POWER LUNCH

BY MARILYN BERLIN SNELL

When Vice President Dick Cheney and his National Energy Policy Development Group met last year, they were supposed to come up with a plan that would best serve the country. Instead, Cheney's task force, made up exclusively of energy-industry executives and lobbyists, sought massive subsidies for the oil, gas, coal, and nuclear industries; the construction of 1,300 power plants ("More than one new plant per week, every week for twenty years running," said Cheney); and increased drilling and mining on public lands. The only serious attention conservation and renewable energy received was when the Department of Energy tapped those program budgets to pay for printing 10,000 copies of the White House plan.

Asked why the vice president would turn exclusively to people like then–Enron CEO Kenneth Lay for energy advice, Robert Bennett, Enron's attorney, responded: "Where are Mr. Cheney and others supposed to get their information from? The yellow pages?"

There are other voices to be heard, though, and other energy paths. For 30 years, the United States has had the means to meet its energy needs and decrease dependence on Mideast oil without having to drill, dig, and destroy this country's exquisite natural places. So *Sierra* decided to flip through a more diverse Rolodex to put together our own energy task force.

We didn't only talk to environmentalists. We also invited the head of a multinational oil company, a labor leader, an architect, a state policymaker, and a utility executive. And on a wintry day in San Francisco, beneath Ansel Adams photographs of blooming dogwoods and Yosemite Valley, we gathered (several joining by telephone)

PORTRAITS BY ANNE HAMERSKY. BOTTOM: JOE FLORES, SOUTHERN CALIFORNIA EDISON; DOE / NREL

What happens when energy executives sit down with environmentalists?

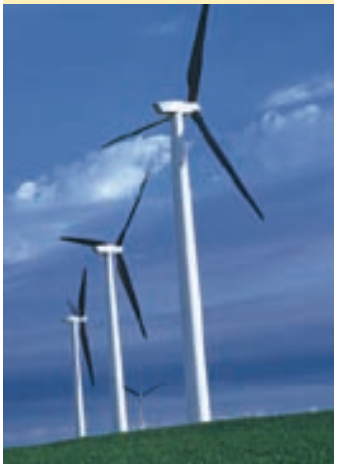
They come up with a plan for the future that leaves fossil fuels to the dinosaurs.

and talked about how we might get past the status quo to implement environmentally positive energy goals.

The group, while more inclusive than Cheney's, was potentially more volatile as well. But instead of sparks between adversaries (which we worried about), there were genuine surprises: a corporate head questioning the sustainability of our consumption-based economy; an environmentalist arguing that growth can be good if we're growing the right things; and the man once responsible for some of our largest nuclear power plants saying that "in this age of terror, we just can't have them."

All agreed, moreover, that the path ahead can and must lead beyond fossil fuels. Even BP's Lord John Browne concurred—though he would not take the bait when the Earth Policy Institute's Lester Brown asked him to finally declare what "BP" stood for these days. (His company had floated the idea in promotional material that the former British Petroleum was now going Beyond Petroleum.) "BP stands for BP," replied a good-natured Browne.

Instead of political gridlock, we found constructive engagement and real surprises. Above left to right: Kurt Yeager, Jane Perkins, Carl Pope, David Freeman, Lester Brown, Yeager, and Freeman. Solar panels track the sun in California (left), and a wind farm rises from the prairie in southwestern Minnesota (below).



Most remarkable was the consensus among participants that a peaceable, sane, and sustainable energy policy is within reach. "In the United States, we have the means to kick the oil habit," says the Electric Power Research Institute's Kurt Yeager. "It's very important to set this as a leadership goal." Or not: "If we like Gulf wars," Yeager also says, "we don't need to do anything."

Despite the fact that much of the Bush administration's plan made its way into House and Senate energy bills, we still have a choice. "Technology isn't what's inhibited our energy

BOTTOM: WARREN GRETZ, DOE / NREL

policy," says the California Power Authority's David Freeman. "It's been pure politics."

All we need is political leadership in Washington with the vision and courage to choose wisely how we light the way ahead. ■

Carl Pope: In "Challenges and Opportunities for the 21st Century," the U.S. Department of Energy published the following statement:

"Our environmental well-being—from improving urban air quality to abating the risk of global warming—requires a mix of energy sources that emits less carbon dioxide and other pollutants than today's mix. Our national security requires secure supplies of oil or alternatives to it. . . . And for reasons of economy, environment, security, and stature as a world power alike, the United States must maintain its leadership in the science and technology of energy supply and use."

Those are admirable words, but the Bush administration's energy plan won't get us there.

We've had recent reminders, both in California, with its energy crisis, and globally, with the terrorist attacks of September 11 and the turmoil in the Middle East, that we should be thinking differently about our energy future, particularly when it comes to our use of fossil fuels. That's why we invited you all here.

David Freeman: I'm intrigued that you quoted from the Department of Energy. As the energy-policy coordinator in both the Johnson and Nixon administrations, I was the first person in the American government with an energy responsibility. Back in the 1960s our energy policy was to pray for mild weather—and that policy hasn't changed. The Appalachian states are still in the hands of the coal people, and politicians still worry about carrying Texas in the next election. The technical solutions are there; they've been there for a long time. Technology isn't what's inhibited our energy policy; it's been pure politics.

We always talk about things that are going to require 25 years and we never begin. Just because it's going to take a long time to do something is all the more reason to start with some urgency. If, after the oil crisis of 1973, we had decided we wanted to pay attention to 19th-century writer Jules Verne, who told us that we were going to eventually get our fuel from water—namely, by separating the water into hydrogen and oxygen—we would probably have a hydrogen economy by now.

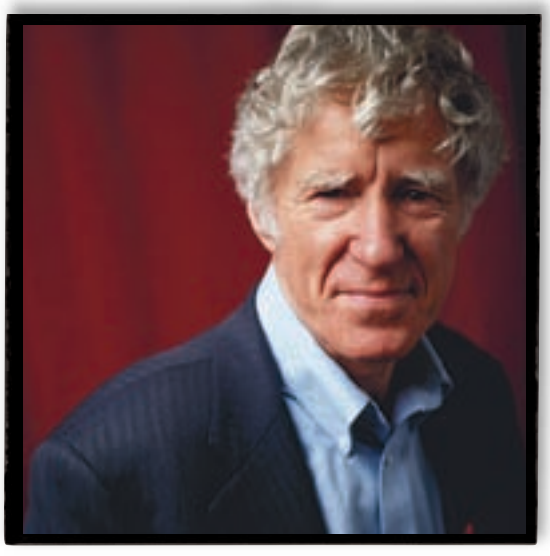
Pope: Kurt, as president of the utility-funded Electric Power Research Institute you sit in the heart of the energy business. From your perspective, how does the world look?

Kurt Yeager: I'd characterize the challenge we face using what the Japanese call the "trilemma" of population, poverty, and pollution. How do we balance those realities on a global basis, in a century when the conjunction of those forces is becoming extremely challenging?

We have to learn how to operate in a world of 10 billion people. But, to a large extent, we're still operating with a hunter-gatherer mentality, particularly in the energy field.

I, too, see the goal in this century being an electricity-hydrogen-energy economy that will make us independent of fossil fuels. The Middle East is the only place in the world where we can get large quantities of oil. As the rest of the world develops we'll all be sucking on that same straw. If we like Gulf wars and all the other issues that are dependent on our addiction to that oil source, then we don't need to do anything. But if that's our choice, I can only see things getting dramatically worse, and creating more and more strains in our relations with other countries. In the United States, we have the means to kick the oil habit, and it's very important for us to set this as a leadership goal.

"North Dakota, Kansas, and Texas have enough harnessable wind energy to satisfy all the nation's electricity needs."



The founder of the Worldwatch Institute, **Lester Brown** is currently president and senior researcher at the Earth Policy Institute. He is the author of numerous books, most recently *Eco-Economy: Building an Economy for the Earth.* (See "Mixed Media," page 69.)

Lester Brown: Unlike some of the rest of you, I'm not an energy expert. But it's clear to me that we have the means to move away from oil and toward renewable energy resources. Over the last several years, there have been two areas of parallel technological progress: wind turbine design and fuel cells. Together, these two technologies are going to provide the basis for restructuring the global energy economy. Fifteen years ago it cost 35 cents to generate a kilowatt-hour of electricity from wind; today, it's down to 4 cents, and the cost is still falling. Wind is now becoming highly competitive.

In 2001, wind-electric generation worldwide increased by 31 percent; in the United States it jumped by a staggering 66 percent. Three of the wind-rich states—North Dakota, Kansas, and Texas—have enough harnessable wind energy to satisfy all the nation's electricity needs. Europe can satisfy its electricity needs from offshore turbines. China can double its electricity from wind alone.

Once you are able to get cheap electricity from wind, you have the option of electrolyzing water and producing

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hydrogen. Hydrogen is the fuel of choice for the fuel-cell engines that every major automobile manufacturer is working on. We're looking at a situation now in the United States where farmers and ranchers in wind-rich states could one day be supplying not only much of the country's electricity but also much of the fuel to run the country's automobiles.

Indeed, the economics of energy begin to overwhelm the economics of agriculture in terms of potential farm income. We already have in Washington very strong bipartisan support for wind, particularly from members of Congress from Great Plains states. These politicians realize that income generated by wind tends to stay in the community. The turbine for which the farmer gets $2,000 in royalties is probably going to generate $100,000 worth of electricity in a year. We're looking at a situation now where, within five years, there will be thousands of ranchers in this country who will be earning far more from electricity sales than from cattle sales.

Pope: John Browne, you run one of the world's largest energy companies. You actually deal with the practical realities of demand. What kind of energy policy do you support?

Lord John Browne: Any sustainable policy first has to make economic sense. Otherwise, it is very difficult to support. Second, it must speak to the quality of life, as Kurt Yeager indicated, with more people on the planet. Third, we need to think about time scales and transitions. How do we get things done in a way that doesn't shock the world financial system, but that achieves an end that is appropriate for the world? Whatever the policy, it must attend to today's problems and recognize that the easiest, most graphic gain will actually come from efficiencies in the current energy system. Fourth, it has to recognize that there is a changing mix of energies. Over the history of energy consumption, use has changed and that won't stop. And fifth, the policy should be determined and enabled by a world commitment to innovation and technology.

We have to start with realism. During the period of this two-hour forum 31,000 people will be born. Population growth is pushing up the demand for energy worldwide by 1 to 2 percent a year. And at present, oil and gas appear to be the only supply sources for this incremental increase in demand. In order to avoid undue dependence on oil and gas—and the attendant economic and social risks—we need to encourage a diversity of supply. This would also, and importantly, reduce the carbon impact of the energy consumed.

William McDonough: I fundamentally agree with Lord Browne that the market has to rule this

> "When you follow nature's laws, growth is good. We can have a fecund economy, and we can have growth that's not something to be terrified of but celebrated."

The founder of William McDonough + Partners, a design and architectural firm dedicated to environmentally intelligent and economically responsible projects, **William McDonough** received the Presidential Award for Sustainable Development in 1996. In 1999, he was named "A Hero for the Planet" by *Time* magazine. He is the author of *Cradle to Cradle: Remaking the Way We Make Things.* (See "Mixed Media," page 69.)

Enlightened design at Oberlin College's Center for Environmental Studies (right and inset) rated William McDonough a place on the American Institute of Architects' top ten list for green design projects this year. The reflecting pond isn't just for looks; it doubles as an organic water-treatment facility.

BOTTOM AND INSET: © BARNEY TAXEL

THE FIRST HYDROGEN NATION

OTHERS TALK. ICELAND KICKS CARBON.

From George W. Bush to Carl Pope, hydrogen is suddenly everyone's favorite fuel of the future. The most common element in the universe, its electrochemical reaction with oxygen can be harnessed to produce electricity, with—ideally—only steam as a byproduct. (For details, see *www.fueleconomy.gov/feg/fuelcell.shtml* or *www.howstuffworks.com/fuel-cell.htm*.)

Hydrogen may first replace carbon in an unlikely venue: the North Atlantic island nation of Iceland. Explosively volcanic, this mountainous country is already blessed with vast renewable energy resources in the form of geothermal and hydro power. The hot showers never run out: 90 percent of buildings are heated geothermally. But hot water can't power a tractor or trawler; largely because of its fishing fleet and metals industry, Iceland is one of the top per capita CO_2 producers in the world.

The solution, says University of Iceland chemistry professor Bragi Árnason, is to capture the island's bountiful renewable energy in the form of hydrogen. "In thirty years," he predicts, "Iceland could be the first country consuming only clean, renewable energy."

Separating hydrogen out of water or other substances is not a technical challenge, but it does take energy. This could be supplied by fossil fuels, of course, but to keep the process totally clean, it has to come from a renewable source—a geothermal plant in Iceland, a wind farm in North Dakota, a solar array in North Africa. Such clean hydrogen is, essentially, transportable renewable energy.

The trick is storing it. Liquid hydrogen isn't very practical, because it has to be maintained at –252 degrees Fahrenheit. As a gas, it has to be kept in bulky pressurized tanks. (Prototype hydrogen cars, whether using fuel cells or internal combustion engines, can presently only store the equivalent of four gallons of gas, although more highly pressurized containers could boost it to ten.) One of hydrogen's drawbacks as an automotive fuel is that it would require an expensive new infrastructure of hydrogen filling-stations.

transition, and the engine of change will be commerce. If we want to change quickly, we need to do really effective commerce. But I see efficiency as having no intrinsic value per se. The question is not "Are we doing it right?" in terms of efficiency, but "Are we doing the right thing?"

Yeager: I, too, believe in market economies, but I question whether technological growth can keep us ahead of the consumption wolf—particularly if you're trying to export a consumption-based economy to the whole world. It seems to me that at some point we need to say enough is enough.

McDonough: From both an economic and environmental point of view, we need to be able to say, "Growth is good." The question is: What do we want to grow? Do we want to grow sickness or health? Do we want to grow intelligence or stupidity? Do we want to grow prosperity or poverty? We need to change the terms of the debate, and choose what we want to grow.

When you follow nature's laws, growth is good. We can have a fecund economy, and we can have growth that's not something to be terrified of but celebrated—the way you celebrate a child growing up, or a tree that grows.

In that context, our firm has done an experiment, and it looks like it's going to work. We've designed a building at Oberlin College that makes more energy than it needs to operate. It purifies its own water. So it's a building like a tree. We've made the building fecund. BP's solar energy company helped us by donating the solar collectors.

"To avoid undue dependence on oil and gas, and the attendant economic and social risks, we need to encourage a diversity of supply."

Knighted in 1998, **Lord John Browne** is the group chief executive of BP (formerly British Petroleum), the world's third-largest energy company.

We're also very involved with wind projects now—I see them as a landscape design issue, as a way of dispersing and providing a new cash crop across the whole farming sector. But instead of simply building clustered wind farms, which are basically central power plants, we are looking at a dispersed system that provides more benefit to more people. The distribution systems would be different, *and* they would look beautiful in the landscape.

Additionally, we're working on small-scale generation—optimization scenarios in which there are stationary fuel cells and microturbines every three blocks. It's what we call "anticipatory design science." We're challenging designers to look at the vector on the costs of renewables as it comes down, and look at the vector on the costs of conventional production, and then watch these two vectors coming together. Anticipate them so that you're ready. Essentially, we prepare our buildings now for photovoltaics so that when they're cost-effective we're ready to put them on. One of the big problems with design is that people don't anticipate these things so they never happen.

Browne: Bill, it sounds very interesting. Localized power generation, using fuel cells, turbines, et cetera, is something that is probably economic today. Obviously, the details vary

The alternative is to produce hydrogen on the spot, from methanol or gasoline, through an onboard device called a reformer. The drawback is that you still get CO_2 emissions, if only half as much as from a gasoline engine. But gasoline-electric hybrids do that already, and they're on the market now. "If we're going to go with hydrogen fuel cells," says Ann Mesnikoff of the Sierra Club's Global Warming and Energy Campaign, "they should be truly clean." (Iceland hopes that it can dodge this objection by producing methanol by combining hydrogen with CO_2 captured from the stacks of Iceland's metals industry, essentially recycling the waste gas.)

Iceland's conversion to a hydrogen-powered economy has already been endorsed by its government, the oldest democratic assembly on the planet. The first step is the conversion of the Reykjavík bus fleet to hydrogen; demonstration buses should hit the road next year. Following will be the introduction of private fuel-cell vehicles, and finally the conversion of the trawler fleet.

"I'm sixty-seven," says Árnason. "People in my generation will see the first steps. My children will see the transformation completed. And my grandchildren will live in this new hydrogen economy." ***—Paul Rauber***

The steamy side of Iceland: Its geothermal energy can be tapped to produce hydrogen.

country by country, region by region. And yet with the possible exception of Japan, where they are easing regulations on new buildings, it's been very difficult to get architects and developers to take localized power generation seriously. Why is that?

McDonough: This is the bane of my existence. My industry is one of the most conservative and slowest to change. The banks have a lot to do with that. Fannie Mae and other banking institutions are all essentially set up for one-size-fits-all financing. They don't know how to factor in something that doesn't meet their criteria. There needs to be flexibility.

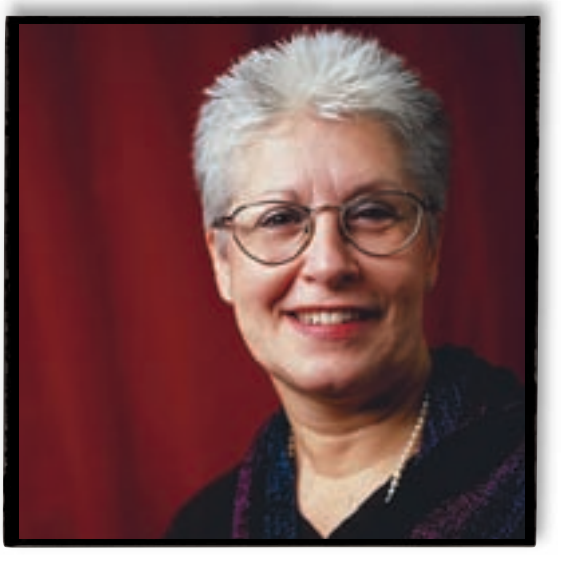
> "In poll after poll, when asked about solar, wind, efficiency, conservation, hydrogen, and so on, union members are even more in favor of these things than the general public."

Our firm had the same problem with Ford Motor Company, when we got the contract to rebuild its Rouge River assembly plant. We spent a year working on that million-and-a-half-square-foot plant, but the engineers wouldn't let us do anything. They just wouldn't experiment. All they could do was say no. After a year, I almost gave up. We eventually found a way to pump air directly to the breathing zone of the workers so that we wouldn't have to heat and cool the entire building. And we're going to be doing it at about 20 percent of what the normal building would cost to heat and cool. But it took getting everybody past their conventional practice—and it required the vision and authority of Bill Ford.

Pope: Jane, among the union members who might be at the front-end of change, do you sense excitement or anxiety about the future?

Jane Perkins: It's a mixed bag. There are so many inconsistencies in the labor movement. Take the International Brotherhood of Electrical Workers, for example. Some of its members build and run power plants. On the other hand, there are members who build houses and hook up their electricity. The home-construction side of IBEW wants it to be the solar union. The utility side of IBEW wants everything to stay exactly the way it is. And so there is a struggle, inside a major union, about what the future ought to look like.

It is also true that in poll after poll, when asked about solar energy, wind power, efficiency, conservation, hydrogen fuel cells, and so on, union members



Until this year, **Jane Perkins** was the environmental liaison for the AFL-CIO, where she developed worker-sensitive environmental policy and programs. She is currently a research fellow at the George Meany Center for Labor Studies and advisor to the Blue/Green Working Group, a coalition of labor and environmental leaders.

TOP: KEVIN SCHAFER/ MARTHA HILL BOTTOM: ANNE HAMERSKY

GOOD DAY, SUNSHINE

ALL TECHNOLOGIES UNDER THE SUN.

When most people think about solar energy, they picture photovoltaic panels on top of someone's cabin in the woods. Thousands of homes are powered this way, and not just cabins (George W. Bush's Crawford ranch house, for one). But while we're waiting for photovoltaics (PV) to become commercially viable, other solar technologies may be much closer.

"The problem with solar is how to get significant quantities of energy out of it," says Rich Ferguson, energy chair of Sierra Club California. Despite substantial improvements in PV cells, they remain extremely expensive, delivering electricity at about 30 cents a kilowatt. (Wind power, by comparison, is down to 4 cents a kilowatt, about the same as a modern natural-gas plant.)

But there's more to solar power than PV. One of the most promising approaches to large-scale solar-energy production is called "solar thermal," in which huge arrays of mirrored, parabolic troughs focus sunbeams on central tubes, heating oil to 750 degrees to drive steam turbines. "If this country is going to get serious about solar power," says Ferguson, "it's going to look more like this than PV."

Since 1985, solar thermal plants in California's Mojave Desert have been generating 354 megawatts at a cost of about 15 cents a kilowatt-hour. The price could go much lower, supporters say, as more plants are built. "This is the most cost-effective form of solar energy today," says Gary Bailey, West Coast head of Duke Solar, which is seeking to build a 300- to 500-megawatt solar facility in the Mojave, and another in Nevada. The holdup, he says, is lack of demand. "We need long-term contracts."

While the solar trough is the most developed of alternative solar systems, two others are jockeying for position. One is the "power tower," in which thousands of heliostats, or movable mirrors, beam sunlight up to a central tower, powering steam turbines. Other innovators are working on a similar design powering the elusive "Stirling engine," a piston engine driven not by internal combustion but by heat from an outside source—for instance, by the sun.

Third on the solar smorgasbord is the dish system, in which parabolic mirrors focus sunlight onto a receiver (they look like satellite dishes) to run a Stirling engine. The technical challenge with this method is finding materials that can withstand temperatures well above 1,000 degrees.

Even so, enthusiasts insist that the main impediment to major advancements in solar energy is lack of political will. "Why do people always think in the short term?" grouses Duke's Bailey. "When you sign up a new natural-gas plant, you don't know how much gas is going to cost in ten years, or even if you'll have a supply. But we have the only stable energy source there is; there's no fuel-cost escalation in the sun." ***—P.R.***

It may look like a ride at the fair, but the dish Stirling solar system in Arizona (left) provides power. Above: reflecting the future in Daggett, California.

TOP: WARREN GRETZ, DOE/NREL BOTTOM: BILL TIMMERMAN, DOE/NREL

are even more in favor of these things than the general public. Clearly, there is a disconnect between the policies that unions champion and the rank and file.

Pope: The Sierra Club conducted a poll in Michigan last winter. We asked people about improving fuel-efficiency standards for cars: 85 percent of the general public thinks we should make the auto companies produce cars that get 40 miles per gallon. But 88 percent of the members of the United Auto Workers think so. This is not the official position of the United Auto Workers, which worked hand in hand with the Bush administration to defeat an effort by Senators John Kerry [D-Mass.] and John McCain [R-Ariz.] to raise fuel-efficiency standards, but it is for 88 percent of its members. Once again we see how institutions are not nearly as nimble as their stakeholders.

Freeman: California's a big institution, but we showed the conservation of electricity to be the most powerful force on Earth in terms of balancing supply and demand. Last summer, the predictions were that we were going to have 100 or more days of blackouts. But we appealed to the people of California and gave them incentives. We said that if you save 20 percent compared to last year we'd knock 20 percent off your bill. In other words, we paid people not to use electricity, and it was cheaper than paying the price-gougers for the electricity. We had no blackouts. We tamed that tiger and—knock on

wood—the market is under reasonable control now. We showed that conservation was more than a "personal virtue," as the vice president had suggested.

At a time of crisis, when the American people are intensely interested in the subject, good things happen. The problem is that the attention span of the American people is pretty short, and we haven't figured out how to connect this issue with the two big issues on Earth: How do we solve this awesome problem of global warming, and how do we win the war on terrorism—because we're not going to win as long as we're getting our oil from the nations that harbor terrorists.

A renewable hydrogen economy is obviously the answer; it's easier and cheaper than fusion power. Over the years, we have spent more than $50 billion working on fusion power and it's still a long, long way off.

Perkins: I'm glad you mentioned nuclear power, because it hasn't come up.

Freeman: That's because the market killed it—at least it's killed fission, which is what powers our nuclear plants right now.

Perkins: But I'm not sure fission nuclear power is dead.

Freeman: It's dead except in the hearts and minds of the religious believers in nuclear power. After September 11, we are surely not so dumb as to build more Trojan horses in our country. The danger of a penetration into a nuclear reactor—which is difficult but not impossible—is so horrendous that we've got to be out of our minds to build more nuclear power plants. And I say this as a person who's had as much experience with nuclear power as anyone in this country. I shut down eight reactors when I was the head of the Tennessee Valley Authority, buried one at Rancho Seco [in Northern California], and nursed one back to health in New York. But in this age of terror, we just can't have them.

While one can, I suspect, develop highly efficient nuclear technologies, the expense of insuring them against being blown up is likely to be a long-term economic issue. I'll concede that a technological optimist can make a case for breakthroughs that will guard against internal failure. I just can't see how you can build a reactor that's safe from external attack.

Pope: Kurt, since EPRI is an advocate of nuclear energy as part of the energy mix, I want to give you a chance to respond.

Yeager: The engineering limitations of the nuclear system we have today are fairly evident. But I believe it would be a tragedy for future generations if we outlaw nuclear power because the current generation of engineering doesn't meet our standards. As a technologist, I strongly believe that we need to maintain that as an option, and we ought to be moving that technology forward, not subsidizing it, but allowing it to move forward on its merits.

Freeman: Well, then, are you in favor of repealing the law that gives nuclear-power providers free insurance?

Yeager: Ah, now we start to diverge. Given where we are today, no, I would not repeal the Price-Anderson Act.

Pope: David, you have dealt with resistance to change in the utility sector—particularly at the Sacramento Municipal Utility District. What was it like?

Freeman: Well, the utilities, if anything, are worse than architects. To put it bluntly, it takes the Lord Brownes of the world. It takes someone at the top saying, "By golly, we are going to go down a different path."

One of the big problems with increasing the use of fuel-cell generators, microturbines, and solar panels—what we in the industry call "distributed generation"—is that you still need to interconnect with the utilities. Yet the utilities view you as competition. So it's hard to get interconnection agreements. They come up with ridiculous standby charges that make it uneconomic. We need to think of utilities like the automobile industry: It takes a law to make something happen. We didn't get seat belts, pollution control, or better mileage without laws.

Yeager: Your comment about the flawed interconnection structure for distributed generation is absolutely true, but it's too easy to attack the industry for being a stick-in-the-mud. The issue is incentives. We need to fundamentally change the incentives so that innovation is profitable for the stockholders. Until we do that, there will be no real pressure to innovate.

I would add that the regulatory system is even more deeply flawed. There is an unholy alliance between incumbent utilities and regulators to make opening the energy market as difficult as possible. We do not have deregulation

"We could put an energy infrastructure in place over the next decade that could increase the productivity and efficiency of the U.S. energy system by at least 30 percent, with a similar level of pollution reduction."

As president and chief executive officer of the industry-funded Electric Power Research Institute in Palo Alto, California, **Kurt Yeager** oversees the investment of nearly $500 million a year in research and development. He has served on the executive board of the National Coal Council as well as the Energy Research Advisory Board to the secretary of the U.S. Department of Energy.

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today. We have re-regulation.

We should have an energy architecture that allows us the broadest possible opportunities. We believe we could put an energy infrastructure in place over the next decade that could increase the productivity and efficiency of the U.S. energy system by at least 30 percent, with a similar level of pollution reduction. This would be achieved not through stringing more wires around the country but by applying the technology we have available to us today to the existing infrastructure. This would enable distributed generation to become an integral part of the infrastructure.

Pope: What specifically are the technologies we can use right now?

Yeager: For starters, today we control our power system with mechanical switches that are little different from those used in the 19th century. Compared with the speed of light, those mechanical switches have an equivalent delay factor of about ten days. If I were running a railroad and I said it took me ten days to open or close a switch, for example, I wouldn't move many trains.

"The Bush administration has endorsed the hydrogen fuel cell but there's no program for development of the fuel. Let's have one seat at the table for common sense, which suggests that the clean technology needs a clean fuel to go with it."

Once President Jimmy Carter's energy advisor, **David Freeman** also served Lyndon Johnson and Richard Nixon. He has held top positions at the New York Power Authority, Tennessee Valley Authority, and the Sacramento Municipal Utility District. In 2001, he accepted Governor Gray Davis's invitation to chair the California Consumer Power and Conservation Financing Authority. He is the author of *Energy: The New Era.*

The fact is that we now have an electric system whose unreliability is creating costs that are equal to its revenues. But we have the ability to control the power system with silicon semiconductor-based switches and related devices. Silicon will allow us not only to carry a lot more electricity on the wires we have, it will also allow us to better control where it goes, and will fundamentally improve the reliability of that power at its end user.

There is another aspect of the silicon revolution that is also really exciting. It goes back to Edison's initial vision of the electricity system as a local DC [direct current] rather than AC [alternating current] system. If you look at most of the distributed renewable energy forms, for example, they naturally produce DC electricity. Converting it to AC is both expensive and inefficient. And if you look at the other end, the user end, digital devices such as computers and just about everything else use DC power. Most of the cost of powering those devices is driven by the cost of transforming AC to DC.

We have the means today to transform the electricity distribution system so that when you're building a new building, industrial park, or residential development, you can power it with a DC microgrid that is integrated into the AC power network. By doing this, you also eliminate the substantial heat and energy losses that result from converting DC to AC power.

The efficiency and cost advantages of creating an electricity grid like this are dramatic. This also doesn't force the transition cost onto those who don't need it but rather allows those who need it to begin to build the capability into their power network. Then, solar power or other renewable energy forms can be incorporated without compromising the reliability of the network.

McDonough: In the 1980s, Joe Morabito of Bell Labs wrote a white paper on the notion that utilities and telecommunications were actually the same industry because they both move electrons—though some are full of power, some are full of information. As a designer, what occurs to me is that there's absolutely no reason we couldn't be sending the information with the power. There's no reason we couldn't tag a kilowatt-hour with information about where it came from, what its price is, and so on. We could even send information about the upcoming weather so buildings could pre-cool at night when they expect a blistering hot tomorrow. In design, information is power and there's no reason that power could not be information.

Yeager: Exactly.

McDonough: Now, if we can tag a kilowatt-hour with its source, customers could decide what kind of power they want. They could say, "I just want wind power," and then pay the price.

We could then get together with our energy producers and our appliance manufacturers and our electronics manufacturers. We could sit down with General Electric and say, You want to bring good things to life? How about a refrigerator that goes back to the old icebox concept and stores coolness in a block of frozen material during certain hours? How about a refrigerator with a brain that simply goes shopping and does some diurnal arbitrage and looks for the cheapest kilowatt-hour, or the greenest kilowatt-hour, whatever it is you want it to look for? For example, it could go shopping at three o'clock in the morning, and freeze a block of salts. When you have an

ANNE HAMERSKY

WARREN GRETZ, DOE/NREL

THE NEW CASH CROP

THE ANSWER IS BLOWIN' IN THE WIND.

Are wind power and ranching compatible? The proof is sticking to the bottom of my boot. While hiking around the Ponnequin Wind Facility in far northern Colorado, I stepped in the soft calling card of a well-fed bison.

The bison belongs to a neighbor of Keith and Myrna Roman's, who own most of the land where the Xcel Energy Corporation planted Colorado's first commercial crop of wind turbines in 1996. There are 44 turbines now, spread along a dry, wind-whipped ridge in Weld County. They resemble the enormous white columns of a Greek temple, overlooking the Front Range to the south and Wyoming's capital city, Cheyenne, to the north.

"You see how quiet it is?" says Keith Roman, standing at the base of one of the towers. Indeed, there's only a gentle whoosh as the rotors sweep around. "The noise doesn't bother the cattle, or the antelope," says Myrna. Or the bison, apparently.

The Romans, who live in Wyoming, have owned these 420 acres just across the Colorado border for 45 years. Their first ranch animal was a milk cow, and when she calved they were on their way to a herd of 120 or so. Like most small-scale ranchers, the Romans worked other jobs as well, all for the pleasure of rising before dawn and working into the night. When someone inquired about leasing their high ground for wind turbines, they weren't surprised, having stood up there in howling blizzards.

Myrna points at the turbines, which are pivoting to face the southwest wind. Inside are computers that control the direction, rotor speed, and pitch of the blades. Collectively, Ponnequin's turbines produce 30 megawatts of electricity, which Xcel sells to some 21,000 subscribers who pay an extra 2.5 cents per kilowatt-hour for the "green" wind energy. The only complaint from neighbors, says Myrna, has been about the blinking lights atop the towers that warn low-flying aircraft.

The turbine technology employed on the Romans' ranch is much more sophisticated than earlier wind farms in California, which chopped up passing raptors. The key was to slow rotor speed and site the turbines away from customary flight paths. Robert Ryder, a biologist from Colorado State University in Fort Collins, scouts the Ponnequin facility for injured wildlife. "We haven't seen nearly the impact we expected from the California data," he says. Last year Ryder found seven dead birds at the site, including only one raptor, an American kestrel. (The impact on bats was greater—17 dead.) And worries that pronghorn would be spooked proved unfounded. "They seem to like it because it's safe—there's no hunting allowed," says Ryder.

Last year was a banner one for commercial wind energy in the United States, with production from facilities in 26 states rising 60 percent to 4,261 megawatts (enough to supply more than a million people). The American Wind Energy Association estimates that new wind farms in 2002 will eliminate emissions of 7.5 million tons of carbon dioxide from fossil-fuel power plants. Industry experts say that wind energy could provide over 5 percent of the nation's electricity by 2020.

For the Romans, it provides extra retirement income as well, though they won't reveal exactly how much. "I can tell you we're making much more off this than we did off cows," says Keith, chuckling. "And, you don't have to feed them, you don't have to break ice, and you don't have to calve them out." ***—Geoffrey O'Gara***

appliance with an inherent storage capacity—such as a refrigerator that can store cold—it wouldn't have to run during peak hours.

Pope: It sounds like the concept of smart electricity, where you trade in the dumb meter for a system that allows the user and the supplier to interact around services.

McDonough: Yes, to communicate. Information is power and power is information.

Freeman: The problem with thinking along those lines is that the technology is so exciting and interesting that we often lose contact with the people of the world and what the serious problems are.

Perkins: That's because the ideas aren't matching up with the politics. We need to go from the ideas and all the solutions that are out there and get down to the "normal" people who respond. The people of California responded to a very simple idea, which was "We'll pay you to not use as much electricity." Conservation is a proven way to deal with an interim problem. Efficiency is a way to deal with an interim problem. But the challenge is getting the ideas to the "normal person," and having the grassroots political voices heard in the process.

The labor movement is an important part of getting ideas spread out among people who can make a difference. But if this is going to happen, it's very, very critical that worker issues are addressed. It is not enough to say that all these ideas are going to create new job opportunities—especially when you're talking to a mine worker who's not going to mine coal, or an autoworker who's worried that his particular company isn't going to transition fast enough to keep him employed.

We also need a plan that says, unambiguously, that there's a role for government—that regulation is not a bad thing if

we're talking about regulating against greed, rip-offs, et cetera. Part of the reason folks in California responded as they did to the energy situation was that there was rampant greed involved and everybody could see that.

Freeman: We simply have not been successful in persuading the American people that dealing with energy issues and climate change is a net benefit to *all* Americans. The opposition—the coal people, especially, but also a lot of others with economic clout—have bombarded Congress and the press with questionable numbers about how much it's going to cost financially and in terms of safety and jobs. We need to be far more aggressive in persuading Americans that the cleaner energy path is in their best interests.

Brown: It was interesting that during the months coming up to the Kyoto Protocol talks on climate change in 1997, the Clinton administration began to realize that the American people were not on board on this issue. So it started holding press conferences. The administration brought together leading scientists, including some Nobel Prize winners, to talk about climate change.

If we are indeed moving into a period that requires rapid change, then governments may have to assume responsibility for educating the public. We don't have time to educate a generation of teachers, who will educate a generation of kids, who, a generation later, will become the decision-makers.

This is a new role that governments must play—they need to systematically hold press conferences, report the latest findings, explain how atmospheric CO_2 levels have gone up, and how we have contributed to it. Let scientists explain what is likely to happen over the next 10, 50, or 100 years if we continue with business as usual.

I hearken back to Franklin Roosevelt, with his fireside chats, where he sensed the need to help the American people understand what was happening, and to communicate with them. Even if he couldn't provide all the answers, at least he was talking with them, and it provided a sense of security and common purpose that had not existed before.

Without realizing it, we may have moved into a period where governments now have to use the bully pulpit to educate—to shape the thinking that will help us bring about a new energy system.

Yeager: My view is somewhat different. I think one of the problems is that in our society, everything has to be sold as a crisis. If it's not a crisis, you've got to make it a crisis. It's taken a long time to get where we are today with regard to climate change. If we were to go to zero carbon emissions tomorrow, the levels would still continue to rise.

This is not an argument for doing nothing. Quite the contrary. What we need is a strategic plan that says the solution is not the tactical step tomorrow but a sustained campaign to improve the efficiency with which we use energy. Carbon, basically, is a measure of inefficiency in combustion. Our strategic solution would incorporate innovation and technology to improve the efficiency of our energy system.

Browne: Yes, you have to think of the time scales. You need to try to figure out as best as you can what the nature of the world will be—not just for the next quarterly earnings, but for 30 to 50 years' time.

These things are impossible to get perfect. But at least you have to build a set of choices that speak to the way in which the world is likely to go, and the way in which the consumers of the world, widely taken, are likely to want to be over a longer period.

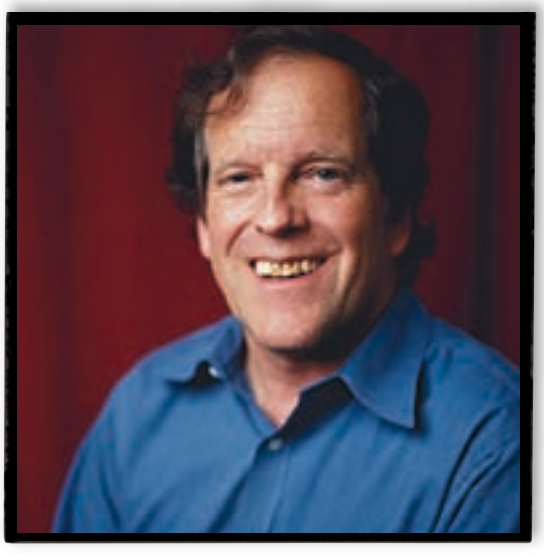
Fifty years ago, BP put out its first review of world energy. On the cover of this report was a picture of coal because at the time coal was actually the most important source of energy. In a short time we've gone through all sorts of transitions. Coal has diminished in importance; we've gone to oil, and now gas. Natural gas produces carbon but much less per unit of workable energy produced than oil, and it's now outstripping oil as the fuel of choice in many parts of the world.

But beyond gas, what is there? Well, I think there's going to be a mix of energies. I expect oil and gas to be contributing for a long time. But there will be more contributors. There will be hydrogen, if we can figure out the many challenges involved. There will be wind. There will be solar. No one silver bullet is clear at the moment.

Freeman: In a discussion I had with Enron's Ken Lay last August, we talked about the natural-gas industry as being the transition industry from the age of fossil fuels to the "solar-hydrogen economy."

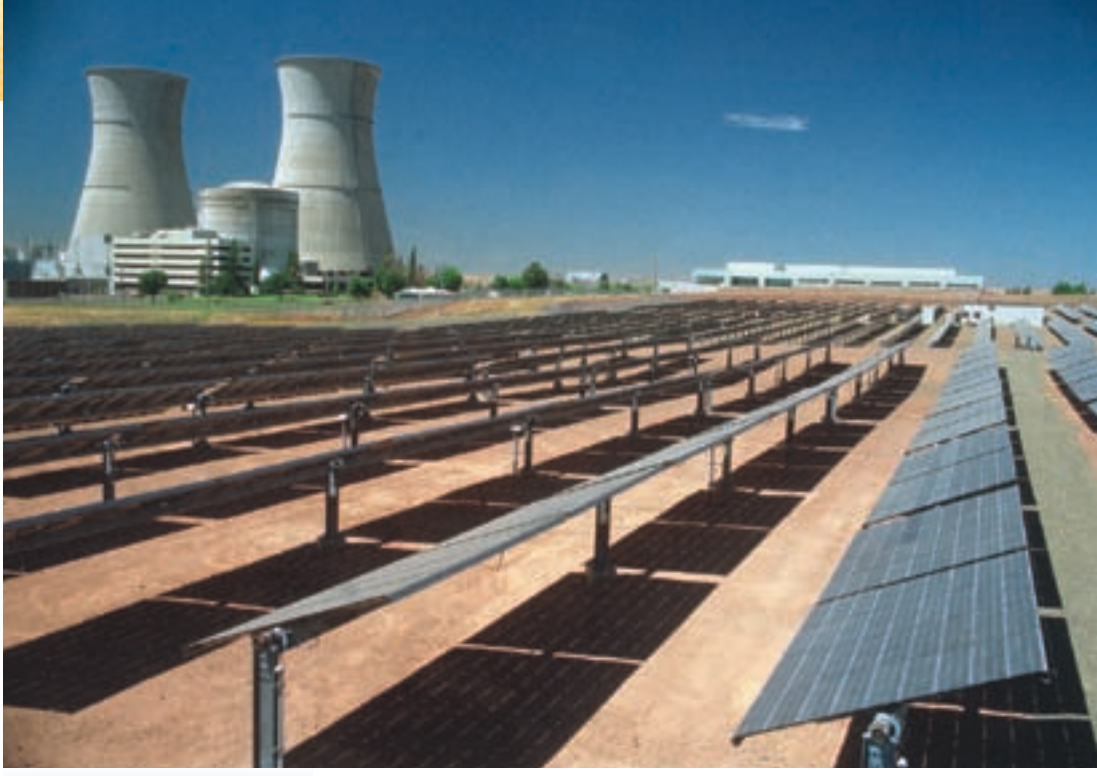
In fact, we even talked about the gas infrastructure that Enron had that could be used to ship, store, and distribute hydrogen produced by wind farms in Texas. We talked about tapping the enormous wind reserves there to replace the natural-gas reserves that are being depleted. Do you see the natural-gas industry as being the obvious transition from

"Eighty-five percent of the general public thinks we should make the auto companies produce cars that get 40 miles per gallon."



Appointed executive director of the Sierra Club in 1992, **Carl Pope** has also headed the California League of Conservation Voters and Zero Population Growth. He served as host and moderator for the *Sierra* forum.

ANNE HAMERSKY



Gone but not forgotten: David Freeman helped put the Rancho Seco nuclear power facility in Northern California out of commission. Surrounding it is the alternative: a two-megawatt solar plant that powers 660 Sacramento homes.

WARREN GRETZ, DOE/NREL

fossil fuels to the solar-hydrogen economy?

Browne: You never know. We only find out later how the energy mix works. Natural gas has some very important attributes. It has more hydrogen than carbon in a ratio, compared with oil or coal. But we need to figure out how to reform it in a way that makes sense—that doesn't simply produce hydrogen and leave the carbon dioxide in someone else's backyard. That research is happening.

Freeman: With regard to natural gas—quite frankly, I'm still with Jimmy Carter, who said that if you take a long enough view, it probably will go down in history that we were barbaric to burn up all this natural gas just to make electricity. I'm not sanguine about what the supply and demand of natural gas, over the next 20 years, is going to be. I think we're in for some real price spikes.

I also want to comment on the role of wind power. I, too, think it's a huge opportunity, but we probably aren't focusing it as well as we could. The point about beginning in earnest with a move toward the hydrogen economy has to be taken seriously. Right now, I'm negotiating power contracts. This afternoon, I'm working on a wind project. Unfortunately, in California, the wind doesn't blow when the peak loads occur. It's real hot on summer afternoons because the wind *doesn't* blow. We need to begin to match wind power with electrolysis plants, in order to use wind power around the clock to produce hydrogen. All this enthusiasm for wind power is a wonderful opportunity to get the hydrogen economy started. But I don't see that happening.

As a matter of fact, I want to criticize my good friends Bill Clinton and Al Gore for their program to build a new generation of fuel-efficient vehicles without having an alternative-fuel program to match it. We have not begun, in America, any systematic plan for developing the hydrogen-fuel infrastructure. Now the Bush administration has endorsed the hydrogen fuel cell but there's no program for the development of the fuel or for building hydrogen-fuel filling stations. I mean, let's have one seat at the table for common sense, which suggests that the clean technology needs a clean fuel to go with it. We are not demanding enough of government.

Brown: The key to rapidly moving from the heavy fossil-fuel dependence of today to renewable energy resources is leveling the economic playing field. Either we eliminate the subsidies for fossil fuels and nuclear or we do something like extend the wind-production tax credit. We need to get the market to tell the ecological truth.

Yeager: I am an energy agnostic. I think we should be striving to raise the bar on all the technologies we've been discussing, and then let them seek their rightful place in the market. For example, say that by 2050 we want our power system to have the following specifications in terms of cost, reliability, cleanliness, safety, and so forth. Then look at all the technologies in the world. If you can meet those specifications, you've got a role to play. If you don't meet those specs, then you don't. We don't do that with coal, we don't do it with renewables. We tend to be proponents or opponents of a particular solution, we tend to pre-define.

We ought to say: This is what we, as society, want the energy system to be able to produce, and you have this amount of time to get there. Why don't we have the intestinal fortitude and commitment to make that the basis for our decisions?

Pope: But we have a system for this . . .

Freeman: . . . it's called democracy.

Yeager: Well, democracy tends to be exploited rather easily.

Freeman: It's the worst form of government, except for all the others. ■

MARILYN BERLIN SNELL *is* Sierra*'s writer/editor.*

HUNGRY FOR MORE?

The power lunch continues online at *www.sierraclub.org/powerlunch,* where you can satisfy your appetite for information on energy issues and hobnob with energy experts. Also, learn about the Freedom Package, the latest bid to make Detroit contribute to a cleaner and more secure energy future.