind the mess. In the mid-1990s, there was a serious loss of momentum in what had been world-class programs to save electricity and money in California. Californians saved one-fifth of their total load—10 GW—by the early 1990s, and hence many, many billions of dollars in costs for power plants that didn't have to be built. Restructuring, however, derailed all this. The utilities slashed their budgets for efficiency and lost most of the savings that they had planned and hoped to achieve.

Another important thing went wrong in 1996: The Legislature—without, I think, entirely understanding what it was doing—reversed a previously very successful system that had rewarded the distribution utilities for cutting your bill, not for selling you more energy. Since January 1998, we've had the opposite system in effect. The distribution utilities are now, as in the old days, rewarded for selling more energy and penalized for cutting your bill. We're rewarding the opposite of what we want. The Legislature started to fix that only on 11 April 2001, although the repairs are not yet implemented. I hope that will happen quickly.

Then FERC made another boo-boo in 1995: it canceled 1.4 GW of well-bid, clean generating capacity urged by environmentalists. The utilities said they wouldn't need the power, and FERC believed them. We ended up paying $90 million for power that was never actually created because we were ordered to cancel it.

California generators, as I mentioned, chose not to build major new power plants, although they could have, and the California Energy Commission (CEC) has dutifully kept on licensing power plants through the 1990s. It has licensed over 6 GW since April 1999, with at least 7-odd more

GW poised to follow. But, we had a record hydro drought in the Northwest, losing initially 5 GW of supply that would normally be seasonally traded with California. Some transmission bottlenecks also limited power flows.

Moreover, power reserves were tightening in the regional pool because sixteen other states and provinces that shared the same capacity did little or nothing on the demand side, despite very rapid population and economic growth in the sprawling slurbs of Phoenix, Albuquerque, Las Vegas, and the Front Range of Colorado. California, which is two-fifths of the pool's load, provided only 15% of its peak load growth in the second half of the 1990s. Ten other Western states, like Nevada and Arizona, averaged over twice California's growth rate in electricity usage. The typical Las Vegas house was so inefficiently designed that it ended up using two or three times the annual electricity of a typical Bay Area house. Therefore California, being the biggest net importer, suffered the most price volatility as the regional pool's reserves tightened.

Meanwhile, trading in nitrogen oxide reductions, which was initially a good idea, worked well. However, it appears that somebody then started gaming that market too, which temporarily drove the price through the roof, creating a huge leverage on electricity prices.

Additionally, as long as the utilities owned the fossil-fueled power plants, they had done systematic maintenance because they had a strong incentive to keep the plants running for use when needed. But when the utilities were forced (or at least very strongly encouraged) by regulators to sell those plants to private operators, and then their maintenance contracts expired a couple of years later in Fall 2000, the new managers had no incentive against outages. Quite the contrary—if half their plants' capacity were out of service, they would make more money that way. Funny thing: that seems to be just what happened.

There's more. Last winter, natural gas prices spiked sky-high, in part because southern California has always had to store gas for winter, but botched restructuring of the *gas* market destroyed the incentive for anybody to store gas. Storage went down 89%. On top of that, five percent of pipeline capacity was lost in a pipeline explosion, and southern California had a cold winter**.** All these things happened simultaneously. Litigation charging that a major gas provider actually manipulated capacity to boost the price further is now in the courts.

The gas-fired generators—even if they'd bought hedges against gas prices going up—passed the gas prices through in their electric rates anyhow. As Southern California gas prices zoomed, electric rates followed suit, contributing to the price spikes in electricity because about one-third of California's electricity is gas-fired. However, much bigger increases in electric prices occurred than the rise in the price of gas could account for. To complicate matters further, some power producers also produce or distribute gas.

Finally, "Green power marketers" had brought real choice to California customers. Most customers who switched suppliers actually did so to get these environmentally benign supplies, which, by the way, are generated at a constant cost because the "God Utility" never raises the price of wind and sun. But that constant-cost attribute never benefited those who were responsible for producing it. And the Legislature has been busily putting the green power marketers out of business, which I don't think is either fair or intentional, but it's happening. The

utilities don't mind because it eliminates their monopolies' most successful competitors.

In short, the market performed brilliantly. The actors followed exactly the incentives they were given. Nobody looked after the public interest. Cascading policy failures made it far worse. The political motivations of many parties continue to distort choices and decisions. The principle of "best buys first" or "least-cost investments" got abandoned early. Customer choice and competition have been shrinking. The result has been the biggest interstate wealth transfer in U.S. history. In April, I was told on good authority that the State had spent more on electricity in the first six weeks of 2001 than in all of 1999.

However, things are getting better. Starting in early June 2001, electricity prices suddenly fell again for a lot of reasons, including increased capacity. Five GW came back from real or imagined maintenance outages. A couple of GW of supply got added, with more on the way. About 5 GW of independent power that had been off because the producers weren't getting paid by the insolvent utilities came back on when the debts were settled. The Bonneville Power Administration (BPA) freed up a couple of gigawatts in the Northwest by paying smelters to shut down, which actually saved money for everybody. Customers were heroes: they saved about 5 GW, even before the big price increases hit. And the State signed up long-term power contracts that greatly diluted the volatile spot market. All these things together put out the fire. Meanwhile, gas prices, which had peaked at $60 per million BTU in December, suddenly dropped to $12 at the end of May. Just then, a certain very controversial gas supply contract expired; and within days, the price continued to fall to $7 and then to $3.50, essentially what it was in the rest of the country. Funny thing.

Electric savings accelerated further in June. In the first half of 2001, Californians cut their weather-corrected electric energy use by 10% and their peak load by 12%. Per dollar of Gross State Product, electric energy use went down 12%, while peak load declined by 14%. In half a year, Californians reversed five or ten years of previous load growth—a stunning result. We don't yet know how much of that is permanent technical change and how much is temporary behavioral change. Yet it happened before the big price increases hit, and before many of the electricity-saving programs that the State has put into high gear this year were fully revved up. They're just gaining traction over the summer, so I think we're going to see a lot more savings. Meanwhile, the supply picture is improving. There are helpful political shifts beginning in Washington. Naturally, hot weather and equipment failures remain an ever-present possibility, but the current focus is shifting toward long-term financial stabilization.

So where do we go from here? Many solutions and non-solutions are being pursued vigorously. Some of them will work. We may have too many of them. We may already be in overshoot. Despite vigorous current demand-side efforts, we're still underinvesting in efficiency compared with investment in supply, which is not nearly as good a buy. Regardless, we can be quite sure the lawyers will get rich anyway fighting over the spoils. There are questions about whether California debt will remain investment-grade. The politics are complex, volatile, and national. Quite rightly, the producers are running scared: the politics are getting extremely unpleasant. It may be a watershed for reviving decentralized and public power.

There may be ways to pay off early the obligations incurred to put out the fire. For example,

efficiency is still a lot cheaper—and these days is very much cheaper—than buying supply. We may be able to take those savings and use some of them to lower rates and to prepay the debt, much like prepaying a home mortgage to avoid the buildup of interest payments. That could get us out of this mess and make it a memory a bit sooner.

We need to think carefully about how to diffuse excess market power. If the same firms that now occupy Boardwalk and Park Place continue to build more capacity, as they're doing, won't that just increase further their already excessive market power and their ability to withhold supply, which they'll have no less reason to exercise? We need diversified ownership and scale of what's being built, or we may make matters worse.

We certainly need full and fair competition on both the supply side *and* the demand side, so that power-plant owners have an incentive to operate their capacity, not hoard it, and so that saving electricity can compete fairly with making more of it.

There are many structural solutions to excess market power. They are all complicated technically, they're all difficult politically, and they're all uncertain of success. We therefore need an additional track of activities, which the State and customers deserve a lot of credit for launching in recent months. It's a complementary approach that doesn't depend on those structurally and politically difficult solutions, but rather relies mainly on the things that are cheapest and fastest, namely electric savings and distributed generation, to shift the psychology from a seller's market to a buyer's market.

Distributed renewable generation and demand-side management (DSM) added over 15 GW to California's supply-demand balance by 2000 and another seven in the first half of 2001. Noticing this will minimize the next financial risk, which is supply overshoot. A prominent economist recently wrote me that in a few years we may well have bankrupt Texas independent power producers and start the cycle all over again.

Cities like San Francisco have a great opportunity to define a model "best buys first" public utility that integrates efficiency, renewables, fuel cells, and other decentralized generation to make its system more reliable. All these options are very important when you have just a few ways to get power into the city, as San Francisco does. Community savings of electricity can then be aggregated, redistributed, and resold. The utility can make vibrant markets in "negawatts"—saved electricity—and ensure that they can compete in supply bidding. California could even decide to buy savings in other states, for example, by fixing up houses in Las Vegas. We also need to fix the broken gas market. Although gas storage is increasing, that market is still broken. And we need to emphasize community initiatives and bottom-up savings, which, as we've just discovered the past six months, can be incredibly powerful, and can be linked to the local motivation for economic development.

We can price in a way that allows customers to know real-time prices and respond to them if desired. This is already starting to happen. In California and throughout the West, we can apply the findings of "ACT^2," an important Pacific Gas and Electric study in which I participated and which showed that most of the electricity in old and new buildings can be saved cost-effectively

to the utility and attractively to the customer. We can mobilize developers and investors around optimal design of buildings and data centers.

There's a lot more we could be doing, but I want to end with some basic questions. In the short run, it's worth on the order of a hundred times as much to avoid the lights going out as it costs to make electricity. Therefore, if we base the price of electricity on the *value* of keeping the lights on, rather than the *cost* of doing so, we have to be prepared, whenever supply gets tight, for producers to raise the price a hundredfold—which is what they just did. Do we really want that? When that happens, we end up doing long-term contracts to get out of the mess, and that can turn short-term into long-term profits. But little of those profits gets invested in electric supply in California. Don't the resulting losses to our economy dwarf the claimed inefficiencies of a well-regulated monopoly? If, as New York has just discovered, twice as much reserve margin is needed to maintain real competition in an open supply market, doesn't that cost something? So why are we doing this in the first place? It makes the old system look relatively efficient.

And why are we trying to get competition at the *retail* level? Essentially all the same benefits are already captured when you get competition at the *wholesale* level. You can only get the benefits once.

Do we really believe in a least-cost portfolio of resources of all kinds—buying the cheapest things first to provide the hot showers and cold beer? Or will we continue to slight the demand side and invest mainly in supply?

Will we continue to bail out the worst buys?

And why do we tolerate such poor reportage of such important issues?

Let's think about a sobering saga. This may sound like a fairytale, but it actually happened. In 1984, California had a peak load of just 37 GW, compared to 53 lately. It had committed 12 GW of savings and was buying another 7 GW. It had bought 13 GW of alternative, independent power production, and was negotiating for another 8 GW. New offers from independent power producers were coming in at a rate of 9 GW, equivalent to a quarter of total peak demand, *per year*. Then the Public Utilities Commission (PUC) slammed on the brakes in April 1985 and said, "Wait a minute—we've got too much already!" If those offers and acceptances had continued through 1985, they would have displaced all 27 GW of thermal power plants in California (which might have been a good thing in hindsight). This transition from scarcity to glut *took only two years* (the key point to remember), because you had slow variables—big, clunky power-plant projects—competing with fast ones, namely savings.

Nowadays, we have more powerful ways to save, and more powerful ways to deliver the savings to customers. We have a better understanding of what the obstacles are and how to overcome them. Now we also have new supply-side resources: micro-turbines, and increasingly, we are going to get cheap fuel cells and cheap solar cells. Now, we also have cheap wind turbines—the cheapest power supply in the country, installable at rates of megawatts a day. So now speed is becoming available on the supply side that previously was available only on the demand side.

If you mix all this together, you have an almighty trainwreck. California had it in the mid-1980s; so did the United States. We had an Administration come into office that didn't know about efficiency and didn't think it was happening. The White House stimulated supply like mad, and guess what, they got both: they got the supply expansions without the demand and the revenue to pay for them, so a lot of producers went broke when the price crashed in 1985–86. Now, it seems, we have an Administration that is quite prepared to repeat the same experiment. I don't see why we should expect a different result. This was a very bad movie. We don't need to see it all over again.

However, I think the genius of the marketplace in a funny way, despite the institutional mess, is starting to reassert itself. Customers are figuring out—and they will figure out more and more—that it is a lot cheaper to save electricity than to produce or buy it. I think that will be our salvation, as long as we don't draw the wrong conclusions and don't assume that any kind of supply at any price is also going to be necessary. Otherwise, we will have exacerbated the historic boom-bust patterns and will have foregone many of the benefits that can come from choosing the best buys first.

I hope that will stimulate a good discussion. Thank you for your kind attention.

Chair (Holly Wells): We have a lot of questions, so I'm just going to get to them. The first is, "Why did deregulation of the telephone industry work and deregulation of public utilities fail? Or did deregulation of the phone industry really work?"

Lovins: Well, whenever I can't get accurate directory-inquiries responses, or I can't figure out how to dial a call, I wonder whether it worked. Or when I get telemarketing calls at dinnertime from somebody who wants to make me an offer I can't understand, I don't know whether it worked. But however you think it worked, or however you think other kinds of so-called deregulation worked, I think it's important to understand that it isn't anything like the electricity industry. We didn't deregulate electricity; we simply transferred jurisdiction from Sacramento or San Francisco, for example, to Washington, which then dropped the ball. And for a number of key reasons, telephony and other restructured industries aren't much like the electricity business. Electricity is unlike any other commodity. It is absolutely crucial to modern life. If it falters for an instant, everybody notices. You could say its value approaches the value of Gross Domestic Product because without it, not much gets produced. It can't be conveniently stored in bulk; that may change as technology evolves, but right now, it's not like other commodities that can be stockpiled. You need to create it at the instant in which it is used, in perfect synchrony across a continent. Electricity is unlike anything else, and I think a lot of economic theorists didn't understand that.

Q: Californians have cut power consumption by 14%. Can this be sustained? How significant is this cutback? What is the ceiling on how much of a cutback we can accomplish?

Lovins: We don't know how much of it is permanent, but I think it's fair to say we have barely scratched the surface of how much saving is available and worthwhile. Even in a state that ranked essentially last in the country in per-capita electricity consumption *before* the recent burst of savings, there is so much *more* to be saved that as an efficiency practitioner, I practically have to wipe off the drool whenever I visit buildings and factories, because there are such juicy

opportunities that the low-hanging fruit is still mushing up around the ankles.

The limits of savings are extremely large. We don't know what they are yet. But having led probably the most detailed analyses of these questions anywhere—which are now on a two-and-a-half-meter-wide bookshelf—I can tell you that at least three-quarters of U.S. electricity can be saved at less than the cost of making it in existing thermal power plants, and we would get the same or usually better services as a result. My own household electric bill, in case you were wondering, is about $5 a month for 4,000 square feet. That paid for itself in ten months, using 1983 technology. As part of that payback, we also save 99% of the space- and water-heating energy and half the water. Today's technologies are a lot better than that.

Q: Could green energy provide all of America's and/or all of the world's energy needs and demands? What are the roadblocks?

Lovins: Five National Labs that have studied this question came up with a resounding "Yes." Royal Dutch/Shell Group—the giant energy firm—concluded some years ago that it is very plausible, even likely, that half the world's energy could be renewable in fifty years. It does take decades to make such big changes in a massive ten-trillion-dollar system, but it is happening inexorably as renewables become more competitive. As a small example, windpower worldwide, which was about 18 1/2 GW at the end 2000, has lately been adding 5 GW a year, which is more than the 3 GW a year that nuclear power added worldwide through the 1990s. Windpower is starting to become quite a significant resource. It's not even limited by convenient sites on land: there's more wind offshore, and Denmark, which is one-sixth wind-powered, is finding that actually it is just about as cheap to put wind turbines offshore (where you can't see them) as onshore. So yes, it's perfectly plausible to run the country—or the world—on renewables. The key to doing that is to use electricity in a way that saves money.

Q: How would you spend one billion dollars in California government funding to support clean energy now? Governor Gray Davis will announce such a subsidy on August 15 and needs advice on what programs to support. Do workforce training and manufacturing need support?

Lovins: Many things need support, and those are two of them. I would actually put some emphasis not just on paying for people to do things, but on what you might call "barrier-busting." For example, in "Climate, Making Sense *and* Making Money" (www.rmi.org/images/other/C-ClimateMSMM.pdf), a paper targeted for CEOs, Hunter Lovins and I identified 60–80 specific obstacles to buying energy efficiency, and showed how to turn each one into a business opportunity. This requires some tweaks in both private-sector and public policy, such as rewarding what we want, not the opposite, and like paying architects and engineers for what they save, not what they spend. What a novel idea—rewarding what we want! Well, it actually works. We've tried five experiments with it. It is also terribly important to do the same for our public utilities, such as are left: we still reward them for selling more energy and penalize them for cutting our bills. Let's get those things straight.

Sure, there are many, very effective ways to spend money for technology. I would also like to emphasize that even the costliest renewable technology—photovoltaics (solar cells)—has been brought down to quite reasonable prices, competitive now for example with nuclear power, by initiatives at the Sacramento Municipal Utility District. Ed Smeloff, architect of that policy, is sitting here and is the new energy czar of San Francisco. Their policy was brilliant and worked

well. They simply put out competitive bids year-by-year to buy solar equipment in bulk, put it on the roof, and pay less and less every year. Prices have been coming down and will continue to do so. We can see five cents per kilowatt-hour clearly in prospect in high volume from existing technology. If you want to buy down photovoltaics to that sort of price, you can just buy as much technology as you would if it were already cheap, because when you buy that much of it, it gets that cheap, so you should have bought it. So let's do it.

Q: What is your opinion about the safety of nuclear power plants?

Lovins: You don't need to ask me; you can ask the insurance industry, which is our society's specialist on risk. They refuse to insure it. It's actually a rather apt question because in August 2002 the Price-Anderson Act will expire unless renewed by Congress. According to this law, nobody is responsible for damage from major nuclear accidents above a certain ceiling. The ceiling is somewhere around nine billion dollars, which would be a drop in the bucket for a big accident.

What does that tell you? That this industry, which we are told is safe and mature, is unwilling to accept for itself the risks it is willing to impose on the rest of us. This doesn't sound to me like it has much to do with free markets. I happen to like free markets very much. I think one of the things they tell us is that if you hold people harmless for their accidents, they may operate less safely, and if you give them a subsidy, people will buy more of their product than they would have if they'd known what it actually costs. So I think the renewal fight coming up in Congress actually puts people who favor both nuclear power *and* free markets in a very awkward position, and rightly so.

However, I would also add that whether nuclear power is safe, whether it spreads bombs, and whether we know what to do with the waste are not very relevant questions, because the technology is unnecessary and uneconomic in the first place, so we don't need to argue about whether it is safe. There are at least three major competitors that knock it right out of the ring, namely the efficient use of electricity; very efficient combined-heat-and-power production onsite—whether at an industrial or single building scale—from constant-price natural gas; and windpower. Any one of those three is enough to replace nuclear power in quantity, but could do so much faster, cheaper, and without its risks. Soon fuel cells will be joining those three, combined with a climate-safe hydrogen economy, and so will solar cells at an affordable price. It only takes one competitor to make nuclear power unviable. We've already got three; we'll soon have five. Nuclear power, therefore, is one of those future technologies whose time has passed. My sympathies to those who want to revive it. I'm sure their intentions are good. But this technology already died of an incurable attack of market forces.

Q: Can you speak to the advantages and disadvantages of public municipal power versus investor-owned utilities?

Lovins: I've worked for both publicly and privately owned utilities for several decades, and I've run into very good and very bad utilities in both categories. I gradually concluded that actually what matters is not so much the form of ownership as the vitality of the political or market process that makes the utility responsive to its customers and other stakeholders. That said, our recent experience with the bandit capitalism approach to utilities—which takes us back about a hundred years, before we had regulation to protect the public interest—has not been a very happy

one on the whole. I think this has rightly led to a resurgence of interest in public power. Cities like San Francisco may indeed re-emerge as the beacons of how to run utilities properly.

Certainly, the Sacramento Muni has set a splendid example. They actually had a nuclear plant shut down by popular vote, although it was operating—not very well, which I think is why people wanted to shut it down; continuing to run the nuclear plant was a bad deal, and some of them were nervous about it. SMUD then bought a portfolio of resources emphasizing efficiency and renewables, and they're in terrific shape now. They're very popular, and I think everybody is happy about the results. That's an interesting example of what a politically accountable and transparent public utility can do. Now, a politically accountable and transparent *private* utility could do the same thing. However, as long as we keep messing with the rules to create this sort of ticket-scalper's paradise, I think it will be a lot more risky for all of us to rely on a monoculture of just one kind of utility. Even if we're sure that private utilities are the way to go—and they can be if they are run right—we still have to reward what we want: reliable service that is environmentally and socially sound, at least cost. That isn't what we've been rewarding lately.

After a thorough study of the issue, California economist Severin Borenstein remarked that it's odd that the Federal regulators "don't seem to realize that these companies are in business to make as much money as possible for their shareholders. That's what they do for a living." Well, I have no problem at all with profits honestly made, and I work mainly for the private sector, but if you have a combination of the profit motive, which is basically a good one, and botched restructuring that rewards antisocial results, then you get what you would expect. It's not where we want to go.

Q: Governor Davis says power suppliers owe the State nine billion dollars. The administrative law judge says about 1 billion. What's the cause for the difference?

Lovins: It depends on whose interests one is representing—those of the customers in the State of California or those of the producers that don't want to pay back overcharges as the State views them. Actually, if you look at the letter that ten eminent, independent, and bipartisan economists sent to President Bush on May 29th, I think you will indeed find that there has not been a properly functioning competitive market for electricity in California. The clear implication of their findings is that more was charged than would have been charged under the competitive conditions that legally must exist in order not to have direct Federal regulation of prices to ensure that the wholesale price is just and reasonable. That duty never went away. FERC simply decided not to take it seriously. I think they are now taking it more seriously, and I hope that one way or another, either FERC or the courts will enforce the law.

Q: Who do you believe is the greatest single villain in California's energy crisis?

Lovins: That's a tough one. There is plenty of blame to go around, and no doubt the lawyers will allocate it one way or another. I think it is more interesting to ask where we go from here. I can tell you the villain was not greedy consumers. In fact, consumers have done awfully well in responding over the past six months, and I think we will do even better as we get better organized to capture some of those opportunities to get our energy services at least cost.

I'd really rather not talk about blame. It will be figured out by the political and legal system.

Doubtless the villains will get rewarded and the heroes will get punished in the usual fashion.

Q: Do you think there will be serious economic and social impacts from this crisis for the rest of the country or even the globe? If so, what might these be?

Lovins: It's already economically serious for Californians. It may become so for other places if the same mistakes are made. I would like to think that nobody could possibly—no matter how hard they tried—reproduce the same constellation of mistakes, but there may be different ones: there's no point repeating the same dumb mistakes somebody else made when you can make interesting new mistakes.

It actually cuts both ways: the bad experience with the way California did the restructuring—combined with all the malfeasance I mentioned in other places—has also limited interest by other states and countries in doing the kinds of competitive reforms that could actually be useful. This reaction is tending to reinforce entrenched monopolies that try to exclude innovation and competition, and that is not a good thing either. Peter Bradford—a former Nuclear Regulatory Commissioner and head of the utility commissions in Maine and New York—recently made a very wise suggestion. He said that after the Three Mile Island meltdown, we formed the Kemeny Commission, a group of eminent, disinterested, smart people, to figure out what happened so we could learn from it and not make those mistakes again. Why don't we do that with California electricity? I think such initiatives are underway. That's a good thing. Except this time, unlike the Kemeny Report, let's really take the lesson seriously.

Q: How can the principles of *Natural Capitalism* be applied to the California power situation?

Lovins: For those of you that haven't read *Natural Capitalism*, you can find the book—and even download it for free, if you like—at www.natcap.org. It's about a new way of doing business as if nature and people were properly valued. It starts with radically improved resource productivity. It's already been proven, for example, that you can build houses that don't need heating or cooling to keep you comfortable in climates ranging between –47°F and 115°F. It also costs less to build them that way, and they are more comfortable to live in. So why not? We know how to save three-quarters or more of the energy used in cooling; actually, our record is a 97% reduction in air conditioning in a California office. We know how to save about half the energy used in motors. The list goes on and on. Radical resource productivity, in a way we call "tunneling through the cost barrier," can actually make very large energy savings cost *less* than small or no savings. The book explains how.

We can also do closed-loop, nontoxic production with no waste. If we don't waste things, we don't need to waste the energy and materials that go into making them, and we make more money by turning waste into profit. We can adopt a business model that rewards both of those outcomes. We can also reinvest in natural capital and in human capital—reinvesting in healthy nature and healthy communities. After all, people and nature are the two most valuable forms of capital, even though industrial capitalism didn't take account of them: it only counted money and goods. But to be a good capitalist—that is, to productively use and reinvest in capital, which is what capitalism is supposed to be about—you have to use all four kinds of capital: not just money and goods, but also nature and people. It turns out that if you do that, you make a lot more money, you have happier workers and happier customers, and you gain a stunning

competitive advantage. The book offers hundreds of examples of that; and it has everything to do with the California and national energy situations. If we take economics seriously, we will end up making energy problems irrelevant. They will become energy opportunities for a safer and more secure world, a better life, and a healthier economy.

Q: I want to put a solar system on my house to provide electric power. Is this practical? How much will it cost? Do you anticipate that my neighbors will also want solar?

Lovins: It is practical, and it can be very worthwhile, particularly with the big rebates you can now get from the State of California. Yes, I think more and more of your neighbors will want it. I've been doing this for about twelve years at our house. (By the way, when I said that our electric bill is five dollars a month for our household, that's assuming that we bought all the electricity. In fact, we make about five or six times that much and sell the rest back to the utility at the same price. It's called "net metering," and you can do it in about thirty-four states now.) It's kind of fun when the hundred-year flood knocks down the power poles by the river, and you're able to call up the emergency services and say, "Hey, want to come recharge your walkie-talkie batteries? Come on over, we've got juice."

Q: OK, this is our last question. What can I do right now to help with this problem? What can we all do?

Lovins: Inform yourself about how to use electricity more efficiently and more effectively to get you more and better services with less electricity, less money, more brains, and better technology. There are many information sources about how to do that. The State of California is offering a lot of good advice. You're going to find more and more information popping up at the local community level. Spread the word. Find the people who are doing it best; follow their example; set a good example for everybody else; and we will soon be looking back on this problem as if it had never happened, wondering what all the fuss was about.