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# Does a Big Economy Need Big Power Plants? A Guest Post

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**Amory B. Lovins** is the energy maven's energy maven, viewed variously as a visionary or a heretic in his assessments of how the U.S. and the world should be generating and using energy. More specifically, he is the chairman and chief scientist at the Rocky Mountain Institute, a man who has won many awards, written many books, and, as if that weren't enough, was a fan favorite for Energy Secretary when we asked blog readers a few months ago to give incoming President **Obama** some advice.

Lovins has written a guest post for us today, which I am guessing that everyone who cares about energy will find instructive in one way or another. It is especially interesting in light of forward-looking projects like this one about battery-exchange stations for electric cars — for as eager as we may be to wean ourselves from oil, it's worth remembering that all that newly-demanded electricity doesn't grow on trees.

Photo: Lady_lbrty

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If I told you, "Many people need computing services, so we'd better build more mainframe computer centers where you can come run your computing task," you'd probably reply, "We did that in the 1960's, but now we use networked PC's." Or if I said, "Many people make phone calls, so we'd better build more big telephone exchanges full of relays and copper wires," you'd exclaim, "Where have you been? We use distributed packet-switching."

Yet if I said, "Many people need to run lights and motors, Wii's, and air conditioners, so we'd better build more giant power plants," you'd probably say, "Of course! That's the only way to power America."

Thermal power stations burn fuel or fission atoms to boil water to turn turbines that spin generators, making 92 percent of U.S. electricity. Over a century, local combined-heat-and-power plants serving neighborhoods evolved into huge, remote, electricity-only generators serving whole regions. Electrons were dispatched hundreds of miles from central stations to dispersed users through a grid that the National Academy of Engineering ranked as its profession's greatest achievement of the 20th century.

This evolution made sense at first, because power stations were costlier and less reliable than the grid, so by backing each other up through the grid and melding customers' diverse loads, they could save capacity and achieve reliability. But these assumptions have reversed: central thermal power plants now cost *less* than the grid, and are so reliable that about 98 percent to 99 percent of all power failures originate in the grid. Thus the original architecture is raising, not lowering, costs and failure rates: cheap and reliable power must now be made at or near customers.

"Central thermal stations have become like Victorian steam locomotives: magnificent technological achievements that served us well until something better came along."

Power plants also got irrationally big, upwards of a million kilowatts. Buildings use about 70 percent of U.S. electricity, but three-fourths of residential and commercial customers use no more than 1.5 and 12 average kilowatts respectively. Resources better matched to the kilowatt scale of most customers' needs, or to the tens-of-thousands-of-kilowatts scale of typical distribution substations, or to an intermediate "microgrid" scale, actually offer 207 hidden economic advantages over the giant plants. These "distributed benefits" often boost economic value by about tenfold. The biggest come from financial economics: for example, small, fast, modular units are less risky to build than big, slow, lumpy ones, and renewable energy sources avoid the risks of volatile fuel prices. Moreover, a diversified portfolio of many small, distributed units can be more reliable than a few big units.

Bigger power plants' hoped-for economies of scale were overwhelmed by diseconomies of scale. Central thermal power plants stopped getting more efficient in the 1960's, bigger in the 1970's, cheaper in the 1980's, and bought in the 1990's. Smaller units offered greater economies from mass production than big ones could gain through unit size. In the 1990's, the cost differences between giant nuclear plants — gigantism's last gasp — and railcar-deliverable, combined-cycle, gas-fired plants derived from mass-produced aircraft engines, created political stresses that drove the restructuring of the utility industry.

Meanwhile, generators thousands or tens of thousands of times smaller — microturbines, solar cells, fuel cells, wind turbines — started to become serious competitors, often enabled by IT and telecoms. The restructured industry exposed previously sheltered power-plant builders to brutal market discipline. Competition from a swarm of smaller electrical sources and savings created financial risks far beyond the capital markets' appetite. Moreover, the 2008 Defense Science Board report "More Fight, Less Fuel" advised U.S. military bases to make their own power onsite, preferably from renewables, because the grid is vulnerable to long and vast disruptions.

Big thermal plants' disappointing cost, efficiency, risk, and reliability were leading their orders to collapse even before restructuring began to create new market entrants, unbundled prices, and increased opportunities for competition at all scales. By now, the world is shifting decisively to "micropower" — *The Economist*'s term for cogeneration (making electricity and useful heat together in factories or buildings) plus renewables (except big hydroelectric dams).

The U.S. lags with only about 6 percent micropower: its special rules favor incumbents and gigantism. Yet micropower provides from one-sixth to more than half of all electricity in a dozen other industrial countries. Micropower in 2006 (the last full data available) delivered a sixth of the world's total electricity (more than nuclear power) and a third of the world's new electricity. Micropower plus "negawatts" — electricity saved by more efficient or timely use — now provide upwards of half the world's new electrical services. The supposedly indispensable central thermal plants provide only the minority, because they cost too much and bear too much financial risk to win much private investment, whereas distributed renewables got $91 billion of new private capital in 2007 alone. Collapsed capital markets now make giant projects even more unfinanceable, favoring lower-financial-risk granular projects even more.

In short, many, even most, new generating units in competitive market economies have already shifted from the million-kilowatt scale of the 1980's to the hundredfold-smaller scale that prevailed in the 1940's. Even more radical decentralization, all the way to customers' kilowatt scale (prevalent in and before the 1920's), is rapidly emerging and may prove even more beneficial, especially if its control intelligence becomes distributed too.

Global competition between big and small plants is turning into a rout. In 2006, nuclear power worldwide added 1.44 billion watts (about one big reactor's worth) of capacity — more than all of it from uprating old units, since retirements exceeded additions. But that was less capacity than photovoltaics (solar cells) added in 2006, or a tenth what windpower added, or 2.5 percent to 3 percent of what micropower added. China's nuclear program, the world's most ambitious, achieved one-seventh the capacity of its distributed renewable capacity and grew one-seventh as fast. In 2007, the U.S., Spain, and China each added more wind capacity than the world added nuclear capacity, and the U.S. added more wind capacity than it added coal-fired capacity during 2003 to 2007 inclusive.

What part of this story does anyone who takes markets seriously not understand? Central thermal stations have become like Victorian steam locomotives: magnificent technological achievements that served us well until something better came along. When today's billion-watt, multi-billion-dollar plants retire, we won't replace them with more of the same. I'm already experiencing a whiff of prenostalgia.

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