

I. INTRODUCTION

Promoters of clean energy often feel like Sisyphus, perpetually pushing a boulder up a mountainside. Just when solar, wind, and other benign technologies¹ seem poised to gain a foothold in the market the ground collapses and the effort must begin again. This is not a new phenomenon. In the 1930's solar panels graced 30 per cent of houses in Southern California and Florida. Several decades later few remained.²

Is this a tragically doomed, mythic quest, or is an economy fueled by clean energy possible? What will it take to get over Sisyphus's hump?

It will require, first of all, an understanding of the role of energy efficiency, not merely a devotion to the various forms of renewable supply.

The best way to do this is to undertake an end-use-least-cost approach. This means asking such questions as: "What are the tasks that we do for which energy is needed? How can we meet those tasks in the cheapest and best ways?" The answers to these questions will demonstrate that any form of energy supply is likely to be the second best option, and will only be part of a durable answer if integrated with the *best* choice: using less of the energy we already have.³ Efficient use of energy should be considered before any supply technology, whether the supply is renewable, nuclear or fossil. Unless the relationship between energy efficiency and supply is understood, any effort to transition to secure, affordable, abundant supplies of energy is likely to fail.

Efficiency will then play the role of spoiler: dampening any supply strategy. It will defeat renewable energy, as surely as it has laid waste to most traditional supply technologies.

II. HOW NOT TO MAKE ENERGY POLICY

Official government energy strategies have tended not to work. This is, in large part, because they have been based on efforts to dictate to the market technologies that cannot survive without government supports. In consequence, the policies have been more honored in the breach. In the 1950s the Paley Commission called for a massive conversion to renewable energy. Its sensible and timely recommendations were completely ignored. The world seemed awash in oil at the time.

The '73 oil embargo changed that perception. It also gave President Nixon the dubious honor of having to put forth an official energy policy. His proposed Project Independence would have had Americans spending 3/4th of all discretionary investment money in the economy on new forms of energy supply, disproportionately coal and nuclear. The market, however took a dim view of this, and few of these investments ever happened. Nixon's response was to deal with the inflation that the run-up in energy costs caused by capping energy prices. This, however, denied institutional and individual decision-makers the market mechanism of a price signal. But in due course, the oil

markets settled down and few people beside the usual suspects of electric utility companies, oil executives and a few beady-eyed policy wonks spent much time worrying about how the country would meet its needs for energy. An increasing number of citizens, though, started to concern themselves about the consequences of how the western world was using energy. The environmental movement, in particular, launched protests against the conventional supply technologies and called for a conversion to a solar economy.

Some people thought that all that was needed was a change of administration. That empirical experiment took place when in 1979 President Carter got to respond to his own energy crisis. Not surprisingly, his big solution also featured governmental mandates and a disproportionate emphasis on conventional supply. To overcome the fact that the market showed continued reluctance to pay for such a prescription, Carter proposed the Energy Security Corporation to override market mechanisms, and the Energy Mobilization Board to supplant democratic institutions to the extent that either might impede supply expansions. In an effort to pacify environmentalists, Carter put solar panels on the White House, and his Department of Energy took a liking to every sort of centralized solar technology imaginable, from solar space satellites to solar power towers in the desert to wind machines with blades the length of a jumbo jet wing.

Once again, though, the effort to “solve” the energy problem with central mandates failed. Even declaring that the country’s shortages of energy were the Moral Equivalent of War did not help implement a program that was so capital intensive that it failed a test of market rationality.

Carter, however, was the first President to recognize the advantages of energy efficiency. His administration implemented such measures as CAFÉ (Corporate Average Fuel Efficiency) standards for vehicles. These were regulatory programs, but they did focus on eliciting the cheapest solutions to the energy problem. They also dramatically increased American security as they enabled the country to buy less oil faster and on a larger scale than OPEC could adjust. New U.S.-built cars increased their efficiency 7 mpg in six years. Europe achieved similar savings but did it through higher fuel taxes rather than efficiency standards. Together, though, these changes tipped the world oil market in buyers’ favor. Between 1977 and 1985, U.S. oil imports fell 42 percent, depriving OPEC of one-eighth of its market. The entire world oil market shrank by one-tenth; OPEC’s share was cut from 52 percent to 30 percent, cutting its output by 48 percent, and driving down world oil prices. The United States alone accounted for one-fourth of that reduction. On average, new cars each drove 1 percent fewer miles, but used 20 percent fewer gallons. Only 4 percent of those savings came from making the cars smaller.

Carter’s plan also put in place two measures that enabled the market to work better: lifting the market caps on price and initiating a variety of programs that provided information on what sorts of energy technologies were available and what citizens could do to use energy more wisely.

Together, Carter's initiatives worked far better than his supply plans, and the effects lingered for half a decade after his term. Between 1979 and 1986, Americans cut total energy use 5 percent—an intensity drop that was five times bigger than the expanded coal and nuclear output subsequently promoted by President Reagan's policy.

Upon entering office in 1981, Reagan sought to stimulate fossil fuel and nuclear energy supplies without realizing that the efforts of the previous administration was enabling the United States to cut energy intensity at the record pace of 3.5 percent per year. Five years later, energy efficiency—disdained as an intrusive sacrifice and a distraction from America's supply prowess—had preempted the markets that were supposed to pay for costly supply expansions. Many of the producers Reagan meant to help were ruined, as efficiency's speed and availability made energy prices crash in the mid-1980s. Despite Reagan's concerted campaign to undo the previous administration's efficiency and information programs⁴, by the mid-80s, the market had had time to work. Entrepreneurs were bringing on myriad technologies that lead to a huge gush of efficiency. Even advocates of renewable supply were caught off guard. They were also hampered by the inept way that government programs sought to subsidize renewables. But the real determinant of the outcome was that efficiency turned out simply to be much cheaper than any form of supply. Despite its imperfections, the market, given half a chance to work, turned out to be smarter even than the supposed energy experts.

Energy efficiency came online far faster than anyone predicted that it could, and far faster than any expansion of supply. From 1983 to 1985, the nation's third-largest investor-owned utility was cutting its decade-ahead forecast of peak demand by about 8.5 percent *each year*, at roughly 1 percent of the cost of new supply. The nation's largest investor-owned utility signed up 25 percent of new commercial construction projects for design improvements in just three months; so it raised its target for the following year—and hit it in the first nine days. Well-designed efficiency programs have captured up to 99 percent of target markets. A huge literature confirms the size of the savings and that the costs of achieving them can be accurately predicted and measured.⁵

This history echoed eerily in 2001 as President George W. Bush sought with similar ardor to stimulate energy supplies, even though in 1996 the United States had quietly resumed saving energy by 3.2 percent a year. Repeating the mid-1980s experiment, Bush called again for opening the Arctic National Wildlife Refuge, and proposed massive fossil and nuclear subsidies. Meanwhile subsidies and other encouragement for inefficient cars led to a situation where the average fuel efficiency of U.S. cars and trucks hit a 22-year low in 2002: 20.4 miles per gallon.⁶ In June, 2003, environmentalists pointed out that the average fuel efficiency of Ford cars and trucks was worse than when the company started 100 years ago with the Model T.⁷ This is tremendous a lost opportunity for Americans. The U.S. National Academy of Sciences reported in 2001⁸ that although light-vehicle improvements have already cut gasoline consumption by 14%—comparable to Persian Gulf imports' share of U.S. oil use—conventional further gains, which would be cost-effective to the driver to make, can roughly double U.S. fleet efficiency without compromising safety or performance. Typical potential fuel savings

range from about 1/5 for small cars to 1/3 for midsize SUVs and nearly 1/2 for big pickup trucks.⁹

Such savings projections are quite conservative, and assume that smarter car companies do not introduce novel designs that will disrupt the industry and put inattentive car companies at risk. While American car companies resist making their product more fuel-efficient, the Japanese and Europeans are again designing the future. The Toyota Prius hybrid-electric 5-seater gets 48 mpg; Honda's Insight gets 64 mpg. An entire American car fleet that efficient would save 32 times the amount of oil that proponents of drilling in the Arctic hope to find there.¹⁰ Daimler Chrysler and GM are already testing family sedans at 72–80 mpg. VW already sells Europeans a 78-mpg 4-seat non-hybrid subcompact. Almost every automaker at the recent Tokyo Auto Show displayed good hybrid-electric prototypes, some getting 100+ mpg. VW has just premiered a super-safe but ultra-light diesel car that gets 285 MPG.¹¹

Markets are, of course not perfect. As prices fall, people are all too happy to resume apathy. Advertising campaigns (and tax subsidies) that encourage Americans to buy a 10 MPG Hummer2 so that they can paste an American flag on it and feel like they are patriotically supporting the troops, ensures that young men and women will be in harm's way, driving .5 MPG tanks and 17 feet per gallon air craft carriers. Such behavior also ensures that we will all get to enjoy yet another energy crisis.

In fact, not having had such a crisis for several years, ham-handed government programs to “deregulate” electricity markets in such a way as to allow the incumbent “big dogs to eat first” created one in 2000 in California.¹² Once the world leader in energy efficiency, with financially healthy utilities and sensible resource policies, California nearly plunged the whole of the U.S. into the next energy crisis. Panicked by so-called power shortages and exhorted by Vice President Dick Cheney's¹³ call to build at least one power plant a week, developers planned to add electric generating capacity equivalent to 83 percent of the state's current total demand, 96 percent of the western region's, and at least one-third of the nation's. But meanwhile, California citizens, companies and communities woke up and implemented exactly the same solution that had worked before: reliance on efficiency that enabled them to save their way out of the hole. Californians cut peak electricity demand per dollar of gross domestic product (adjusted for weather) by 14 percent in six months—a third of customers cut their usage by 20-plus percent. In just the first six months of 2001, customers wiped out California's previous five to 10 years of demand growth, taking away proposed new power plants' market before plans could even be finished. This abruptly ended the crisis that the White House claimed would require 1,300 to 1,900 more power plants nationwide. An August 2001 *Barron's* cover story noted a coming glut of electricity. By now, scores of plants have been canceled for lack of demand¹⁴, and their irrationally exuberant builders are reeling as Wall Street, stung by Enron's collapse, downgrades their bonds.

But efficiency keeps quietly gaining. A recent report by the American Council for an Energy Efficient Economy, "State Scorecard on Utility and Public Benefits Energy Efficiency Programs: An Update" states that there has been a halt to the decade long

trend to eliminate or reduce efficiency programs in the United States. Spending on utility and related state energy programs has rebounded modestly from the late 1990s. Annual spending on energy efficiency programs reached a high point of about \$1.6 billion in 1993 and dropped dramatically to about \$900 million in 1997. This resulted from the spread of utility “deregulation” in the mid-1990s. Now revived interest in energy efficiency by the states has begun to reverse that trend, with total spending by states and utilities on energy efficiency programs back to about \$1.1 billion in 2000. "Our analysis clearly illustrates that there remains a vast resource of energy efficiency opportunities in the United States that is being largely ignored and untapped," stated Dan York, ACEEE's Utilities Research Associate and co-author of this report. Most states still offer no significant support for efficiency programs, and federal energy legislation has so far ignored the need for a national matching funding mechanism for state efficiency programs. This leaves the main burden of support for efficiency programs to a few states."¹⁵ Since that report, however, at least three states have voted to implement efficiency programs as a way to cut emissions of carbon dioxide.

III. Efficiency is the Real Energy Supply Technology

In each energy crisis that has beset the world, efforts to promote one or more forms of energy supply have ignored the role of efficiency in making any sort of energy strategy successful. As if to spite all the brainpower and paper thrown at the energy problem (some wags suggest that the solution to the energy problem is to burn energy studies) the manifestly imperfect market quietly bought more efficiency than any form of supply. Markets are motivated by price, information and consumer values. After '79 there was a real perception of a crisis. Prices spiked. People sought information. And when the government, utilities and various non-profits supplied it, the market mechanisms worked rapidly to “solve” the energy crisis. Efficiency swamped supply and prices crashed.

This persistent oscillation, driven by what could be called “the overhang of profitable efficiency”, has repeated itself at least four times since the '73 Arab Oil Embargo, and will do so again. Every time price hikes, apparent shortages, or political instability create the perception that the time is right to make a transition to a different form of energy supply, cheaper and quicker efficiency will eliminate the perception of a need to change, and will allow the energy status quo to resume. This fuel bazaar will continue to result in bankrupt supply companies, a climate that will grow less stable by the year, energy vulnerability and continued war in the Middle East.¹⁶

Few people other than those whose careers depend on energy analysis really want to focus on how they get their energy. If prices remain relatively low (and the world price of oil is still below that of bottled water) few people will overcome the “hassle factor” to make a change in their energy system. Every time the price for the prevailing energy source (usually oil) gets high enough to make people interested in overcoming that hurdle, the myriad ways of using energy more efficiently become even more attractive. Given that it is typically far quicker to implement efficiency than to install any form of new supply, efficiency outpaces all supply options. This reduces demand for energy,

drives prices down, and dissipates any sense of vulnerability. Proponents of supply are back at square one, the falling price of oil having diminished the relative attractiveness of their pet technologies. Avoiding this cycle of boom-and-bust requires understanding its three root causes. First, efficiency costs far less than energy supply, so most people, given the choice, buy it instead. Second, policies that force acquiring *both* efficiency and supply risk getting both—customers will typically use only one (usually the cheaper one), idling the other. Third, efficiency is far *faster* than new supply. Ordinary people are able to implement efficiency long before big, slow, centralized plants can be built, let alone paid for.

Since Western economies ceased to think that oil was infinite and predictably available, more efficient use has been the biggest “source” of new energy—not oil, gas, coal, or nuclear power. Efficient use of energy enabled Americans after the 1979 oil shock to cut oil consumption 15 percent in six years while the economy grew 16 percent. There are many ways to measure progress in saving energy but even by the broadest and crudest measure—lower primary energy consumption per dollar of real GDP—progress has been dramatic. By 2000, reduced “energy intensity” (compared with 1975) was providing 40 percent of all U.S. energy services. It was 73 percent greater than total U.S. oil consumption, five times domestic oil production, three times all oil imports, and 13 times Persian Gulf oil imports. The lower intensity was mostly achieved by more productive use of energy (such as better-insulated houses, better-designed lights and electric motors, and cars that were safer, cleaner, more powerful, and got more miles per gallon). The savings were only partly caused by shifts in the economic mix, and only slightly by behavioral change. Since 1996, saved energy has been the nation’s fastest-growing major “source.”¹⁷

In nearly every case, energy efficiency costs less, usually far less, than the fuel or electricity that it saves. It is cost effective to save at least half the energy now used in developed countries at prices averaging around 2¢ kWh.¹⁸ Almost no form of new supply, and few historic ones, can compete with this. And there is a lot of efficiency that is worth buying.

The 40 percent drop in U.S. energy intensity since 1975 has barely dented the potential. The United States has cut annual energy bills by about \$200 billion since 1973, yet is still wasting at least \$300 billion a year. That number keeps rising as smarter technologies deliver more and better service from less energy. And the side benefits can be even more valuable—for example, studies show 6 to 16 percent higher labor productivity in energy-efficient buildings.¹⁹

IV. RENEWABLE POWER TECHNOLOGIES

This huge overhang of efficiency can contribute to a transition to a clean energy economy. It can also make it very difficult unless national energy policies integrate strategies to implement efficiency as a conscious part of implementing other clean technologies.

We are witnessing a renewed boom in renewable energy, as advocates of clean energy call ever more loudly for a transition to clean energy:

Trends in Energy Use, by Source, 1995-2001

Energy Source	Annual Rate of Growth (percent)
Wind power	+ 32.0
Solar photovoltaics	+ 21.0
Geothermal power*	+ 4.0
Hydroelectric power	+ 0.7
Oil	+ 1.4
Natural Gas	+ 2.6
Nuclear Power	+ 0.3
Coal	- 0.3

*Data available through 1999.²⁰

Europe is perhaps the best known of the regions pursuing renewable supply, driven by a much clearer understanding on the part of Europeans that climate change is real and that effective policy measures are needed to counter it. In 2001, EU decreed that 22 percent of electricity, and 12 percent of all energy, should come from renewable sources such as wind within 10 years. This target is part of the way the E.U. intends to meet its obligations under the Kyoto protocol.²¹

According to a study released in 2002 by the European Wind Energy Association (EWEA), Europe's wind energy industry grew by 40 percent over the last year. In the 21 countries included in the study, installed wind capacity rose from 14,652 MW to 20,447 megawatts between October 2001 and October 2002. According to the same study, capacity on the continent could rise to 100,000 MW by the end of the decade. The European wind power industry estimates that, given the right legal and financial support, wind projects could provide energy for 50 million people in Europe in less than 10 years' time.²²

Following on the German government's decision in the late 90's to phase out nuclear power completely, Germany has begun to pursue the most dramatic expansion of renewable energy in the world.

In recent years Germany has accounted for roughly half of all wind turbines built worldwide. Bundesverband WindEnergie, the German wind energy association, recently announced that 2002 was another record-breaking year for installation of wind energy systems in that country. A total of 3,247 MW of generating capacity were installed last year, bringing German wind supplies to more than 12,000 MW, produced by nearly 14,000 wind turbines. Four and a half per cent of German electricity is now generated from wind, surpassing the contribution from hydroelectric power. The wind sector in

Germany now employs 45,000 people, one-fifth of whom were hired last year.²³ This rapid growth in wind power is central to reaching Germany's goal of reducing carbon emissions 40 percent by 2020.

Authorities in Germany are now considering plans to build up to 5,000 turbines off the country's north coast.²⁴ Giant turbines, double the size of conventional ones, are being developed for this use. Some of the turbines would be located in the open sea up to 45 km from land—a feat never before attempted. Since wind is stronger at sea, the energy potential is highly attractive. Already the world's leading country in the development of onshore wind energy, Germany has plans to add 25,000 MW to offshore capacity by 2030, up from a current level of zero.²⁵

Close behind Germany in installed wind power is Spain, which currently ranks number two in Europe with 4,079 MW installed capacity.²⁶

The US Press is beginning to take notice of such developments. According to an article published in *USA Today* on 7 Feb 2002, "Throughout Europe, wind power has turned into a serious source of energy, leaving the USA—the country that pioneered it as a modern technology—in the dust. Amid growing concern about climate change and other environmental problems blamed on the burning of fossil fuels, European governments are encouraging utility companies to harness the wind, especially at sea where it blows hardest.

"In 2001, EU countries produced more than four times as much energy through wind as the USA, and experts predict that within 10 years at least 10 percent of Europe's electricity will be supplied by giant wind turbines hooked up to main power grids. Even the technology used to produce power from wind, originally a US development, has moved to Europe. GE is the only company that still makes wind turbines in the US—90 percent are now produced in Europe. According to Randall Swisher, executive director of the American Wind Energy Association, 'We have frittered away our dominant role in this technology... We had the strategic advantage, and we lost it.'"

However, while the United States is not leading the wind revolution, neither is it ignoring it. U.S. wind generating capacity expanded by nearly 10 percent in 2002, to a total of 4,685 MW. However, development depends largely on the existence of a federal wind tax credit, which must be renewed every two years. Growth in 2002 was slower than in previous years due to the fact that the tax credit had expired at the end of 2001 and an extension was not signed until mid-March. During those first months of 2002, many wind development projects were placed on hold.²⁷

Environmental researcher and author Lester Brown of the Earth Policy Institute writes, "Over the last decade wind has been the world's fastest-growing energy source. Rising from 4,800 megawatts of generating capacity in 1995 to 31,100 megawatts in 2002, it increased a staggering six-fold worldwide. Wind is popular because it is abundant, cheap, inexhaustible, widely distributed, climate-benign, and clean—attributes that no other energy source can match. The cost of wind-generated electricity has dropped from

38¢ a kilowatt-hour in the early 1980s to roughly 4¢ a kilowatt-hour today on prime wind sites. Some recently signed U.S. and U.K. long-term supply contracts are providing electricity at 3¢ a kilowatt-hour. Wind Force 12 projected that the average cost per kilowatt-hour of wind-generated electricity will drop to 2.6¢ by 2010 and to 2.1¢ by 2020. U.S. energy consultant Harry Braun says that if wind turbines are mass-produced on assembly lines like automobiles, the cost of wind-generated electricity could drop to 1-2¢ per kilowatt-hour. In contrast with oil, there is no OPEC to set prices for wind. And in contrast to natural gas prices, which are highly volatile and can double in a matter of months, wind prices are declining. Another great appeal of wind is its wide distribution. In the United States, for example, some 28 states now have utility-scale wind farms feeding electricity into the local grid. While a small handful of countries controls the world's oil, nearly all countries can tap wind energy.”²⁸ Worldwide, in 2001 alone wind grew by a robust 36 percent.

Renewables are making headway in developing countries as well. A rapid switch from coal to gas, efficiency and renewables is underway in the People's Republic of China, pushed by the need to boost economic development and reverse the public-health emergency caused by air pollution. In 1996, China mined 1.4 gigatonnes of coal. Most experts thought that would double early in the new century. But in 2002 China's coal mining was back to its 1986 level—0.9 GT—and heading for 0.7 GT. A modern natural-gas infrastructure is being built with wartime urgency in five key cities. Modern Danish wind turbines are being installed in Mongolia. China, which cut its energy intensity of economic growth in half in the 1980s, has nearly done so again, and can do more. China is very interested in hybrid-electric cars, fuel cells, and hydrogen. China's transition is driven not only by the fact that coal is unacceptably dirty, but also the realization that if they were to rely on coal as their basic fuel for their development, they would have no rail capacity to carry anything but coal. In addition, the Chinese are becoming very interested in the entire concept of sustainability. The first run of the book *Natural Capitalism* sold out in two days. They have recently created a Department of Sustainability at Peking University. The Chinese have also been active participants with Royal Dutch Shell in developing energy planning scenarios.²⁹

Similarly India is one of the world leaders in wind energy, adding 240 MW of wind capacity in 2001. As of 2002 it had 1,627 MW of installed wind turbines.

Lester Brown acknowledges that, “Projecting future growth in such a dynamic industry is complicated, but once a country has developed 100 megawatts of wind-generating capacity, it tends to move quickly to develop its wind resources. The United States crossed this threshold in 1983. In Denmark, this occurred in 1987. In Germany, it was 1991, followed by India in 1994 and Spain in 1995.”

By the end of 1999, Canada, China, Italy, the Netherlands, Sweden, and the United Kingdom had crossed this threshold. During 2000, Greece, Ireland, and Portugal joined the list. And in 2001, it was France and Japan. As of early 2002, some 16 countries, containing half the world's people, have entered the fast-growth phase.”³⁰

Projections of worldwide use of renewables follow what is happening at the country level. In 1998 the Royal Dutch Shell external relations newsletter, Shell Venster, stated that, “In 2050 a ratio of 50/50 for fossil/ renewables is a probable scenario, so we have to enter this market now!” Shell’s Dynamics as Usual scenario finds it plausible that renewables will supply 20 percent of world energy by 2020, and a third by 2050. Their more aggressive scenario, Spirit of the Coming Age finds a transition to a hydrogen economy plausible by 2050, driven in part by a Chinese conversion to hydrogen.³¹ In 1995 London’s Delphi Group began advising its institutional investment clients that alternative energy industries offer “greater growth prospects than the carbon fuel industry.”³²

The US-based Solar Energy Industries Association said that solar research has cut prices to a point where the world could expect to see photovoltaic panels competing with natural gas-fired generation within the next five to eight years.³³ Statistics from the Global Environment Facility (GEF) show that the market for photovoltaic solar energy is growing by 15 percent a year.³⁴ The United Nations’ World Energy Assessment said solar thermal power plants covering just one percent of the world’s deserts could meet the entire planet’s current demands for energy.³⁵

Japan leads the world in installed solar generating capacity with approximately 400 MW. Installed solar power in Germany stood at 200 MW in 2001, while the United States ranks third with approximately 179 MW in installed solar capacity.³⁶

V. How Many Economists Does it Take to Change a Light bulb?³⁷

Efficiency is a well-established technology with favorable economics. Renewables are on a rapid growth path. Shouldn’t the market simply sort all this out?

Perhaps...if we had a true market, free of distorting subsidies. Unfortunately, nowhere does such market exist in energy or any other commodity with the possible exception of illicit drugs (though the DEA may be the most effective agricultural subsidy in history). Energy choices around the world are beset by subsidies and market distortions of all sorts, which have, in large measure, dictated the energy mix that we have today. Worldwide, it is estimated that subsidies to the energy sector, overwhelmingly to fossil fuels, top \$240 billion each year.³⁸ Any strategy that seeks to foster a transition to clean energy has to reckon with these distortions. Unfortunately, few government officials even want to know what those are.³⁹ This is especially true in Europe, where only recently have any competent estimates been made of subsidies to the energy sector.

In the United States, historic subsidies, for example, to nuclear power, have exceeded the money spent on the Vietnam War and the space program combined. This to deliver less energy than the burning of wood. According to even recent estimates, government subsidies to the energy sector in the United States alone are at least \$30 billion per year, a disproportionate amount of that going to support the nuclear and fossil fuel industries.⁴⁰ Because of this, “The American economy is, after Canada’s, the most energy-dependent in the advanced industrialized world, requiring the equivalent of a quarter ton of oil to

produce \$1,000 of gross domestic product. Americans require twice as much energy as Germany—and three times as much as Japan—to produce the same amount of GDP.”⁴¹

One reason renewables have had such a hard time gaining a foothold in the U.S. is that they compete not only with subsidized conventional energy, but also directly with efficiency. Recently, the US Department of Energy reported that the use of renewable energy fell in 2001 to its lowest level in 12 years. Much of that was due to low hydroelectric output from reduced snow pack in western states, but the DOE noted that the base of solar generating equipment was also being retired faster than it was being replaced.⁴²

This is all clearly daft. It is also a recipe for uncompetitiveness. But in light of the 2001 Cheney energy proposals (which remain largely a gleam in the Administration’s eye), it is perhaps unreasonable to look to the Bush Administration to provide a level playing field on which efficiency and all forms of supply might compete fairly.⁴³ The Administration even took money from the Energy Department's solar and renewable energy and energy conservation budgets to pay for the cost of printing its national energy plan that called for reducing such programs and increasing subsidies to fossil and nuclear technologies. Reuters reported that, “Documents released under court order by the Energy Department this week revealed that \$135,615 was spent from the DOE's solar, renewables and energy conservation budget to produce 10,000 copies of the White House energy plan released in May 2001.”⁴⁴

Despite public opinion polls showing support for renewable energy, there is also growing resistance to particular applications. The citizens of Cape Cod are fighting a proposed wind farm proposed for Nantucket Sound, the first off-shore facility in the U.S. The New York Times reported, “But like residents of dozens of communities where other wind-farm projects have been proposed, many Cape Codders have put aside their larger environmental sensitivities and are demanding that their home be exempt from such projects. As (Walter) Cronkite puts it, “Our national treasures should be off limits to industrialization.”⁴⁵ The proposed wind farm is on hold.

There is also some question about how the electricity from the wind farms would get to market. While farmers and ranchers throughout the Heartland welcome wind farms as great neighbors to their cows and corn fields, the communities through whom the transmission lines carrying the wind energy to distant power-hungry cities would have to pass are considerably less enthusiastic. And it is not entirely clear where the money for the transmission lines will come from. Such capital costs will raise the cost of the *delivered* power. Once again, efficiency may come to look increasingly attractive.

VI The Beginnings of An Integrated Policy

While American energy policy is drafted by promoters of technologies beloved in the oil patch, the Europeans are beginning to realize that an integrated strategy of efficiency and renewables might just enable them not only to get beyond the historic boom and bust oscillations, but could give them a competitive edge as well.

In 1999, then British Environment Minister Michael Meacher said, “I cannot over-emphasise that improved energy efficiency, and growth in renewable energy, are not alternatives – we need to pursue both issues vigorously, and we are doing so.” And Deputy Prime Minister John Prescott announced the Climate Change Programme in March of 2000 by saying, “We need a radical shake up in the way we use energy and we need to generate energy in new sustainable ways.”⁴⁶

An integrated policy is vital not only because ignoring efficiency will endanger a renewable (or conventional) supply strategy. Perhaps more importantly, focusing first on efficiency makes any supply strategy so much more attractive. In the absence of energy efficiency supply strategies become prohibitively expensive. With efficiency, renewables can provide a far greater fraction of supply, and do so more cost effectively than conventional power.⁴⁷ A dollar can only be spent once. If it buys efficiency, the best buy, more of our budget is left to buy the increasingly attractive renewable supply options. If that dollar is spent first on either centralized, capital intensive conventional supply, it can not then be spent to save the energy that will make much of that supply unnecessary – until the higher prices that the supply will require to pay back its investment elicits defensive investments in efficiency. But it is exactly this sort of oscillation that has ensured energy insecurity. The only answer, as the Europeans are starting to realize, is to invest first in efficiency, then renewables, and to do so as part of a conscious, integrated plan.

A recent European Commission Green Paper, “Towards a European Strategy for Energy Supply Security” highlighted a central role for energy efficiency in increasing the security of supply and reducing greenhouse gas emissions. It stated that improving the efficiency with which energy is consumed by end-users is a central theme of energy policy within the European Community, since improved energy efficiency meets all three goals of energy policy, namely security of supply, competitiveness and protection of the environment. This is further developed in the recent European Climate Change Programme (ECCP), which highlights the large cost-effective potential for improving energy efficiency of end-use equipment.⁴⁸

Recent pronouncements go even further. The Energy-Intelligent Europe Initiative is a cross-party and cross-nation action within the European Parliament, which calls for making Europe's economy the most energy intelligent in the world. By 15 February 2002, 41 Parliamentarians from all of the 15 European member states had signed the call, which states that the purpose is to promote energy efficiency in Europe as the number one energy "source". Linking Energy Intelligence to the knowledge-based economy "will help Europe to become the most competitive economy worldwide while achieving its the fullest attention of the EU and of Member States". The initiative concludes that energy efficiency is not perceived as an important policy tool for the moment, but points out that energy efficiency and a more energy intelligent economy is what will enable Europe to remain competitive and promote a high quality of life.⁴⁹

But critics disagree, claiming that funds for the promotion of energy efficiency are inadequate, “The entire budget will amount to just over 1 million Euros per member state per year... a minor percentage increase upon budgets originally set well over a decade ago, when not even lip-service was being paid to the need to prioritize sustainable energy.” They noted that, “It is appropriate for the Union to concentrate on guiding and steering demand, unlike the United States, which seeks to meet demand by constantly boosting supply.”⁵⁰

VI. THE ECONOMIC BENEFITS OF AN INTEGRATED STRATEGY OF EFFICIENCY AND RENEWABLES

What would an intelligent combination of efficiency and renewable supply look like? It turns out it has been done, and the combination offers a winning way to strengthen local economies and create new jobs. The example is also evidence that if national governments continue to be unable to grasp this concept there is hope at the local level.

Sacramento is California’s capital city of 400,000 (in a Metro area of 1.8 million). The Sacramento Municipal Utility District (SMUD) demonstrated how investments in efficiency *and* locally generated power can enhance the bottom line of the utility and the health of the regional economy.

SMUD is the sixth largest municipal utility in the US, serving 1.2 million customers.⁵¹ In 1989 its customers/owners voted to close the Rancho Seco Nuclear facility. Noted Jan Schori, who became general manager of the utility in 1993 and remains at the helm today. “When we closed the Rancho Seco nuclear plant we lost 913 megawatts on a 2,100-megawatt system. It became an opportunity for us to start over.”⁵²

By 1995, SMUD was spending 8 percent of its gross revenues on energy efficiency and was being described “as a symbol of what’s possible...the national poster child of green utilities.”⁵³ This investment reduced the peak load by 12 percent and enabled SMUD to hold rates constant for 10 years. Had Rancho Seco operated, rates would have increased 80 percent.

SMUD also installed:

The nation's largest photovoltaic power plant, providing 2 megawatts (MW) of solar power to 500 homes, located next to the closed Rancho Seco nuclear facility.

- One of the largest utility-owned commercial wind turbine project in the United States, producing 5 MW.
- The largest solar home project in the nation—supporting 100 customers a year with installation of a 4-kilowatt (kW) photovoltaic panel system on their rooftops.
- One of only two photovoltaic recharging stations for electric vehicles in the United States.

- Two geothermal projects with a total generating capacity of 134 MW.⁵⁴

SMUD partnered with the Sacramento Tree Foundation to plant 300,000 shade trees from 1990-2000 and continues to offer customers free trees (with advice, fertilizer and free delivery) for planting on the east, west or south side of buildings. Full-grown trees can reduce indoor cooling requirements up to 40 percent.⁵⁵ The district has also helped customers to purchase over 42,000 super-efficient refrigerators.⁵⁶

Continuing its cost-effective focus on reducing energy demand, SMUD instituted a Cool Roof program. Building owners, through contractors, can earn a SMUD rebate of 20¢ per square foot for installing Energy Star sun-reflecting coating on flat roofs. The highly reflective coating helps block heat from the sun from being absorbed through a flat roof and into a building. This means less energy consumed by air conditioning systems.⁵⁷

An economist calculated the present value of SMUD's 1997-2001 energy efficiency programs for the Sacramento region's economy as \$130 million over the life of the efficiency investments. Most businesses are expected to save 10-19 percent on their energy bills, which translates into more profits/jobs/wages/competitiveness. The impacts include the creation of over 150 additional job-years for a dozen years.⁵⁸ One company, which had projected that higher rates would force it to close, was able to stay in business, saving 2,000 jobs. Sacramento's competitive rates attracted such new factories as Apple, Intel, and a solar manufacturer. The program lowered the utility's debt, upgraded its credit, and made it the most competitive utility in California.

By 2000, SMUD's photovoltaic installation program had installed more than 450 residential and 30 commercial photovoltaic systems. These systems are grid-connected and feature net metering, which by earning revenue from providing power to the electrical grid buys down more than half of the cost of the systems.⁵⁹ The current program offers homeowners lower costs than private marketers do. The SMUD website says the systems are "virtually free energy after an 8-15 year payback period." They are expected to have a 30-year system lifespan. Though home values increase, no additional property taxes are levied on the value of the system. As of September 2001, the California energy shortage has caused tremendous surge in interest in rooftop solar systems, leaving SMUD with a large backlog of orders.⁶⁰

About half of SMUD's current power supply comes from its own hydro, wind and photovoltaic power plants (at 8 MW, SMUD uses more solar than any other utility in the US) and four highly efficient natural gas cogeneration plants built in the 1980s and 90s. The other half is purchased through long-term contracts and SMUD plays the market for best prices. Despite Sacramento's continued growth, SMUD helped shave annual peak power requirements by nearly 3 percent from 1999 to 2000.⁶¹

The U.S. EPA office in Richmond, CA (a Bay Area suburb) became the first federal facility entirely powered by green power through a contract with SMUD in 1999. During the first year of the contract between the EPA and the SMUD, 60 percent of the building's

power was sourced from geothermal energy, with the remaining 40 percent coming from a landfill gas generation. In the future, all of the building's energy will come from the landfill.⁶² Other such projects came on line in 2000 and 2001.

In October 2001, SMUD's Board voted for a ten-year strategic plan developed by General Manager Schori.

The proposed plan calls for:

- Saving enough electricity through energy efficiency to power more than 40,000 homes.
- Maintaining competitive rates that are now 30 percent less than neighboring utility, PG&E's.
- Adding new wind power to meet the needs of 12,000 homes and new solar power to serve up to 8,000 homes.
- Building a new 500-MW combined-cycle gas-powered plant adjacent to the closed Rancho Seco plant. The new plant will meet a large portion of Sacramento's round-the-clock electricity demand and bolster SMUD's system reliability.

The plan diversifies SMUD's fuel mix, reducing the financial risks of relying on one fuel or generating source. "As we've seen in the past 18 months, no one can predict uncertainties such as prolonged dry water years and major shifts in market conditions," Schori said. "This is a progressive yet prudent plan for meeting Sacramento's long-term energy needs with one of the cleanest, most reliable and affordable energy mixes in the state."⁶³

VII. Conclusion

Albert Camus argued that Sisyphus was free because, though condemned to forever roll his rock by the gods, he also had the trip back down the hill to reflect and to enjoy his own personal thoughts. But for promoters of renewable energy supply, this freedom comes with a terrible cost.

Currently in North American we are squandering our back hauls, taking the time to neither put in place a smart energy policy nor a timetable for making the transition away from conventional fuels. Energy efficiency should be the cornerstone of any energy policy that hopes to survive the rigors of the market. It is the cheapest way to meet demands for the services that energy can deliver: hot showers and cold beer, the ability to move goods and people around, and the legitimate demands of emerging economies for abundant power for development. Coupled with renewable energy technologies it offers a policy that can meet the needs of the world for energy services, while supporting local

community economic development. It is cheaper than any form of supply, and in a real competition, will render most proposals for new supply unattractive.

But in North America it remains the ignored energy source. At least until the next energy crisis.

¹ “Clean technologies” refers to appropriately scaled solar, wind, hydro, biomass, wave/tide energy supply technologies, and especially to the wide array of ways to use all forms of energy more efficiently. It does not include nuclear, or the various efforts to centralize renewable technologies. Energy efficiency means doing the same or greater tasks but using less energy to achieve it. It is distinguished from energy conservation, which means curtailing activities to save energy.

² K. Butti and J. Perlin, *A Golden Thread, 2,500 Years of Solar Architecture and Technology*, Cheshire Books 1980.

³ Efficiency is not the same as curtailment, which entails cutting back activities so as to use less energy. Confusion between these concepts is what led Vice President Dick Cheney, architect of the Bush administration’s national energy policy, to state that that a nation cannot conserve its way to greatness. Expansionists may argue that this is true of curtailment. Only someone profoundly uninformed of economics would make the same argument of efficiency. Doing more with less, paying less, causing less harm to the environment and thereby enhancing national security is not only an effective foundation for a national energy strategy, it is the cornerstone.

⁴ Early in Reagan’s administration he ordered DEO to pulp the Agricultural Yearbook that taught farmers how to use energy more efficiently. The then Executive Director of the Daughters of the American Revolution went to the DOE warehouse at night and loaded a pickup with as many copies as his truck could carry and distributed them to DAR members at their Continental Congress the next day.

⁵ A. Lovins and H. Lovins “Mobilizing energy Solutions”, Feb 02, *The American Prospect*

⁶ According to David Roodman, an analyst at the Center for Global Development, the U.S. government subsidizes automobiles at a rate of \$111 billion a year above and beyond what it reaps in auto taxes and fees – an estimate that does not include the environmental, health and military costs of burning fossil fuels. One recent example of a subsidy is the provision in the Bush economic plan to increase the amount that business owners can deduct for the purchase of an SUV.

For example: Dodge Durango Sticker price \$27,205 Current law Equipment deduction \$25,000 Total tax deduction* \$25,971

Bush economic plan Equipment deduction \$27,205 Total tax deduction \$27,205. This includes the bonus tax write-off enacted by Congress in March 2002 and a deduction for normal depreciation.

How the write-off works

Hummer H1

Sticker price \$106,185

Current law

Equipment deduction \$25,000

Total tax deduction* \$60,722

Bush economic plan

Equipment deduction \$75,000

Total tax deduction* \$88,722

Sources: Detroit News research, IRS, Taxpayers for Common Sense

Reported in a story by Jeff Plungis / Detroit News Washington Bureau, article in Detroit News by Jeff Plungis, Jan 20, 2003

⁷ “environmentalists Criticize Ford Fuel Efficiency, Reuters, 5 June, 2003
”<http://www.planetark.org/dailynewsstory.cfm/newsid/21045/story.htm>

⁸ www.nap.edu/books/0309076013/html/. This is a conservative analysis.

⁹ Achieving such savings would be good for more than driver’s pocketbooks: Such vehicles release 20% of American carbon dioxide emissions.

¹⁰ Some analysts doubt that there is any economically recoverable oil in the Refuge. The U.S. Geological Survey conducted a peer-reviewed assessment of the probability of finding oil under the refuge that would be cost effective to extract, and concluded that there is probably *no* economically recoverable oil beneath the Refuge—at the moderate oil prices discovered in the futures market, forecast by industry and government, and relied upon by the state of Alaska’s revenue forecasts. For more details on Arctic Refuge oil, see the July/August 2001 *Foreign Affairs* article “Fool’s Gold in Alaska.” Its published plain text and a hypertexted and heavily annotated version are both at www.rmi.org/sitepages/pid171.php.

¹¹ http://www.wbcsmobility.org/news/cat_1/news_106/index.asp

¹² “California and the Energy Crisis: Diagnosis and Cure”, a report by the American Council for an Energy Efficient Economy for the Energy Foundation, March 2001: <http://www.ef.org/california/>

¹³ “Conservation may be a sign of personal virtue, but it is not a sufficient basis for a sound, comprehensive energy policy.” Dick Cheney quoted in the New York Times, 6 May 2001

¹⁴ R. Smith, “Power Industry Cuts Plans for New Plants, Posting Risks for Post-Recessionary Period,” *Wall St. J.*, p. A3, January 4, 2002, reports data from Energy Insight (Boulder, CO), showing that at least 18%, or 91 out of a total announced portfolio of 504 billion watts planned for construction, had been cancelled or tabled by the end of 2001. (The 504-billion-watt portfolio included longer-term projects than those summarized at the beginning of this paragraph.) Ms. Smith interprets the reductions as likely to create power shortages; we interpret them as likely to reduce financial losses when demand assumptions prove exaggerated—especially if saving electricity is allowed to compete fairly with producing it.

¹⁵ The states most actively supporting energy efficiency programs continue to be primarily in the Northeast, the Pacific Northwest, and certain parts of the Midwest, along with a handful of other states, including California, Florida, and Texas. The average annual spending across all 50 states is \$ 3.88 per capita. Connecticut ranks first in per capita program spending at \$19.48. While this overall national trend is encouraging, the research demonstrates that only about one-third of the states account for nearly all (86%) of the spending by utilities and states on energy efficiency programs. The report “State Scorecard on Utility and Public Benefits Energy Efficiency Programs: An Update” is available at ACEEE’s web site for further information, contact: Email: aceee_publications@aceee.org.

¹⁶ No doubt Saddam is a bad actor, but if Iraq grew only broccoli would we be massing an invasionary force on its borders.

¹⁷ This and other information about energy efficiency can be found in “Mobilizing Energy Solutions”, Lovins and Lovins, Feb 02, *The American Prospect*

¹⁸ A. Lovins “Negawatts, 12 Transitions, Eight Improvements and One Distraction” Energy Policy, 24 (4):331- 343 (April). Also 'World Survey of Decentralized Energy - 2002/2003', <http://www.localpower.org/>

¹⁹ That’s because workers can see better what they’re doing, breathe cleaner air, hear themselves think, and feel more comfortable. Offices typically pay about 100 times as much for people as for energy, so 6–16% higher labor productivity increases profits by about 6–16 times as much as eliminating the entire energy bill. See J.J. Romm & W.D. Browning, “Greening the Building and the Bottom Line,” Rocky Mountain Institute, 1994/98, www.rmi.org/images/other/GDS-GBBL.pdf; www.h-m-g.com/Daylighting/daylighting_and_productivity.htm.

²⁰ THE EARTH POLICY READER by Lester R. Brown, Janet Larsen, and Bernie Fischlowitz-Roberts, 2003, http://www.earth-policy.org/Books/EPR_contents.htm

²¹ http://www.viridiandesign.org/notes/251-300/00254_europe_doubles_green_power, quoting a Reuters article on the EU vote. The strategy was first laid out in: .htmlEnergy for the Future: Renewable Sources of Energy See p. 9, section 1.3.1. An Ambitious Target for the Union http://europa.eu.int/comm/energy/library/599fi_en.pdf

²² European Wind Energy Association Report - European Wind Generating Capacity breaks 20,000MW. <http://www.ewea.org/doc/20gw%20briefing.pdf>

²³ <http://www.planetark.org/dailynewsstory.cfm?newsid=19548>

²⁴ The Irish, British and Danes are also building offshore wind facilities.

²⁵ <http://www.planetark.org/dailynewsstory.cfm?newsid=19129>

²⁶ <http://www.ewea.org/doc/20gw%20briefing.pdf>

²⁷ Reuters article, 27 January 2003: US Wind Power Growth Waned in 2002

²⁸ WIND POWER SET TO BECOME WORLD'S LEADING ENERGY SOURCE, Lester R. Brown, 2003, <http://www.earth-policy.org/Updates/Update24.htm>

²⁹ H. Lovins and W. Link, Insurmountable Obstacles, Invited paper to the UN Regional Roundtable for, Europe and North America. Vail, Colorado, 2001, <http://www.theglobalacademy.org/>

³⁰ For more information on the emerging solar/hydrogen economy, see Chapter 5 of Eco-Economy: Building an Economy for the Earth. <http://www.earth-policy.org/Books/index.htm>

³¹ <http://www.shell.com/home/media-en/downloads/scenarios.pdf>

³² M. Mansley, “Long Term Financial Risks to the Carbon Fuel Industry from Climate Change, Delphi Group London, 1995

³³ Article by Michelle Nichols, “Solar Power to Challenge Dominance of Fossil Fuels,” 9 August 2002 Reuters

³⁴ Ibid

³⁵ Ibid

³⁶ Reuters article, 25 November 2002

³⁷ None, the free market will do it.....

³⁸ C. van Beers and A. de Moor, *Public Subsidies and Policy Failures*, Edward Elger Publishing, 2001. The European Commission took the first step towards possible reform of EU energy subsidies by producing an inventory of all forms of state support provided to the fossil fuel, renewable and nuclear energy sectors. Published at the end of December 2002, the document clearly signals that subsidies to power sources are under Commission scrutiny. The Commission says the inventory may "provide the starting point for a reform of national and EU aid schemes", determining "whether certain energy sources are... given advantages that do not adhere to the objectives of energy policy and combating climate change". "The fact that the Commission has undertaken this study is a major step because they have consistently refused to do so before," energy specialist Rob Bradley of environmental group CAN Europe told Environment Daily. In recent years, MEPs, environmentalists, international bodies such as the OECD and, increasingly, member state governments have been asking for the support granted to different energy sources to be made more transparent.

The EU renewable energy directive, adopted in 2002, also calls on the Commission to propose a harmonised support framework for renewables if a comparison of subsidies identifies any "discrimination" between energy sources. European Commission energy subsidies working paper and power point presentation. ENDS Environment Daily, (2003-01-09)

³⁹ I have sat in meetings with senior energy officials from such European nations as France who have denied that their governments, give any subsidies, and when confronted with clear evidence of a variety of subsidies, have refused to reveal the amounts given, for example to the nuclear programs of Electricite de France, clearly one of the most heavily subsidized electricity program in the world.

⁴⁰ R. Heede, A Preliminary Assessment of Federal Energy Subsidies, 1984, www.rmi.org

⁴¹ Ricardo Bayon, *The Atlantic Monthly*, Jan/Feb 2003, p. 117

⁴² Matthew Wald, "Use of Renewable Energy Took a Big Fall in 2001" *New York Times*, 6 December 2002

⁴³ The Administration even took money from the Energy Department's solar and renewable energy and energy conservation budgets to pay for the cost of printing its national energy plan that called for reducing such programs and increasing subsidies to fossil and nuclear technologies. Reuters reported that, "Documents released under court order by the Energy Department this week revealed that \$135,615 was spent from the DOE's solar, renewables and energy conservation budget to produce 10,000 copies of the White House energy plan released in May 2001." Tom Doggett Reuters News Service, 2 Ap. 2002

⁴⁴ Tom Doggett Reuters News Service, 2 Ap. 2002

⁴⁵ Elinor Burkett, "A Mighty Wind", *NYT*, June 15, 2003, <http://www.nytimes.com/2003/06/15/magazine/15WIND.html?ex=1057204576&ei=1&en=c6657f4c00300148>

⁴⁶ Speeches to the British Wind Energy Association. <http://www.bwea.com/pdf/gen.pdf>

⁴⁷ *Energy Revolution*, Howard Geller, Island Press, 2002

⁴⁸ EU programmes to achieve this include the GreenLight Programme, the Standby Initiative, the Motor Challenge Programme, the Luminaire Design Competition, the EuroDEEM database, and initiatives in the

field of appliances, building (e.g. the Thebis database) and industrial fields (e.g. E2MAS and LTAs), and DSM/ESCOs area.

<http://energyefficiency.jrc.cec.eu.int/html/readmore.htm><http://energyefficiency.jrc.cec.eu.int/html/readmore.htm>

⁴⁹ http://www.eceee.org/eceee_forum/EI-Europe.lasso

⁵⁰ Statement by the European Alliance of Companies for Energy Efficiency in Buildings, testifying at Parliamentary hearings on Intelligent Energy for Europe, <http://www.europarl.eu.int/hearings/20020911/itre/euroace.pdf>

⁵¹ Sacramento Municipal Utility District website: <http://www.smud.org>

⁵² Public Utilities Fortnightly 1 December 1994

⁵³ E Magazine, “Lights Out: The Case for Energy Conservation” by Stephen Beers and Elaine Robbins, January 1998

⁵⁴ Ibid.

⁵⁵ SMUD website, Sept. 01: Shade Tree Program.

<http://www.smud.org/sacshade/index.html>

⁵⁶ E Magazine, January 1998

⁵⁷ SMUD website, <http://www.smud.org> September 2001

⁵⁸ Dr. Robert Fountain, Real Estate & Land Use Institute, California State Univ. at Sacramento, “Economic Impact of SMUD Energy Efficiency Programs”, March 29, 2000. Available at <http://www.smud.org>

⁵⁹ The Electricity Daily, August 24, 2000, Despite the Fuss, Some Things Work in Calif.

⁶⁰ SMUD website, <http://www.smud.org> September 2001

⁶¹ SMUD website, Facts and Figures. The actual decrease was from 2,759 MW to 2,688 MW.

⁶² San Francisco Business Wire, July 23, 1999: First Federal Facility Switches to 100 % Renewable Power.

⁶³ SMUD website, <http://www.smud.org> September 2001