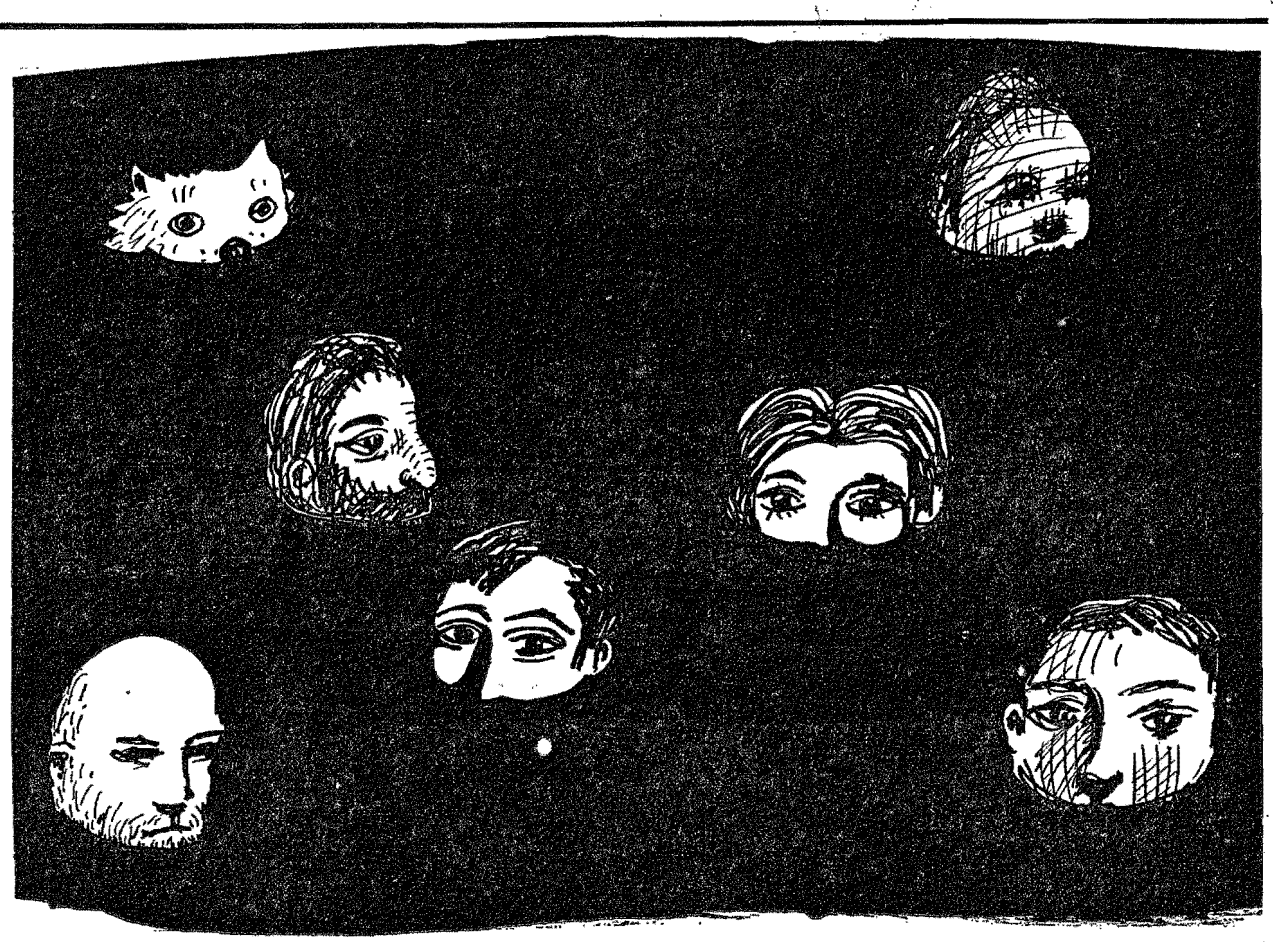
Resilience In Energy Strategy



By Amory Lovins

BRIDGTON, Me.—We have developed a society in which the basic functions of life depend on a continuous supply of electricity. In New York, traveling, going upstairs, opening doors, even waking, eating, seeing and breathing may depend on the electrical supply.

When the supply of anything—food, sewage treatment, gas, electricity—falters, even for a day, the latent brittleness of urban society becomes apparent and can even cost lives. Centralized electrification greatly magnified this brittleness and vulnerability.

Our electrical systems are so brittle because they depend on many large and precise machines rotating in an exact synchrony and the power they generate is delivered through a frail web of aerial arteries which accident, human failure or human malice can sever. Electricity cannot readily be stored in bulk—any failure is instantly disruptive. Failure also becomes less tractable on a large scale. Since 1900, the size of our generators has been doubling every six and a half years.

Of course the probabilities of failure have been calculated and electric grids are expensively designed to be very reliable. But thunderstorms do not read Federal Power Commission regulations. Consolidated Edison may have done as well as anyone could have done in delaying the inherently vulnerable grid's collapse and preventing the blackout from spreading beyond the New York area. But Con Ed's best was not good enough for ten million people.

Rare events happen. The "totalitarian law of physics" states that "whatever is not forbidden is compulsory"—that is, anything physically possible will happen sooner or later. But the possible rare events, each of vanishingly low probability, are infinitely numerous, so we live in a world full of nasty surprises.

Our survival, therefore, requires that we not only calculate the probability of failure but that we include in our design the broader philosophy of resilience in the face of the incalculable: madmen, guerrillas, Middle East wars, freak winters, earthquakes, unpredicted high-technology failures.

In the long run, the penalty for insufficient resilience is high: Billions of years of biological evolution, with resilience as the central theme, show that designs lacking in resilience were all "recalled by the Manufacturer." The Con Ed grid appears to be reliable but not resilient.

The social tensions released by the New York blackout suggest, too, that we need to worry about more than mistakes. A rifleman could do what the lightning did, deliberately making a possibility a certainty.

Further, the enormous capital intensity of electric grids places "power to the people" in the hands of a few people: As an official of the British power workers' union has remarked, "The miners brought the country to its knees in eight weeks; we could do it in eight minutes."

Thus, our man-made vulnerability can fundamentally alter the power balance between large and small groups, fostering suspicion, intolerance, paramilitarization, and abrogation of civil liberties.

Can New Yorkers, who will want electricity for a long time to come, evolve the kind of electrical system that is more resilient, less vulnerable, less susceptible to catastrophic failures than the kind they have been building?

I believe they can and that this carries a broad lesson for our energy policy: to avoid too much centralization and complexity. If we cannot afford failures on such a large scale, we should reduce the scale.

Our centralized electrical supply cannot discriminate well between users: Electricity for a water heater, which may be unaffected by a few hours' interruption, must bear the cost of the extreme reliability required for a subway or elevator.

And the grid is all-or-nothing: It *must* be so reliable *because* its failure is so catastrophic. If your oil furnace breaks down, you can go next door. But if the grid fails, there is no next door.

Last winter's gas shortages showed that relative decentralization can be more resilient: The least hard-hit region was northern New England, which distributes gas not by grid but by bottles. Not everyone ran out at once, and system-wide failures (low pressure extinguishing pilot lights, so gas had to be turned off) were impossible.

A less-centralized energy supply not only reduces civilian and military vulnerability (the latter a design criterion in Israel and China); it has other virtues not properly considered by the electric utilities.

First, its smaller scale encourages "total energy systems," which use both electricity and the waste heat from generating it, saving money and fuel.

Second, smaller power stations, less than a tenth the size of existing thousand-megawatt giants, tend nowadays to cost *less* to build and operate than big ones, because small plants take less time to build (saving interest payments, cost escalation, etc.), often run more reliably, need less back-up capacity, save the costs and losses of electrical transmission, and can often use more attractive and flexible processes.

Third, smaller plants encourage local initiative and control. They help to rebuild a sense of neighborhood and reduce political centrism, technocracy, and humiliating dependence on remote bureaucrats who can simply disconnect you.

Big plants deliver their energy to the city while inflicting their polluting side effects on rural people too weak politically to enforce environmental safeguards. With smaller plants, the same people who benefit from the energy must also live with the side effects, and have the power to insist that the local plant be clean and quiet. Europe today is proving that we know how to make it that way at reasonable cost, actually reducing total pollution while saving money and jobs.

Local plants can benefit from the existing national grid, but, when it fails, can decouple from it and continue to serve their communities rather than be dragged down by it. Thus, while a recent strike disabled much of the Finnish grid, the district-heating power station in Jyvaskyla kept supplying the city, avoiding so many factory layoffs that it repaid its capital cost immediately.

New York City hospitals, to their credit, reported no blackout-induced deaths because most of them had working back-up generators; but if properly designed, those systems could run routinely, as in many large buildings abroad.

Vulnerability could be dramatically reduced, too, by using energy far more efficiently. Good architecture would have eliminated the peak air-conditioning load that made Con Ed unable to cope with the line failures.

The unavoidably high price of electricity—equivalent to about $120 per barrel of oil in New York City—gives us the strong incentive to use this special, vulnerable, high-quality form of energy only for the roughly 8 percent of all end uses that can exploit its quality to advantage and so give us our money's worth out of it.

Meeting our dominant end-use needs—58 percent heat and 34 percent liquid fuels—directly with other forms of energy would make energy storage easier and interruption less likely, besides saving money and fuel.

A truly resilient energy strategy would use fossil fuels far more efficiently to tide us over while we rapidly deploy diverse, relatively simple, renewable sources of energy that are matched in scale and in energy quality to the tasks at hand.

We could run the United States just on appropriate, renewable energy technologies that are already proved, practical in New York conditions, and cheaper than their nuclear or long-run fossil-fuel competitors.

Using such "soft" energy sources as solar energy, and the conversion of farm and forest waste to fuel alcohol for transport, would cost us less—in money, delay, risk, pollution, nuclear proliferation, inequity, unemployment, inflation, and political nastiness—than if we tried instead to keep on centralizing, electrifying and substituting technological brute force for brains.

Living on our many forms of solar income would give us an energy system essentially invulnerable to cartels, mistakes, oiligopolies, unions, saboteurs, bureaucrats, acts of God, and Acts of Congress.

A transition to a benign, resilient, and sustainable energy system will take a long time—perhaps 50 years—but if we do not start soon, the option will slip away, foreclosed by other commitments.

The alternative—the ever-more-electrified, centralized, large-scale and vulnerable system that we have been unthinkingly weaving into our lives—would insure ever larger, more frequent, and less reparable failures.

That choice is framed for us by the New York blackout. If we see the blackout as a sort of warning "heart attack," signaling the need to reexamine our approach to the energy problem and the myriad other problems intertwined with it, then we may live to be grateful for the shock.

Amory Lovins, a consultant physicist who works in London for Friends of the Earth, is author of "Soft Energy Paths: Toward a Durable Peace."