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But We'll Freeze in the Dark!

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> Unless we tell our politicians to ignore Al Gore's scam, we'll all freeze in the dark. —Will Offensicht

Like Carol Overland, every participant in the No New Coal Plants listserve was out to stop coal-fired power plants. But was this a responsible position to take? Electricity, after all, is the lifeblood of modern society, the effect of its absence a rapid descent into chaos.

Opponents of coal scoffed at the idea that a moratorium on new coal-fired plants would pose any threat to the country's energy security. They pointed to the existence of ample reserves of electrical capacity and to studies showing massive untapped potential for expansion of wind, solar, and geothermal resources, at costs competitive with coal plants. They also pointed to the large gains in energy efficiency that were also available, at an even lower outlay.

Alan Muller of Green Delaware observed that costs for renewables like wind were dropping while coal plant costs were rising quickly. In a fair matchup with renewables, he believed that coal would lose. The key step, therefore, was to create regulatory procedures that forced coal plant proposals into one-on-one cost competition with alternatives. If such matchups could be made a regular step in the consideration of new plants, Muller was confident that coal would lose.

In 2007 Muller got a chance to test his hypothesis, as Delaware put into effect a new process for judging utility expansion proposals known as integrated resource planning, or IRP, and at the same time began evaluating competing proposals for new power supplies. One proposal, from NRG Energy, was a coal-fired power plant known as Indian River. A competing proposal, from Bluewater Wind, involved offshore wind farms located about eleven miles from the coast, and backup power provided by natural gas turbines.

In Delaware, a public opinion survey by the University of Delaware showed strong support for wind and strong opposition to increased coal generation. But Muller felt that despite such sentiments the state was committed to its analytical process and would not choose the Bluewater alternative unless the cost data strongly supported that option. Ensuring that the numbers being provided by the bidders were valid was impossible to verify, since both NRG and Bluewater were seeking to prevent public disclosure of their respective bids. Muller suspected that NRG was supplying Delaware officials with low-ball figures, and he appealed to members of the No New Coal Plants listserve in other states for cost studies from other pending coal plant cases.

In response to Muller's appeals, data poured into Delaware from dozens of activists across the country: Colorado, Minnesota, and elsewhere. The most timely information came from Carol Overland, whose work in the Mesaba case had unearthed a trove of data showing dramatic increases in the costs of IGCC. Overland flew to Delaware and met with state officials to present the numbers. When the dust had settled, Delaware announced that the Bluewater Wind proposal had been chosen. "Carol's numbers drove the nail in the NRG coffin," said Muller.

Across the country, others were finding the cost of wind power increasingly favorable compared to the cost of new coal power. An analysis by the investment banking company Lazard Ltd. found the cost of generating electricity from coal to be 7.4 to 13.5 cents per kilowatt-hour (the high end included carbon capture and storage) while the cost from wind was estimated to be 4.4 to 9.1 cents per kilowatt-hour. A study released by the California Energy Commission estimated a cost range for coal of 10.6 to 17.3 cents per kilowatt-hour, compared with 8.9 cents per kilowatt-hour for wind. Mass production of wind turbines promised to lower costs even further. By the end of 2007, worldwide wind capacity had exceeded 93,000 megawatts and was on course to nearly double in three more years.

The U.S. Department of Energy (DOE) released a study showing that wind could supply 20 percent of the country's electricity needs by 2030. Under this scenario, wind would displace 50 percent of electric utility natural gas consumption and 18 percent of coal consumption, at costs ranging from 6 to 10 cents per kilowatt-hour, including the cost of connecting the wind into the grid. About a sixth of this power would be produced by offshore wind farms like the Bluewater proposal, bringing power to populated urban centers. Nor would the demands placed on U.S. manufacturing capacity be excessive. In the peak year of the buildout, the DOE study called for 16,000 megawatts of new capacity, an amount comparable to the amount of new gas turbine capacity installed in the United States in 2005.

Of course, in order to create the utility demand that would bring wind farms into actual existence, coal plants needed to be canceled. For that reason, Delaware's Indian River decision was particularly significant, because it shattered the conventional wisdom that coal is the lowest-cost way to provide power.

Wind was just one of several technologies that offered an alternative to new coal plants. Another was solar thermal, which energy analyst Joe Romm called "the solar power you don't hear about." In this surprisingly straightforward way of generating electricity, acres of mirrors heat pipes containing water or molten salt. The heated fluid in turn drives turbines to create electricity.

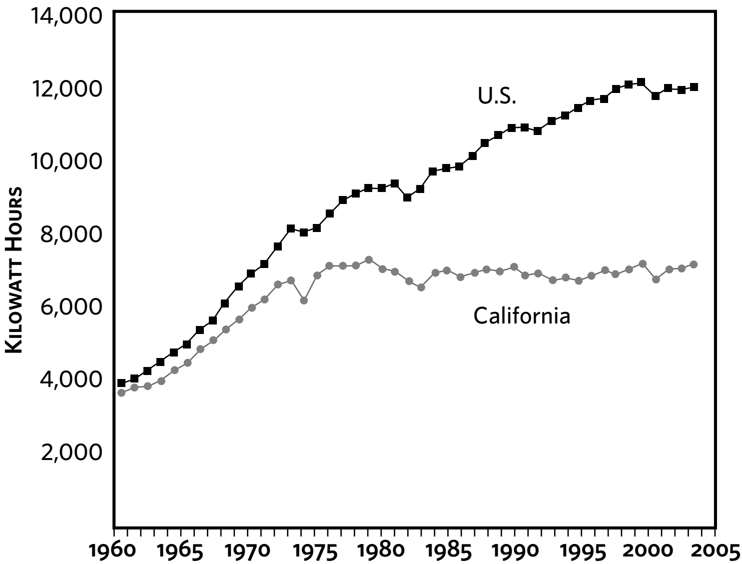
Under prodding by the California Energy Commission (CEC), solar thermal was rapidly moving into a position to become a major supplier of the electric grid for that state. The CEC liked the technology because its costs were estimated to be 27 percent lower than new coal plants with carbon capture and storage—12.7 cents per kilowatt-hour for power from a solar thermal plant versus 17.3 cents per kilowatt-hour for power from a coal plant equipped with carbon capture-and-storage technology.

During 2007, numerous solar thermal plants were moving forward, not only in the western United States but also in Europe. Several of the plants included on-site thermal storage, a feature that makes solar thermal a reliable source of baseload power. For example, in Spain, the Andasol 1 plant included large tanks containing tons of molten salts that absorbed heat during sunny periods and released it to generate power during cloudy periods or nighttime. The result was 7.5 hours of thermal storage and the ability to generate power for nearly twenty-four hours per day.

According to David Mills, chairman of solar thermal pioneer Ausra, a rectangle of land in the sunny southwestern United States measuring about ninety-five miles on each side, if devoted to solar thermal installations, could fully supply the U.S. electric grid. With favorable locations for solar thermal plants, Morocco could similarly supply power to Europe, as could the Gobi Desert to China. The necessary amount of land, while sizable, is about the same as the amount disturbed by coal mines, which are far more destructive. It would be just one-sixth of the area devoted to lawns, one-fifteenth of the area once devoted to raising feed for horses, and one-thirtieth of the area devoted to parks, wilderness, and wildlife refuges.

Further evidence that economically attractive alternatives to coal could be developed was contained in the report *The Future of Geothermal Energy*, penned by an eighteen-author team at the Massachusetts Institute of Technology and released in 2006. The report focused on the potential for enhanced geothermal power, a method for exploiting the hot dry-rock resource that exists nearly everywhere at depths of three to ten kilometers. To provide steam for an enhanced geothermal plant, deep wells are drilled, followed by injection of cold water to produce a network of cracks in the rock. Water is then pumped into the fractured rock and harvested as steam for generating power. According to the MIT study, the necessary step toward developing enhanced geothermal power is a government-financed research and development program to refine today's deep-well drilling technology. The study estimated that 100 gigawatts of enhanced geothermal plants could be built by 2050, an amount sufficient to replace about a third of today's coal plants, at a cost cheaper than building new coal plants.

Figure 2 Per Capita Electricity Usage in California and the United States, 1960–2005



Beyond wind, solar, and geothermal power, a way of supplying energy needs existed that was even more competitive and plentiful: efficiency and conservation measures. Some environmentalists suggested that using the term "negawatts" was the best way to convey that energy savings weren't just a matter of changing behavior by consumers, but rather could be proactively effected through utility investments and tougher standards for buildings and appliances.

To anyone who questioned the potential size, cost, or effectiveness of negawatts, the answer could be summed up in a single word: California. As shown in figure 2, electricity consumption patterns in California were the same as those in the rest of the United States until the early 1970s. But then something happened. Beginning in 1973 and continuing for the following three decades, California's electricity usage flattened out, while that of the rest of the country continued to rise another 50 percent.

The difference was astonishing. Sixty large coal plants that otherwise would have been necessary were not built in California. The main reason for California's lower energy usage was a bevy of state-mandated efficiency improvements that were largely invisible to the average citizen of the state. The flattening of per capita usage had been named the Rosenfeld Effect in honor of the Lawrence Berkeley Laboratory physicist responsible for many of the innovations, Art Rosenfeld.

Rosenfeld had been the last student of Enrico Fermi, one of the leading physicists behind the Manhattan Project. He was forty-six, with an extensive career in basic physics already behind him, when his moment of destiny arrived with the OPEC oil embargo of 1973. The embargo created a crisis across the United States, as lines of cars formed at gas pumps and a sense of panic filled the air. Rosenfeld's response was to bring a collection of experts in the fields of energy, utilities, transportation, and building design together for a month-long brainstorming session at Princeton University. One of the surprising findings of the meeting was that buildings alone account for two-thirds of the electricity used in the United States each year.

Recalling the watershed conference, Rosenfeld later said, "We realized we had found one of the world's largest oil and gas fields. The energy was buried, in effect, in the buildings of our cities, the vehicles on our roads, and the machines in our factories. A few of us began to suspect that the knowledge we gained during that month would change our lives."

Back in Berkeley, Rosenfeld founded the Center for Building Science, which over the next two decades developed a broad range of energy efficient technologies, including the electronic ballasts that led to compact fluorescent lamps, and a window material known as "smart glass" that blocks heat while allowing light to pass through.

Not content merely to develop such ideas, Rosenfeld pushed them into the California state policy arena. Luckily, the governor of California, Jerry Brown, reveled in new ideas. Under Brown's watch, California developed a bureaucratic structure to implement energy conservation. In addition to developing hardware, much of Rosenfeld's work had to do with developing policy mechanisms to make the electricity market "smarter" so that price signals could translate more effectively into conservation. For example, he pushed for time-of-day pricing, so that consumers and businesses that shifted their energy use to evening hours could benefit from lower rates and power company "peaks" could be smoothed off, eliminating the need for power plants. Another idea was smart meters, which could receive electronic signals offering lower prices for cutting back at critical times.

Each such innovation may seem trivial until you consider the size of the markets involved. There are about a hundred million refrigerators in the United States—maybe more. In the early 1970s refrigerators were lightweight and noisy. Rosenfeld and crew upped the efficiency of refrigerator motors from 30 percent to 90 percent and added insulation. The result was a machine that used a quarter of the electricity that it previously required and saved its owner $200 or more per year. Due to refrigerator improvements alone, a hundred large coal plants that would have been required were no longer needed.

This was the best answer to "If you block this coal plant, we'll have rolling blackouts and the lights will go out." To build a coal plant requires eight or more years of planning and construction. But efficiency measures can be implemented much faster.

Meanwhile, the reverse is true. If coal plants are built, utilities develop a powerful incentive to run those plants and have no reason to invest in alternative ways of meeting their customers' need for electricity; indeed, when utilities have excess capacity, they may even discourage rather than facilitate conservation measures. So energy efficiency and stopping coal plants are two efforts that work hand in hand.

Perhaps the most astonishing thing about the California energy revolution was how cheap it was. Innovations such as low-flow showerheads or tighter insulation standards for new housing cost 1 or 2 cents per kilowatt-hour, about a tenth of the cost of building a new power plant. Strict energy efficiency standards for refrigerators pushed manufacturers to innovate in ways that actually saved rather than cost money. Rosenfeld's energy-efficient windows, which were enabled by the careful development of a high-tech film coating, can reduce a building's energy use by 30 percent. Such windows yield many times more in savings than their initial cost.

Other than the entrenched political power of the coal and utility industries, there was no reason that the innovations Rosenfeld and his team had developed could not be adopted around the country. If that were to happen, it would hugely affect how many coal plants would be built in the future, if any.

Even a slight downward adjustment in projected growth rates is capable of having a dramatic effect on the building of new coal plants, since the expectation for growth is a prerequisite not just for utilities to plan new coal plants but also for regulators to approve them and banks to finance them. This became obvious when a bureaucrat named Guy Caruso caused 132 coal plants to disappear with a wave of his magic mouse.

Caruso was the head of the Energy Information Administration (EIA), which in 2007 projected that electricity consumption would grow at the rate of 1.5 percent per year through 2030. But on March 4, 2008, Caruso told Congress that the EIA had decided to adjust that number to 1.1 percent.

A change from 1.5 percent to 1.1 percent annual growth may not sound significant, but by 2030 the lowered growth rate would reduce the projected electricity generation requirements by the equivalent of 132 coal plants, each rated at 500 megawatts. While the EIA administrator does not actually decide which power plants are going to be built—that's done by individual utilities and power authorities, each making its own economic and power growth projections—the EIA projections do set the tone for governmental policy at all levels. So even though 132 coal plants weren't directly canceled by Caruso's scaled-back projection, the revision was a signal to utilities, state agencies, banks, and others involved in the planning and approval process: be careful not to overextend yourself in coal.

This admonition had a historic precedent in the fiscal meltdown of the nuclear industry. During the 1970s and 1980s, many utilities had committed themselves to immensely expensive nuclear plants that required a decade each to plan and build. During that period, costs leaped upward as did interest charges, exhausting and even bankrupting utilities that had once thought nuclear would be "too cheap to meter."

In terms of avoiding expensive overbuilding, alternative ways of supplying power, such as solar, wind, and efficiency investments, enjoyed an advantage. Such technologies could typically be deployed in a year or two. With such short lead times, utilities could control the amount of new capacity more precisely, raising investments during boom times and culling them during recessions.

The combination of slowing growth, new efficiency measures, and emerging renewables provided a promising pathway not just for halting the construction of new coal-fired power plants but for phasing out the existing fleet of plants. That vision was fleshed out in a detailed energy plan released by Google, Inc. Under the Google "Clean Energy 2030" plan, by 2030 the use of coal and oil would end, natural gas usage would be halved, and oil used for cars would decline by 38 percent. The plan would implement the following measures:

- End-use electrical energy efficiency improvements sufficient to reduce demand by 33 percent
- 300 gigawatts (GW) of onshore wind power
- 80 GW of offshore wind power
- 170 GW of photovoltaic power
- 80 GW of solar thermal power
- 15 GW of conventional geothermal power
- 65 GW of enhanced geothermal power

The fact that the plan was developed by one of the world's most respected high-tech companies gave it immediate credibility, as did the high-profile backing of Google CEO Eric Schmidt. On radio and television and at numerous conferences and seminars, Schmidt emphasized that Google's plan could be justified not merely for its environmental benefits but on a cost basis alone. Discussing the plant with the *Wall Street Journal*'s Alan Murray, Schmidt said, "I make the argument this way.

You've got to solve a whole bunch of problems. You've got to solve the energy-generation problem, and you've got to solve the transportation problem. So when you add it all up, if you make, in our view, the right assumptions and you invest in the right ways, you end up saving money. That's the thing that was most surprising to me. So the rough numbers are, we need about $3.5 trillion of investment over 22 years, as opposed to over three months, and we generate on a cost basis a savings of $4.4 trillion. If you invest in the right way, you can make money by doing this."

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