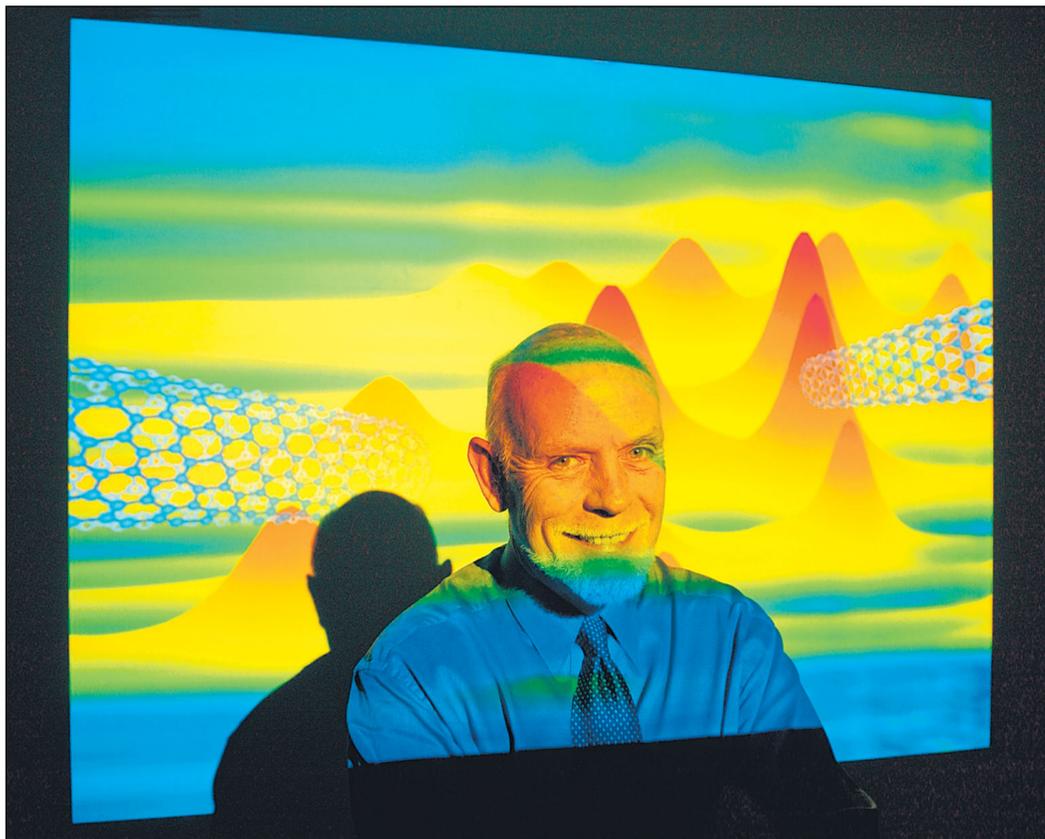


THE SMALLEY VISION



**PET PROJECT:** The late Rice University professor Richard Smalley is shown in this 2003 photo in front of a projection of nanotubes. SMILEY N. POOL / CHRONICLE

# Imagine a world that's energy-rich

■ Storing electricity locally was late Nobelist's dream

By RICHARD SMALLEY

**Editor's note:** *The Late Dr. Richard E. Smalley was a Nobel Laureate and professor of chemistry at Rice University. His Nobel Prize in Chemistry was awarded in 1996 for the discovery of a new form of carbon, buckminsterfullerene ("buckyballs") with Robert Curl, also a professor of chemistry at Rice, and Harold Kroto, a professor at the University of Sussex in England. At the time of his death in October 2005, Smalley was focused on finding solutions to the global energy problem. The article below is a summation of Smalley's thoughts on an energy solution excerpted by his colleague, Amy Myers Jaffe of Rice's Baker Institute.*

I HAVE been on a personal journey for the past year and half in a search to find some happy answer to the energy problem.

I believe the problem is, simply stated, that we have to find a new oil. Oil was, unquestionably, the basis for prosperity for this country and the planet in the last century — particularly the last half of the century.

But it is very clear to many of us, including leading scientists and policymakers, that if oil remains the basis for prosperity for the world throughout this century, it cannot be a very prosperous or happy century.

There are two reasons for this. First, we will certainly peak in worldwide oil

production sometime in the earlier part of the century; and second, there will be vastly more people (billions of people) on the planet consuming energy in the future.

As this energy consumption rises worldwide, we will create a huge wall of carbon with immense negative impacts.

So we need to find an economic alternative to oil. We need a new basis for energy prosperity.

(We need) a technology that makes us energy-rich again in an environmentally acceptable fashion for 10 billion people.

I have tried to imagine at least one acceptable scenario for new energy by 2050. When I think about the answer to that question, I am imagining a scenario where we do not cart energy around as mass and then reconvert it, but we cart it around as electrical energy.

And so, if you have one word in this scenario to describe this new oil, it would not be "oil," it would be "electricity." That is the key conceptual insight that makes things work.

The biggest single problem of electricity is storing it. When we are trying to find a way to store electrical energy on a vast scale, as we generally need energy in gigawatt power plants, there are very few options that one can imagine on that large scale for energy storage.

But if you imagine attacking the energy storage problem locally, at the scale of a house or a small business, the problem becomes vastly more solvable because there must be many more technologies that are accessible at the smaller scale.

If 100 million local sites each had their own local

storage (based on improved batteries, hydrogen conversion systems and fly wheels), and they locally decided for their own particular sociological, economical reasons to use a particular technology to give themselves an hour of buffer or a day of buffer, five days of buffer, however long they have decided to do it — then the electrical grid could afford to be fairly erratic.

The local sites would determine what period of time they want to be buffered. The primary energy producers would simply dump the power onto the grid in the cheapest possible way, and locally, the local storage would buy it off the grid when it is cheapest and most abundant and store it for high use times.

It is fascinating to imagine what the impact of this change of approach could have. No longer do you have to have a system as we have currently in the United States, in which we have almost twice the generating capacity than we use on average because we have to account for the peaks and the lows of demand.

The most interesting part about this scenario is that the local storage aspect to this new electricity-based system means that innovation would be continually and efficiently motivated by free market forces. This gives you tremendously robust energy sources and the possibility to mix locally produced electricity with grid-delivered centralized sources.

For this grid, I need one other key technology; I need to be able to transform the efficiency of transporting electrical power over thousand-mile distances, including over

continental distances. Instead of taking a hundred megawatts over a thousand miles, I need to take a hundred gigawatts over a thousand miles and do it cheaply (possibly via carbon nanotube, high voltage wires that minimize loss).

The value (of this transmission system) is that we can not only integrate residential solar; we can also hook up very remote sources to this same grid, including vast solar farms in the deserts, where you are using the local storage as a buffer supply for when the sun's down; from wind when it is blowing. You can import vast amounts of electrical power from remote nuclear power sources, behind some military fence, where you are absolutely sure there is no nuclear weapons risk associated with plant operations. You could link in electricity generated from clean coal plants, wherever we have found a place for them where we can strip the CO<sub>2</sub> away and store it more easily.

Of course, you still have to solve the transportation fuel problem. The answer to that would be plug-in electric hybrid vehicles and possibly hydrogen produced in the system.

I believe climate change is a much more critical problem than has been taken into account in our current political debate.

And there is just no answer to reducing greenhouse gases, short of a major new program of a magnitude and sustained level of concentration as the Apollo or perhaps actually beyond it.

It may take us a whole generation to get this problem solved.

# GREEN: A path to prudent policy

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To construct a comprehensive and beneficial energy policy, our next president will need to consider environmental values at every level of our energy debate — and work with Congress to redefine the proper role of "environmental regulations."

For too long, environmental advocates and economists have assumed that well-designed environmental laws help promote effective energy policies. In reality, these laws do almost the opposite: They create a false comfort zone that promotes poor decision-making.

Lawmakers debating any new energy policy — such as federal subsidies for hydro-power projects — mistakenly believe that the Endangered Species Act and other "environmental regulations" will address any environmental consequences of their decisions. History, of course, proves otherwise and numerous energy-related projects have been delayed or thwarted when environmental issues ultimately collide with new construction spawned by ill-conceived energy policies.

There is a better path to prudent policy, and it involves granting environmental values a larger role at the policy formulation stage and beyond. In 2005, the Energy Security Act created massive subsidies for ethanol producers, ostensibly to help reduce demand for fossil fuels via a "renewable" resource. Today, we have learned that growing corn for ethanol uses more energy and generates more CO<sub>2</sub> than it saves — a lose/lose proposition for everyone (except corn farmers, of course).

Europe made similar mistakes by pushing for renewable palm oil, which is being grown on land once covered by tropical forests that have since been burned, releasing millions of tons of CO<sub>2</sub> into the atmosphere. No "environmental regulations" governed CO<sub>2</sub> production in either of these examples, but even if they were available, it's doubtful that anything could have slowed policymakers in their headlong pursuit of the "environmental benefits" of corn and palm oil. Pure and simple, these lawmakers made mistakes — and crafted energy

policy around simplistic assumptions about renewable energy rather than thoroughly investigating all of the environmental impacts surrounding their decisions.

Our new president should heed the lessons of these experiences — and appreciate how environmental considerations deserve a seat at the table where policies on energy supply and energy security are being discussed and finalized. To do otherwise puts a fly in our energy ointment.

Should we pursue nuclear power to reduce our dependence on coal or foreign oil? Perhaps — but someone needs to properly address the challenges associated with nuclear waste.

Do we boost federal support for CO<sub>2</sub> storage-technology research? It sounds like a great idea, but only if coupled with a plan to deploy the technology to reduce CO<sub>2</sub> production in China as well as this country.

Should we enact new climate-change laws to elevate carbon prices? Only if we're prepared for the energy security issues that attend coal becoming a more expensive source of our electricity.

The complex calculus behind the decisions needed for a comprehensive and beneficial energy policy is almost beyond comprehension, and every choice brings consequences.

Every barrel of oil we choose to refine may eventually produce toxic air pollutants that could affect human health depending upon proximity, and all fossil fuel combustion increases the warming potential of our atmosphere. Even so-called "green" options can be troublesome, with wind turbines threatening migratory birds and hydroelectric projects threatening anadromous (from salt water to fresh water) fish runs.

Our next president must make sense of it all — and environmental values can play a vital role in directing the new administration toward a sound energy policy.

Failing to consider these values today only ensures a future filled with tougher political decisions, higher costs and a larger toll on humans here and throughout the world.



CHRIS VAN ES

# REAL: Energy diplomacy is the new game in town

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production alone. Cabinet members mustered by the incoming president need to accept the reality that we will continue to depend on other nations to supply much of our oil and gas. Earlier this month, Secretary of State Condoleezza Rice told a Senate Foreign Relations Committee hearing that she intends to appoint an "energy envoy" to address the "politics of energy" that is "warping diplomacy in certain parts of the world."

Secretary Rice is a latecomer to a reality that has been obvious for a long time: Namely, that today's petropolitics may be a tame harbinger of a harsher future ahead of us. Without exception, foreign policies crafted by the incoming administration must connect to answering global energy needs, and the new secretaries overseeing the departments of State, Commerce and Energy must work collaboratively to formulate policies that contribute to that goal.

Energy diplomacy in an age of energy internationalization is the new game in town — and success will hinge on the skill of the people who play it.

The new team we install in Washington should understand that unilateral decision-making must

end if the United States is to hold any hope of answering its energy needs in world markets. In numerous ways, including our failure to embrace the Kyoto Protocol, we have acted apart from the world. It is time for us to join the mainstream of countries seeking solutions to global warming — and also time to ratify the U.N. Convention on the Law of the Sea — so that the United States can optimize its access to Arctic petroleum reserves. The sooner we realize that energy policy cannot be made apart from climate-change issues or broader foreign policy, the sooner we can participate in (if not actually lead) the world search for solutions.

Realism rather than rhetoric should define the next administration. Toward that end, our policymakers should accept some truisms:

■ "Big Oil" is not to blame. As tempting as it is to castigate large U.S. energy companies for profiting from our energy challenges, the reality is that these companies are relatively minor players

on the world stage. We're paying more for filling up our tanks because there is a limited supply of oil available — and developing nations such as China and India are demanding a larger share than ever.

■ Renewables are not the only answer. Renewable energy from wind, solar and biomass simply cannot grow fast enough to make a material impact in the world mix of energy sources over the next two decades.

■ It's time to open some new areas to development. Even as we plead with other nations to give us access to their reserves of hydrocarbons, we resist new exploration off our East and West coasts. Our hypocrisy must end. Offshore drilling and production can be done cleanly and safely if regulatory agencies are adequately funded and staffed to enforce our laws.

Consider this: Canada, our friendly neighbor to the north, has massive reserves of tar sands. In order to meet its commitment to lower greenhouse gases, Canada will have to build nuclear re-

actors to boil water into steam to process tar sands into usable fuel to feed oil and gas to hungry consumers. Tar sands use far more energy and generate far more greenhouse gases than conventional oil production. Shouldn't the United States do its part on both the demand and supply side of the energy equation to contribute to global solutions to the world's hunger for petroleum?

So, what can we do? If our history of generating Nobel laureates and Science Foundation medalists is any guide, the United States has the collective brainpower to provide the best and brightest answers to almost any challenge.

One of the most powerful things the new administration can do is galvanize the upcoming generation of researchers to develop new technologies for everything from carbon sequestration to safe nuclear waste disposal, and to clear a path for our experts to work cooperatively with scientists and policymakers in other countries and speed the world's access to new technological breakthroughs.

Unlike a race to the moon or Mars, a national commitment to energy-related R&D has the potential of answering the world's most critical need: finding enough energy to fuel the global economy without endangering our planet.

*The new team we install in Washington should understand that unilateral decision-making must end if the United States is to hold any hope of answering its energy needs in world markets.*

Magenta

Yellow

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Cyan